



Terrain Portrayal for Synthetic Vision Systems Head-Down Displays Evaluation Results

Compilation of Pilot Transcripts

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Introduction

The focus of the Synthetic Vision Systems General Aviation (SVS-GA) element of the National Aeronautics and Space Administration's (NASA's) Aviation Safety and Security Program (AvSSP) was to develop technology to help eliminate low visibility induced general aviation (GA) accidents through the application of synthetic vision techniques. SVS displays present computer generated three-dimensional imagery of the surrounding terrain to greatly enhance pilot's situation awareness (SA), potentially reducing or eliminating controlled flight into terrain (CFIT), as well as low-visibility loss of control (LVLOC) accidents.

A critical component of SVS displays is the appropriate presentation of terrain to the pilot. At the time of this study, the relationship between the complexity of the terrain presentation and resulting enhancements of pilot SA and pilot performance had been largely undefined. The terrain portrayal for SVS head-down displays (TP-HDD) simulation examined the effects of two primary elements of terrain portrayal on the primary flight display (PFD): variations of digital elevation model (DEM) resolution and terrain texturing. Variations in DEM resolution ranged from sparsely spaced (30 arc-sec) to very closely spaced data (1 arc-sec). Variations in texture involved three primary methods: constant color, elevation-based generic, and photo-realistic, along with a secondary depth cue enhancer in the form of a fishnet grid overlay.

The TP-HDD simulation experiment addressed multiple objectives involving twelve display concepts (two baseline concepts without terrain and ten SVS variations), four evaluation maneuvers (two en route and one approach maneuver, plus a rare-event scenario), and three pilot group classifications. The TP-HDD simulation was conducted in the NASA Langley Research Center's (LaRC's) General Aviation WorkStation (GAWS) facility. The results from this simulation establish the relationship between terrain portrayal fidelity and pilot situation awareness, workload, stress, and performance and are published in the NASA TP entitled *Terrain Portrayal for Synthetic Vision Systems Head-Down Displays Evaluation Results*.

Compilation of Pilot Comments

This is a collection of pilot comments during each run of the Terrain Portrayal for Synthetic Vision Head-Down Displays simulation. These comments are not the full transcripts, but a condensed version where only the salient remarks that applied to the scenario, the maneuver, or the actual research itself were compiled. Text in parentheses denotes the experimental systems operator's or principal investigator's comments; text in italics represents observations made by the author; general text indicates comments made by the subject pilots.

Legend: CC = Constant Color, EBG = Elevation-Based Generic, PR = Photo Realistic, FN = Fish Net, BSBG = Blue Sky/Brown Ground, BRD = Baseline Round Dials, Baseline = BL, DEM = Digital elevation model, FOV = Field of View, HWY = highway, ILS = Instrument Landing System, OTW = out the window, RWY = runway, SA = situation awareness, SW = software, S&L = straight and level, VV = velocity vector.

Subject 1 (Blue Sky / Brown Ground (BSBG) Baseline):

Audio recording was inoperable on the date of this subject's participation. These data are not actual transcripts, but notes that the principal investigator took real-time during the experiment.

Block 1, High Altitude:

Principal investigator's notes are missing for this block.

Block 2, Low Altitude:

BSBG BL: No comments on the first run of this block.

EBGFN3: Would be nice to have a power meter. Fishnet kind of useful down here at this altitude. Things are getting easier because he's learning how to do things.

PRFN30: Fishnet is more useful for PR than for EBG.

CCFN1: Don't like CC at all. FN is not very useful.

PR1: PR is better at a lower alt, but still not better than EBG.

EBGFN1: No comments.

PRFN3: FN is better here. Still like EBG better. Still like 60FOV. Haven't found much use for 30 or Unity FOV. Preference does not change WRT terrain displays.

CCFN30: FN implies a greater resolution than the DEM. Has a problem with this. CC doesn't provide much info. Doesn't feel FN is providing adequate information, it's way too coarse. More of a distraction.

EBGFN30: Terrain looks flatter, but his sense of proximity to terrain is consistent with that of the other displays. 30DEM here isn't too bad. Still not used to the orientation of the roll pointer.

PRFN1: Isn't too bad. Likes it better with FN than without. FN benefits PR more than EBG. Still likes EBG better.

EBG1: He feels that he's starting to get a mild fatigue effect, so performance is affected, but not by much.

Block 3, Approach:

PRFN1: Presence of tunnel takes away from terrain. Competing with each other. Gets a sense of terrain w/PR1. Not overwhelming. Presence of tunnel really reduces workload. Stopped early due to software crash.

PRFN1: Had to rerun, because memory error occurred at 2000MSL (700ft above stop point). See smokestacks on left on display, but not OTW. Happy with 30deg FOV, since terrain clearance isn't an issue. However, objects of interest are already off of the display. In terms of sensitivity, likes it, though. Wants to fly low in this tunnel - maybe by 1/2 dot.

CCFN30: His least favorite. Display looks like farmland, compared to the terrain out the window. Terrain really isn't doing him any good. However, the tunnel gives him the reassurance that he's where he need to be. Certainly no worse, but no better, than what is currently in place.

EBGFN3: Definitely more awareness of terrain with this concept. Tunnel bank tends to provoke pilot to cut the turn (suggests larger bank than needed). Slight split between center of tunnel and center of glide slope beam. Seems like the center of the tunnel is below the center of the glide slope. Terrain awareness was pretty good this time.

BSBG BL: Presence of fishnet attempts to indicate the level of terrain. MX20 provides some blocking information. Misses cultural feature data. Cartoonish perspective. Experiencing higher workload. Missed having a runway target with this concept.

PR1: Prefers 60FOV for the turn. The dogbones go completely off scale in the turn, when it looks like on the display that you are fine. Thinks there is a bug in the system. Looks pretty much like OTW. Doesn't think it's as good as EBG, because of the shadow cues in EBG. Gets a reasonable feel for terrain. Likes presence of terrain over the BL, and he likes seeing the RWY.

EBG1: Good sense of terrain. If he lost an engine, can pick out where peaks are.

EBGFN30: Certainly better than CCFN30. No doubt that there are mountains out there. Doesn't look as low as he really is - it has flattened out. Dogbone more sensitive in turn. Terrain resolution not as good as the high resolution stuff. Not as misleading as the CC stuff, though. Tunnel makes things so much nicer. This is how he wants his checkride to go. Everything is red on the MX20, but still 300 ft AGL. Could work less and get sloppier and still meet requirements, because he is getting used to things.

CCFN30NT: Working a bit harder without the tunnel. Would like to have commanded track. Would normally have on most displays. It seems to be following him wherever he goes. Easier to fly glide slope without the dogbones. The dogbones clutter display. Would like option to turn databases off. Terrain awareness is absent, assuming guidance cues keep him out of trouble. Performance may have gone up.

EBGFN1: I like this mode. FN helps down low like this. Better sense of rush cues and distance cues. Like overall configuration in general. 30FOV - likes sensitivity in close, but w/crosswind, makes it a little harder to scan - has to go back and forth a lot. Smokestacks are really close on final.

CCFN1: FN is washing out - not getting a good sense of terrain. Knows that he starts pretty close to terrain, but doesn't get a sense of that in this terrain. Pretty good upsets here from turbulence. Only advantage to this over BL is the obstacles, but the terrain info is nil. Run ended at 1300' instead of 1380'.

PRFN30: Very little terrain information in this display. First tunnel box seems to indicate start of turn. Vertical tunnel guidance seemed to indicate flying out of the tunnel for the first two or so tunnel boxes.

PRFN3: Largely no terrain info, even with the 3 DEM, I don't get a feel for the ridgeline. Tunnel takes on gargantuan size at FOV30, doesn't really like.

CCFN1: Noticed terrain above the horizon at 3:30. Felt that since he did notice the terrain, then his terrain awareness on the SART was actually pretty good.

Subject 2 (BSBG Baseline):

Audio recording was inoperable on the date of this subject's participation. These data are not actual transcripts, but notes that the principal investigator took real-time during the experiment.

Block 1, High Altitude:

EBG1: Likes view of terrain. Sees mountain very well. Likes 90FOV better. Very good SA. Missed turn - had to be prompted.

PRFN3: Likes terrain. Very realistic. Harder to decipher the hills this time. Can't tell that it's really a hill. Didn't pick up on the turn point again.

EBGFN1: Doesn't like Unity FOV. Throws him off. Likes the "compass card" - the artificial horizon heading line. It's all right there for him to use. Likes terrain view. FOV90 is very nice to see the mountain. Gives depth perception that the others don't necessarily give. Didn't feel like he kept up with airspeed very well. He did have trouble maintaining 100kts, but we felt it was desired for 90% of the time.

BSBG BL: As far as terrain goes, does not like this screen. Using more of the gages, than anything else. Actually, a little less distracting, helps him focus in on the gages. But, can not tell where any mountains are. If were in the mountains, would not be able to tell. He would be relying solely on altitude. He has no idea of what the terrain is, unless he would have looked at a map before-hand. Had a memory SW crash, 20 seconds before normal end. Would like to have the ability to cycle between terrain and baseline display.

CCFN1: Would be nice to see numbers on heading line, even when VV precludes it. Has no idea where the terrain is, unless he's looking at the window. Focusing on the VV because a lot of info that he needs is right in the cluster, like the rudder cue. Can't tell that there are hills at all, even with the FN. He doesn't like it. If anything, this terrain is almost distracting. Grid was a distraction more than anything else. Didn't like terrain depiction.

PRFN30: Couldn't really tell depth perception. FN was very distracting. Forgets to look at waypoint. Never flown in IFR conditions, so takes a little more concentration so forgets to look at MX20.

EBGFN30: View is very nice with FOV90. Cannot tell presence of fishnet. Like to look over the map. (Map compelling.) Can tell terrain pretty well in this one. Can't tell anything with Unity. 90 gives most information.

EBGFN3: Unity is a little harder to control. Terrain is quite nice, not too distracting. This one, he tends to be looking at the ground more often. But, if he changes it to Unity, then he can just concentrate on symbology. Without reference to ground, though, in turn it's a little tougher. With ground ref, it's easier to make turn. Barely sees grid, not distracting at all. Gets good ground following with this display. FN makes no difference on this display.

PR1: Can definitely tell exactly what terrain is. Looking at display is almost like looking at the window. Unity seems a little touchy. Like the terrain. Exactly what is outside. Prefer the PR more than the rest. More realistic: Good SA, horizon line, etc. Want to see numbers behind airplane on the horizon line.

PRFN1: First comment, before run started - almost like a gold shot, the more you do it, the easier it is. He is flying his heading off of the horizon line. Unity allows him to zero in on the horizon

line, but it's too touchy for the turn. Lines are distracting, and don't give much cue for elevation. Flying straight, likes Unity to help him flying S&L. Likes PR1 without FN a whole lot better. The FN is very annoying and distracting.

CCFN30: Notices River. Wasn't sure that was what it is, but noticed it. Brightness of red is very distracting. There are markings on the red portion that he can't tell what they are. What he saw from previous displays he thinks some of them are towers. Is flying by gages instead of ground references, so likes Unity. FN and ground color both distracting.

Block 2, Low Altitude:

PRFN1: Fishnet is a distraction. Prefer the screen over the others but not the fishnet. Like the turning application for this concept. FN is very distracting.

PRFN3: FOV30 preferred for S&L. Likes it for the turn, also. Markings for VSI is a little more controllable. FN - doesn't really give him any information as far as elevation goes. Can definitely see the terrain in this texture. Resolution was really good.

EBGFN30: Can barely see the FN, so is not even a problem. Can see the river in this display. Can actually tell shadows and terrain. Really likes this display. Does not like FN. Sees tower. Lines are distracting.

EBG1: Really likes this screen. Can tell heights and everything with this one. Just really looks good. Really can pick the mountains out. Can tell that there is a valley ahead, in case he has an engine out would know where to go. Rerun because had a SW crash. Making turn with 30FOV, because he can dial in gages. Terrain looks great. In the valley ahead, was able to pick out RWY. Really likes this terrain.

PR1: Extremely realistic - exactly what he's looking at OTW. Even color-wise. Once he gets into the soup, likes to see the ground, actual valleys, etc. Likes 90FOV because it shows him exactly where he is on the mountain. FOV90 gives him a lot of information. Can see rivers and everything quite easily. Likes this and the EBG. This one may be just a touch better, due to the fact that it's not as colorful. FOV90 with this terrain was good. The EBG, he liked the FOV a step closer.

EBGFN1: This screen allows him to see what he saw beforehand. FN is very light. Not as distracting as in the PR display (I think that is what he was referring to. After turn, he feels that he can really see FN, and it definitely takes away from depth perception. Hard to find tower on display. OTW the towers look a whole lot closer. This run ended at about 4:40, due to software glitch. Does not like FN at all. Get rid of it.

BSBG BL: FOV60 on this particular display. Likes the scale to be there in this display. Has no clue where land is, strictly flying by instruments. No idea what terrain was. FOV of Unity and 30 was hard to "keep up with".

CCFN1: Likes FOV60. The FN actually gives him a little bit of terrain, but not much, as far as height goes. And, he can see the river - the only good terrain depiction there is in this concept. Can barely pick out terrain in this one. Relying on instruments. When he made the turn and descended, he could see terrain a little better. Can definitely see the towers now. Can't hear RPM changes in the engine sound. He's trying to listen for that. FN helped that color background on that display, but still did not help you know where the terrain was at all.

EBGFN3: Resolution fuzzy, but likes this display. Still shows mountain pretty well, but the FN is still annoying. The shadows really helps him determine height (contours and relief). Good as far as terrain goes, but lines were distracting, and the resolution was a little fuzzy, causing some extra thought to be put into the run.

PRFN30: FN almost looks like power lines above the mountains. Likes this one, but the resolution is a little fuzzy. He feels that grid takes away from contours. Can see the contours in the actual terrain, but the grid takes away from that. With grid, it's hard to tell will top of the mountain is. On FOV90, can see the top of the mountain better. Little bit of fuzziness in the picture itself, and the grids are still very annoying (hasn't changed).

CCFN30: With the CC, finds that the FN enhances the terrain, a little bit. With the FOVs smaller, he finds himself chasing the numbers a little more. But, once he gets lined up, may be a little more precise. Since not much to take in as far as terrain, he thinks he prefers the smaller FOV (30). This FOV is a little more precise, forcing him to fly better. FN (right down there at the bottom of screen right after turn) allows him to actually see the mountain - would not have seen without the FN.

Block 3, Approach:

PRFN1: Can see terrain fairly well. Adjusting to different FOV is hard. Right now FN not even coming into play. Blurry land is an extreme distraction. City looking white. Also, he missed one box during turn, but since performance is based on 90% of the time, still gave him "desired". Also, had a little trouble distinguishing what the error duration was for flight path and Loc/GS.

CCFN30NT: Likes the fact that the red is behind him. Had a lot of trouble flying this approach without the tunnel. FN is real hard to tell distance to the ground, without looking out the window. Because of terrain, not necessarily the tunnel. Without the tunnel, can still use Loc/GS. This terrain doesn't give him any information.

PRFN30: Tunnel does put highway right in the sky. Gives you something to shoot at, more so than the terrain itself. FN with the city is still annoying. Due to the FN, and when finally saw RWY OTW, could see low, but couldn't tell that it was low on display.

EBGFN3: Definitely has a better feeling for terrain on this one. FN is distracting.

CCFN30: Terrain has no clue on depth perception. FOV90 definitely helps in the turn. Had a shaky start at the beginning, but got it under wraps at the end. Desired, but based on color of ground. Distracting, couldn't really tell where ground was. Tunnel was saving grace on this one. FOV90 was good for turning. Sensitivity of the Unity is needed on final, in close.

EBGFN1: Likes resolution, and more boxes (FOV90) also. FN still has to go. Can see terrain very well, but FN is distracting. FN is confused with HWY/rivers. Closer to airport, still like tunnels (middle marker) closer together. Can see towers pretty easily. 5 seconds after middle marker, starts flying visually to threshold. Deals with transition at that point.

CCFN1: Can see mountain out if front of him, but has not clue with the terrain. FN on this gives a little bit of terrain bumpiness, but still can't tell much from it. Could pick out river, but thought it was a HWY. Very hard to determine performance on this one. He forgot to use FOV90 during turn, so made an extremely shallow turn. Had a hard time at the beginning. Gave him desired, because it was very borderline. Terrain color, didn't give him any information at all.

PR1: Perfect terrain awareness. just as if looking OTW. Find that he likes the left side of the tunnel. City looks just like a city does. Very realistic. See towers coming up. Looks good. Can see what appears to be a HWY. Got confused on the GS - instead of following diamonds, went away from them. Confusion with which way to go on the GS. No distractions, terrain awareness was right there.

BSBG BL: Have no idea where terrain is, just flying the tunnel. Using MX20 for tower info. The bits that he can see OTW and using the MX20 is the only terrain info he has. Noticed the terrain warning on MX20. Did not know where the terrain was on SVS, but saw MX20 was red.

PRFN3: FN takes away from mountain. Also takes away from knowing what's on the ground. FOV90 gives boxes close in to each other, and works well. Gives more of a tunnel to fly through. Looking at this display, not even bothered by looking OTW. City is a bit blurry, and causes a bit of distraction. Blurriness is a big factor, and FN (which is a given).

EBGFN30: FN is "terrible". But really likes this terrain. Can see towers. On flatter spot, don't really have an idea of the terrain. Saw series of lines below, but wasn't sure if they were highways. See city OTW, but does not see on the display. See RWY quite easily, and like FOV60 at the end. Based on FN, fuzziness, and doesn't depict city. Takes away from some of the awareness without having the city on the display. Not having been there, it would be nice to see.

EBG1: This is one of his favorites. Terrain is unbelievable - identical to what he's seeing OTW. Not distracting. FN was very. Here can pick out the roads/rivers. Would not have seen it that soon had there been a FN. Can see the mountain coming up on left, the valley in front, and the towers coming up on the left. Free of distractions, can concentrate on what he's doing, no where he is, he's very very comfortable. Doesn't see city. Most comfortable one, yet. Is a little low on GS every time.

Rare Event:

PRFN3: Terrain looks good. Identical to what he's seeing outside, except for the FN. Can see terrain quite well. Flying with FOV90. Changed to 60 in the turn. Sees mountain range in front of him. "Terrain looks pretty doggone close." Between 3:45 and 4:00 noticed that terrain was too close.

Subject 3 (BSBG Baseline):

Block 1, High Altitude:

EBGFN1: *Subject pilot needed to be prompted to turn and descend, and didn't descend to the target altitude.* It's kind of sluggish. I was trying to descend, but I made some boo-boos. The controls felt different than they did when we were doing it during training. So I was just trying to get used to the controls. And then it's like, it's not descending as it was earlier, so I was trying to descend as I was turning, and it was like – I just wasn't getting the responses because just a minor movement and it'd take off running, versus before when I made a minor movement it responded immediately, so – I know you were telling me be prepared for high-altitude to be a little different. (You held your speed great at the beginning. You did great on keeping your speed up, and that's what a lot of people have trouble with is keeping their speed up.) I think I was focusing more on the speed than I was altitude. If I had practiced that higher scenario, the high-altitude scenario... (It would have helped you a little bit?) I think so. That's just my opinion. I would have like to have practiced at high-altitude. SVS display characteristics – okay, based on my interpretation of what happened I ranked it as a nine because intense pilot compensation is required to maintain control, but I want to make sure – with mitigating circumstance – I want to make sure I'm ranking this properly, because I didn't find anything necessarily wrong with the display. It was

just my adjustment to the display under those conditions. (That's correct. We understand that and we understand that – we are taking your suggestion into consideration about training on the high-altitude scenario.)

CCFN1: Ah, come on. (Did a lot better this time, so you can rank it assuming an adequate performance.) I marked it as a six. Very objectionable but tolerable differences. Adequate performance requires extensive pilot compensation. Again, I'm speaking of myself, I'm – maybe I take a little bit longer than most people to make adjustments to the electronic display system. I'm more familiar with the analog dials. So I'm still converting information as we go along here. (Okay, so that rating's pretty much based on your familiarization of the system?) That's what I believe. Because I think if I had more time to practice on just using the electronic display I think I could make the adjustments a lot quicker. It was hard to depict the fishnet. I don't know because of the resolution, but it was very faint, so it was almost nonexistent.

PRFN30: (How's that picture look to you?) It's not bad. The outside is gone. (How did you like that display: the photo realistic, fishnet, 30?) I thought it was pretty good. It's something I would like to rely on, because once the conditions for VFR to IFR, I still was able to use that – use the display – as a reference as to what it looked like outside. (Could you see the fishnet fairly well?) Yes. (Do you think that would give you some elevation-based cues, or that it didn't give you any benefit?) There is some question about the fishnet itself. As the elevation increases, if it increases steeply versus increasing gradually, the fishnet itself will rise and – in proportion to the gradient, correct? (Yes.) Okay. Just from looking at it I could tell briefly that, okay, some hills are a lot steeper than others. Some were more gradual. But that's about as much as I got out of it. (You stayed within the PTS, the pilot test standards, the entire time.) I ranked this one as fair: some mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance. Taking into account the view I guess it was a matter of making – when I switch from one field of view to the other is when I notice I appear to be looking close to where I should be on one field of view and I switch to another it appeared to be a lot further off. So that's the reason I chose that.

EBGFN3: Yeah, I can barely see the fishnet, but I can see the terrain features very nicely. It's a very nice display. It gives me an idea exactly what I'm looking at, or what I should see. I can pick out the hills and the valleys very easily. The green and the brown sticks out like – very good contrast. I can tell – I can see the rising terrain versus the valleys, but the fishnet's not making that big of a difference to me right now. But if the fishnet's were up a little higher I could pick them out... The intensity on them. I marked it as a two. And the reason why was because the display was quite excellent. I could really pick out the valleys versus the peaks; however, if we were supposed to be using the fishnet as a reference, I didn't really use it that much because it was so faint that it really didn't stand out to make a difference. And at that particular point if it did I'm not sure if I would have used it because the realistic view on the display here was enough for me to use as the kind of cues that I was looking for.

EBG1: We lost visibility outside. Okay, this display at the setting it is right now I can see the images close up fairly well. I can make out the differences between the peaks and the valleys very well, the brown and the green. However, it would help me out knowing which one I was using, the 30 or the 60 (FOV). (Currently you're using the 60.) Looks pretty good. It's almost as clear as if I was looking at it right outside my window. (Do you miss the fishnet at all?) No. Not really. I don't think the fishnet was making that big of a difference to me. The images that stick out the most were the hills and the valleys. The contrast: the dark versus the light. The light highlights on the top of the ridges. I marked this as a number three. I felt that the simulation was excellent, so should I mark that as a one? But I'm also judging my performance as well. (So the

only reason why you chose three over one is because that you feel your performance was a little off?) Correct. (But in general you felt – on this one if you could go ahead and just rank the system.) Okay. The system would get a one. And when the outside references went away, of course the only thing you have was the display, which was excellent.

PRFN3: Okay, outside is gone. Turn left. I overshot. Okay, I can see the fishnet better on this one. (Is it giving you any extra cues?) Stand by, please. Okay, in this FOV I can tell a lot better than I could in the other ones and (That's 90, just so you know.) *Computer crashed at the end of the run.* Okay I marked this one as number two, which is good. Negligible differences; pilot compensations not a factor for desired performance. The fishnet was there, but they weren't really being utilized for elevation purposes, or from distances from one point to the other. Basically I was looking at the difference in the contrast between the high elevations and the lower elevations. The different colors, and that's what I was using more than anything else. That's what stood out and captured my attention.

EBGFN30: The display is fine. The highlights show the peaks very nicely. The highlights the higher the peaks are in relation to those surrounding. (Fishnet of any value?) I'm not really using the fishnet. It's the dark green versus the brown versus the lighter brown. The lighter the brown, the higher the peak is. And the reason why is the fishnet was again not a primary factor in my decision-making. I was using mostly the different contrast in the colors as to my terrain and the field of view. (Okay, so basically pilot compensation not a factor for desired?) Yes, sir.

PRFN1: Okay, outside looks like inside, and inside looks like outside. Other than I can get a more accurate picture of what's beyond the further out from the inside. The outside's gone. I can see the fishnet fairly well. Okay. I can see the contrast very nicely on the display, but the fishnet sticks out but I'm not really using it as a – well, yes I am. I can tell the difference. It helps on the contrast. I can pick out a peak a lot easier than I could without it. (You can pick it easier with the fishnet?) Yes, I can see a peak as it rolls over the top of a hill. (We noticed you cycling through the field of view. Do you have any preferences on what you've observed?) I like this view that I'm in right now. Yeah, I like this one a lot better. Okay. I just wanted to make sure I'm doing this correctly again. I'm evaluating the system itself, not my performance, correct? (That's correct. You're evaluating the entire system from the standpoint that you're a test pilot now for this system.) Okay, well, I marked that as a one: excellent, highly desirable. Pilot compensation not a factor for desired performance. Okay. Pilot decisions. Is it tolerable? I put yes. Is an adequate performance attainable with tolerable workload? I put yes. Satisfactory without improvement? I said yes and I marked that for SVS display characteristics as excellent, highly desirable. Demand on the pilot is (unintelligible) task. Pilot compensation not a factor for desired performance.

PR1: Okay, the display view is a lot crisper than what I'm seeing outside. It's like I'm coming into weather on the outside and lose my vision cues out there whereas I can still see very clearly on the inside. Turning left. (What are your preferences when you went through that range of field of view?) I like this view right here (FOV60). This particular view it seems like it gives me a crisper picture. A wider field of view as to what's further out in front of me and I can see it seems like it's sharper – the images are sharper what's right in front of me. Okay, pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. So I marked that as a good. Number two. Negligible deficiencies. Pilot compensation not a factor for desired performance.

CCFN30: Okay, looking outside and looking inside I can tell that this is – well, looking outside I can see it's relatively minor hills compared to some steeper hills that I've seen previously, but it

doesn't quite depict that as sharply as the color pictures were – as the previous displays. The outside is gone. Okay, turn left. Okay, it's hard to depict the terrain. The closer it is to the aircraft, the easier it is to see, but the further out is not as easy. In this case the fishnet does make a difference. (Overshot target altitude by 800 ft.) Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? I put yes. Is it satisfactory without improvement? I said no, deficiencies warrants it. And I marked this as a six: very objectionable but tolerable deficiencies. Demand on pilot in selected task: adequate performance requires excessive pilot compensation.

BSBG BL: Okay, I don't have any visual cues outside. Go ahead and turn left. Come on. Okay, sir, pilot decisions. Is it controllable? I said yes. Is adequate performance attainable with a tolerable workload? I would say yes. Is it satisfactory without improvement? I would say no; deficiencies warrant improvement. SVS display characteristics I would mark it as a four: minor but annoying differences. Demand on pilot in selected task: desired performance requires moderate pilot compensation not a factor for desired performance. The answer would be a four.

Block 2, Low Altitude:

EBGFN3: I can see the highlights of the terrain very easily. (How's the fishnet helping you out?) I can see the fishnet very easily, but it's requiring me a lot to process what I'm going to use it for other than a peak and a valley. Just to try to figure out – okay, because the further out it is, the harder it is for me to tell exactly how far out it is. (If you wouldn't mind just scrolling through the fields of view right now and let me know if you have any comments on the field of view choice. You stayed on the 60 while you were flying. I don't know if that's a preference or if that's because you may have not remembered to scroll through.) I was going to wait until I got lined up a little bit better and stabilized to scroll through it because for me it would have created probably a problem distracting me. You could see the fishnet closer to the nose of the aircraft than you could further out and trying to determine how far like the towers were that I was approaching – I couldn't tell how far out they were if I was trying to use the fishnet, and then I had to process that information, okay? Is that one block or two blocks or three blocks, for example?

CCFN1: Comparing it to what I'm seeing outside and I can tell that it's corresponding with what I see outside. However, it's very hard to distinguish the terrain that's well ahead of me. Okay, now I've lost my outside visual. Turning left. Okay. I can make out the definite difference in the horizon and the ground; however, the other distinguishing factors are not there that I was accustomed to seeing, compared to the other displays. I can make out the hills and the valleys. The fishnet is definitely helping in this scenario. Okay, for that scenario I rated the pilot decisions. Is it controllable? I would say yes. Is adequate performance attainable with a tolerable workload? I would say yes. Is it satisfactory without improvement? I would say no. Deficiencies warrant improvement. I marked that particular scenario as a four. SVS display characteristics is a minor but annoying deficiencies. Demand on the pilot in selected task. Desired performance requires moderate pilot compensation. I selected four because I was using it in comparison to the terrain that I viewed with the other displays. This particular one took more work to determine what was a hill and what was a valley. But the fishnets definitely helped in that particular scenario to determine which was which. But it just required more work versus me just looking at something and automatically processing it.

PRFN30: Okay, the terrain outside looks just like what it looks on the inside. It makes it very easy to take a look at where you're at in relation to where you think you should be. Okay, just lost outside. Okay, coming up on my point. Turning left. Okay, I'm not able to pick out the hills and the valleys as sharply out far ahead as I am with the other resolutions, but as it gets close to

the nose of the aircraft it makes sense. (Below altitude for more than 10% of the time.) Pilot decisions. Is it controllable? I would say yes. Is adequate performance attainable with a tolerable workload? I put no. Deficiencies require improvement. I selected number seven. I'm sorry – yes, number seven. SVS display characteristics major deficiencies. Adequate performance not attainable with maximum tolerable pilot compensation. Controllable not in question. Controllability not in question. And I marked number seven. The reason why I did that was I got distracted by trying to focus on what the gridlines were telling me in the fishnet and instead of watching my instruments. So I think I was taking in too much information, processing it, and not flying the aircraft.

BSBG BL: (That was a little bit harder to fly wasn't it?) Yes it was. I think I've gotten accustomed to looking for terrain. Okay. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Say yes. Is it satisfactory without improvement? I would say no. And I selected rating six. SVS display characteristics very objectionable but tolerable deficiencies. Demand on pilot in selected task: adequate performance requires extensive pilot compensation. I chose number six because when I got – I've gotten accustomed to looking for the terrain and trying to interpret what I'm seeing, but I don't see it here, so I have to unfocus on that and then remain focused strictly on the information that's being provided. And in doing so I got distracted. I overshot my bearing.

PRFN1: Okay, I like that particular view. (That's 90 by the way.) Corresponds to what I'm seeing outside. Turning left. (So how did you like the unity?) It was hard to determine what was out in the horizon; well, not the horizon, but down by the airport or in the valley and I could see the hills that's right in front of me a lot closer. I like this particular one better. Which would be 90, that's right off the nose of the aircraft. I like that a lot better. I still can see out in front of me, but I can see the images that's right in front of the aircraft a lot sharper. (What did you think of the fishnet in this scenario?) Fishnet helps as where it's sharp angles in the fishnet. You know, there's a sharp peak, and that just helps me pick out where there's a trough or a ridge a lot quicker than if it's not there. (Okay, so you did find it slightly useful in this particular situation?) Yes. Pilot decisions. Is it controllable? I would say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. And I selected a rating of two. SVS display characteristics good. Negligible deficiencies. Demand on the pilot in selected tasks. The pilot compensation not a factor for desired performance. I selected two only because when I was going through the different fields of view I was trying to determine which one gave me the better view for what I was looking for: what I personally wanted to see. And then try and interpret it with the fishnet overlay.

PR1: Okay, I like that view right there. It gives me a long shot down the path I'm going. (Were you referring to the field of view or the display?) Yes, the field of view. Okay, no more outside. I'm going to be turning left. In this particular field of view it looks pretty sharp to me. I can see immediately what's ahead of me. (You're in 60 right now.) Okay. I can also get a good range – a good idea what's further out past my nose as well, as far as terrain and the differences in contrast in the color. I can pick out the hills and the valleys. (Do you miss the fishnet?) No. No. Pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. Ma'am I gave that particular scenario a rating of one. SVS display characteristics: excellent, highly desirable. Demand on pilot in selected task: pilot compensation not a factor for desired performance. (You just really liked that display?) Yeah. I felt very comfortable with it. I don't know if it was because I've done several of these previously, but it just didn't feel like it was beating me up that badly.

PRFN3: And I've lost outside cues, cues inside are pretty good. And I'm coming up on my turn. Okay, the fishnets are helping out as far as getting a feel for the flow of the hills and valleys. (How do you like that field of view?) It's pretty comfortable from here. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. And I'd like to give that a rating of one. SVS display characteristics: excellent, highly desirable. Demand on pilot in selected task: pilot compensation not a factor for desired performance. And I ranked that as a one because I think I was – I'd gotten used to start using the fishnet for maybe not the intended purpose, maybe it is, but I was able to pick out the – based on the contour of the fishnet I could look at it very quickly and determine where there was a drop-off or a rise and using that along with the realistic view that the display gave me.

EBGFN1: I like this resolution on the field of view. (And again that's a 90. You're pretty consistent on that.) Yeah, it looks pretty sharp. I can see further out ahead of me and I can see what's right at me as well. Okay, I'm losing my outside cues. Okay, turn left marker. *Software crashed in the middle of the run, so reran the run.* I particularly like this color scenario because the highlights are very useful and easy to pick out. Okay, coming up on the TURNL. The turn left marker. Yeah, I really like this display. I get a good feel for what's up close and what's out there as well. I get a comfortable feeling of both. Can't see nothing outside, but I can see what's far ahead of me and I can see what's up close fairly sharp. (Fishnet helping you?) Yeah, it's giving me a feel for how it's rolling. How the hills are rolling. Pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. And I rate that particular scenario a one. SVS display characteristics: excellent. Highly desirable. Demand on pilot in selected task: pilot compensation not a factor for desired performance. I rated a one because I was able to very easily pick out the differences between the horizon and the ground, the lower elevations versus the higher elevations, because of the contrast, higher elevations being lighter and the lower elevations being darker and green. The fishnet helped out also for me to pick out very quickly – it enhanced what I already – what I was already seeing. Meaning that as the fishnet was sharper in the ascent or descent I could pick out and pick that hill out a lot quicker than I could if it wasn't there.

EBGFN30: Okay. Lost all outside. Turning left. Come on back up here. Come on back up. (On that one it seemed that during your bank you momentarily went at least twice the PTS on bank angle.) Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Say yes. Is it satisfactory without improvement? I'm feeling yes, but in keeping along with your scenario, it says I would have to go with no. Deficiencies warrant improvement. I'll go moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation. That would be a five rating. I may have skewed that one by changing the field of view when I did and then trying to compensate for it in a different view. And also when I made the left bank, if memory serves me correctly, I went too far to the left and kind of lost my numbers there. Lost the little triangle. (That one was the elevation based generic, fishnet, with the 30 resolution, so that's the lowest resolution database. Did you have any comments on how that compared to the higher resolution databases?) I like the higher resolution a little bit better because – well, a lot better actually, because it would seem as though it was sharper if I'm not mistaken. When I compared it to this one wasn't quite as sharp, but I still could pick out the terrain. But of course the sharper, the better.

CCFN30: Okay, I lost outside. Turning left. Okay, I can see the horizon versus the ground, but it's kind of hard to depict what's out there ahead of me versus what's close up. *Software crashed in the middle of the run, so reran the run.* Okay, I'm losing outside. Okay, coming up on my

turn point. As it sits right here the fishnet helps in this particular constant color because it helps me determine that there is a hill or not a hill, but it's of course in this field of view that I got it and it's right very close to me, but it's hard for me to see out beyond the immediate. But without it, it would be very difficult to see 00 without the fishnet. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I said no. And I rate this as a four. SVS display characteristics: minor but annoying deficiencies. Demand on pilot in selected task: desired performance requires moderate pilot compensation. I rate that as a four and I do that because compared to the other displays that I've seen today this one takes a lot more work to try to figure out what type of terrain is out there and without the fishnet it would have been hard to determine the hills and the valleys.

EBG1: Okay, I lost all outside. This resolution is pretty good. I like the contour colors. They're easy to pick out, very easy to pick out. I'm at my turn point. Turning left. Try descending 1,000 feet per minute, 20 degrees of bank, and try to maintain approximately 100 on the speed. 050. Yeah, I'm liking this view. It gives me immediate close-up, and pretty decent visuals on the distant horizon. (Are you referring to the field of view of 90?) Yes, field of view. Correct. Pilot decisions. Is it controllable? I say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. And I rate this a one on the rating scale. SVS characteristics: excellent. Highly desirable. Demand on the pilot in selected task: pilot compensation not a factor for desired performance. One. I think I may have just started getting used to flying the scenario, and it was less tasking for me, but the – just the color contrast is the thing that sticks out in my mind the most and it was most helpful in depicting the type of terrain that was out in front of me. (So you like the color contouring the best?) Yes, I did.

Block 3, Approach:

PRFN3: Pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory with improvement? I put no; deficiencies warrant improvement. I put very objectionable, but tolerable deficiencies. Adequate performance requires extensive pilot compensation. Number six. My rationale for that is I guess I just started out cold and just really didn't have the, I guess, warmed up – just starting out on approach, so I hadn't gone through my cycle of maybe let's say taking off flying and then starting approach rather than just starting right in the middle with winds and the conditions. I liked the display. The boxes made it easy to know where I was supposed to be. The terrain looked just like if it was if I was to look outside, so I really like that. (Did you notice the fishnet in the view?) Yeah, I did, but I didn't use it. I really didn't use it. I was more or less trying to concentrate on flying the aircraft and keeping it from impacting the ground.

CCFN30NT: *A little coaching up front on the maneuver, since this display concept has no tunnel guidance. But, the transcripts were hard to decipher. This subject pilot had to be talked through the maneuver as he was flying. But, the software crashed half-way through the run, so we had to re-run it. More coaching before the re-run, and more coaching during the actual research run.* Okay, then, the dotted line is my glide slope, correct? The dotted horizontal line? (Yes.) Okay. Okay, I see the runway. Okay. (You picked up your turn real well on that one. You picked up your turn where you were supposed to turn. It may have been a little – a hair late, but it looked like you were watching the diamond on the bottom, but the only problem was your airspeed was – it got away from you. How did you – it's real hard for us to tell sometimes where your performance is, especially when you're borderline. Because we're just watching and you have to base it on the duration of things. It was hard for us to figure out your performance whether it was adequate or below adequate on that one, so I'm just curious how you think you did on that one.) It was below adequate. (Okay. Would you mind going ahead and filling that out

based on that?) Okay. Pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? No. Deficiencies require improvement. I marked that as a number eight. SVS characteristics: major deficiencies. Demand on the pilot in selected task: Considerable pilot compensation is required for control. And the reason why I say that is for me, personally, I was a little task saturated trying to take in all the information. I guess once I get used to absorbing the information I'll probably be able to put it all together. (Did you miss having the tunnel?) Yes, definitely. The tunnel gave me a – it's like night and day. It gave me a definite area of where I should be. It narrowed my focus as to the other areas I did not need to really necessarily be concerned with as far as navigating the aircraft, or where I wanted to point the nose in other words. If it wasn't in the green box, then I know I need to get within the green box. I know I need to stay in the center versus being below it or above it or beside it or too close to the edge even with inside the green box, so it gave me a perimeter to deal with. (Okay. Did you notice the terrain at all?) The terrain was there. I knew to stay away from it, but it wasn't – it didn't stick out as sharply as the photo realistic. (Did you use the fishnet by any chance?) I didn't even – fishnet wasn't even a concern.

CCFN30: (Looks like that one you did pretty well. At the end you were a little below the glide slope, but not long enough that it would bump you down into adequate, so go ahead and fill out side two with a desired performance rating.) Okay, for that scenario. Pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. And I marked that as a three. Fair – for SVS characteristics: fair, some mildly unpleasant deficiencies. Demand on the pilot in selected task: minimum pilot compensation required for desired performance. Overall rating of three. I rate that as a three because the brown ground and the fishnet, even though I recognize the – it was a difference in the terrain based on those – the fishnets and the brown ground. It really did not make that big of a difference to me as much as having the boxes there. The boxes were definitely a plus over the other previous scenario.

EBGFN1: Okay, this is photo realistic, correct? (EBG. Okay, I ended the run. I let you get in a little closer. I was going by the time. I timed this thing at six minutes and 20 seconds before, but seems like you're getting there a little faster.) Okay. The horizontal dotted line – the glide slope line. (Yes?) In order to remain on glide slope it should be placed at the forward, or the leading, edge of the runway, correct? (No. If you place it approximately 1,000 feet down the runway –) Down the runway. Okay. All right. The reason why I'm asking that is when we're like in a 90 field of view it's difficult to see the runway and how far to place it down the runway, because the item – because the runway looks so small. (Right. The minification factor that's associated with the FOV of 90 kind of squashes the runway down.) Right. So it'd be easier to see it – the glide slope, on the 30? (Yes, the 30 or the unity.) Or the unity? (Correct.) (You had a hard time on that one too. And it was borderline adequate and desired. So how do you think that you did?) I would have been – I would have put less than desired. (Okay, well how about we'll stick to adequate?) Okay. (Do you understand the three-degree glide slope thing now?) Yeah. I wasn't using it properly at first, so I understand better what I need to do but how to do it is the question. How I'm going to be able to do it is what I'm going to try to work at now. Because when I change the field of view to 30 the controls are much more sensitive, so I'm flying all over the sky, but it's easier to place the glide slope line where it should be. But I still need to maintain control of the aircraft. Said – that's pilot decisions. Is it controllable? I say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say no. Deficiencies warrant improvement. I marked that as a five. Overall rating as a five. SVS characteristics: moderately objectionable deficiencies. Demand on the pilot in selected task: adequate performance requires considerable pilot compensation. And the reason why I marked it that way is because trying to maintain the glide slope with a field of view at 90

was difficult toward the end of the run. Trying to switch it to the other field of views made it more sensitive and having to adjust it that close to the ground was – wasn't adequate for me, so I left it at 90 and still was off the glide slope.

PRFN1: Okay. I notice all the obstructions on the ground right in front of me and in the distance as well. Color contrast makes a big difference. Pilot decisions. Is it controllable? I say yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. And I would mark that at a rating of one. Excellent for SVS characteristics: excellent, highly desirable. Demand on the pilot in selected task: pilot compensation not a factor for desired performance. (You have any comments about the display itself?) No, I thought that was – it was great. I can't imagine it can get any better other than I know I have my own personal deficiencies, but one of the things I was thinking about was as easy as it may seem to say fly the airplane in the center of the box if there was like, for example, a little red dot or something that would pop up with the most current box it would kind of give me something more to focus on. (Like an aiming point or something?) Right. I know it's not there. I know to focus on the center of the box, and that's what I'm aiming for, but just a thought that crossed my mind.

BSBG BL: Okay, this field of view is more difficult to center it up. Yes it is. It's more sensitive. I guess once you get used to flying it in this field of view it's probably as comfortable as maybe the others. I think I can see the runway outside. I don't see it now. I was looking for the runway here. I was looking outside. I should have looked outside a little sooner, because now I'm off the glide path. Just a little off course. (Did you miss the terrain cues?) Well I was having a little problem controlling the aircraft, so I was focusing more on that. I guess I did miss them to be honest with you. But I felt as long as I was staying inside the box I was making the turn to the proper time, as long as I stayed within the box -- the center of the boxes. (It seems like you bounced around a little bit on that one, but it looks like you still stayed within the PTS 90 percent of the time, so if you can continue on to side two with a desired performance rating. Just out of curiosity, are you surprised by that? It seemed like you were working pretty hard.) Yeah, I was very surprised. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I would say no. Deficiencies warrant improvement. Minor but annoying deficiencies for the SVS characteristics. Demand on the pilot in selected task: desired performance requires moderate pilot compensation. I gave it a rating of four. I think just based on my ability to interpret all the inputs that I'm receiving and to make the necessary corrections. I find it much more difficult in that scenario, previous one, simply because I don't have the terrain input and I also was looking for some type of symbology of a runway on the display, which I didn't have to focus on the horizontal glide slope lines. (So you miss the runway on the display as well?)

EBGFN3: Okay, I can pick out the terrain in this pretty good. I'm looking at the fishnet, but I'm not really using it to interpret any information. The terrain by itself is – seems as though it's sufficient for what I need. I can see the water or road, whatever that is, directly beneath me. See I can see the two stacks. (Any initial comments, prior to starting the questionnaire?) I felt like I was starting to get the hang of it. It was a lot easier than the previous ones. I was able to pick out the differences compared to what I'm looking at outside versus what's inside. I could pick out the terrain a lot easier. Okay, pilot's decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. SVS display characteristics: I'd say excellent, highly desirable. Demand on the pilot in selected task: pilot compensation not a factor for desired performance. Overall rating of one. I selected that because I felt fairly comfortable as if I was to fly by myself in the aircraft without any assistance

from anyone other than what I have here. Would I have been able to find the runway? And I believe I would have based on the scenario.

PR1: Okay, what it looks like on the inside looks just like it does on the outside. Green boxes does make a big difference. Since I'm flying in the field of view from 90, it's a lot easier than flying in the 60. Here I can't see anything outside. Looking through my display on the inside I can pick out the hills and valleys, vegetation, what appears to be clearings – very well could be facilities or buildings, I'm not sure, but they're up ahead and there's some that's coming and I'm flying directly over. I can see the monitor. I see a couple of stacks out there. Corresponds with what I see out my window. Excellent view (display). Okay, I'm going to try it in this field of view. Pick up the runway very quickly – very easily. (You had a little bobble there at the beginning. It kind of put you outside of the desired performance rating, so if you could fill this out with the adequate performance rating that's be great.) Okay, for the scenario pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Said no. Deficiencies warrant improvement. SVS display characteristics: moderately objectionable deficiencies. I didn't find anything wrong with the SVS display. I just found it was my flying was the problem. So to mark this it seems like they would – should be two separate markings on here, one for the SVS display and one for the demand on the pilot. I don't know. It's just something I was thinking, but I didn't find anything wrong with the SVS display, but in this case I would have to mark it a five for adequate. Performance requires considerable pilot compensation. (I'll just note that you really liked this display.) It was just my flying was the issue, not the display or anything about it. It was very comfortable. So it was just a matter of me making the necessary adjustments to the environment.

EBGFN30: Okay, I can pick out the hills and valleys, but not nearly as sharply as I could in some of the other views. (For a good part of the run you were a little bit low, so we need to fill that out based on an adequate performance rating.) Okay. Pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say no. Deficiencies warrant improvement. I mark it as a five. SVS display characteristics: moderately objectionable deficiencies. Demand on the pilot in selected task: adequate performance requires considerable pilot compensation. I marked it as such simply because, again, I didn't see anything wrong with the SVS display, but piloting skills require some refinement. (Did you use the fishnet at all?) I noticed it. I was trying to see, as I was using it, or as I was viewing it, I was trying to see what I was actually using it for. And there was a couple times when there was some roads that intersected across several of the fishnet lines and I couldn't tell exactly was it another part of the fishnet or was it a road, so it kind of distracted me when I was trying to figure out what it was. So – (So it was easy to get the roads, or anything else for that matter, confused with the fishnet?) If it was straight, like very linear. If it looked like it was a river or something that meandered, then no. I could pick that out relatively easily. Again, I'm one of those people who can pick out colors a lot quicker than I can some other things. So a different color maybe if it would have contrasted I would have picked it out easier.

CCFN1: (Comments on that display concept?) It takes a little getting used to because of the sensitivity. (Are you talking about the field of view?) Yeah, the field of view. Yes. That particular field of view – having the fishnets in that particular one I feel does enhance the terrain, the terrain elevation. Being able to pick out the terrain a lot easier with the fishnets in that view. Also, the terrain is one color and the fishnet's another, which also gives it the contrast. (You were a little low for a good part of the run. You were a little fast at some points and a couple times bank angle was a little high.) Okay. Just so you know, I don't fly this way. And for this particular run, pilot's decision. Is it controllable? I'd say yes. Is adequate performance

attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I said no. For SVS display characteristics: very objectionable but tolerable deficiencies. Demand on the pilot in selected task: adequate performance requires extensive pilot compensation. I said six – a rating of six. Yes. As compared to the higher resolution photo realistic or the EBG I'd much rather have either one of those than to have the one that we just completed.

EBG1: The roads I can pick out. The hills. The high hills versus the lower sloping hills. (There on your final you remained pretty high.) Okay. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say no. Mark it as a five. Deficiencies warrant improvement. SVS characteristics: Moderately objectionable deficiencies. Demand on the pilot in selected task: adequate performance requires considerable pilot compensation. I marked it as a five because as I was changing the field of views I was trying to get adjusted to one field of view versus another for the runway and trying to line up the glide slope. So I wasn't really sure which one would work best.

PRFN30: *Software crashed halfway through the run, so had to re-run. No comments during the run.* (How did you like that display by the way?) It was pretty decent. I was able to focus on flying the aircraft. I could pick out the terrain very easily, easier than some of the others. Okay. Pilot's decision. Is it controllable? That's a yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. SVS display characteristics: I would say were good. Negligible deficiencies. Demand on the pilot in selected task: pilot compensation not a factor for desired performance. I marked it as a two. My rationale is I'm just now starting to figure out how to use these instruments. The display is great. The fishnet doesn't necessarily make that big of a difference to me at different times, so there's times that I can use it and then there's times I don't use it. I can't tell you exactly when they are and when they aren't. It's just something that I glance at very quickly and then if it's not there I don't miss it.

Rare Event:

EBGFN30: I'm not much into video games at all. (I understand. Is there something significant with this run?) Just pointing that out. Well the view is good. I can pick it out a lot better than I can see outside my window. Bit foggy out there and I guess this in this instance the fishnet does kind of help give a – some type of characteristic difference between the hills and the valleys. Seems like I'm awful low -- awful close to the ground. *Noticed it at 4:14 (t minus 22 seconds).* Okay. And for pilot decisions. Is it controllable? I'd say yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say yes. And I look at the SVS characteristics: excellent. Highly desirable. Demand on the pilot in selected task: pilot compensation not a factor for desired performance. I rate it as a one. And it caught me off guard, but I was able to pick out certain things in there to cue me that something wasn't right, but I couldn't quite figure it out, so my instincts told me I needed to go around or pull up or something.

Subject 4 (Basic Round Dials (BRD) Baseline):

Block 1, High Altitude:

CCFN1: I'd say it's definitely tough to tell the peaks. The tower's showing pretty good. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I would say it was fair. Some mildly unpleasant deficiencies; minimal pilot compensation required for desired performance. A three. I felt like I could control it and I felt like I could accurately tell that the ground was not close to me, but I did get a good feel for exactly how far. I felt like maybe it was 2,000 or 3,000 feet

below me. But in actual conditions I think I would want more detail, but as far as stepping away from the terrain and looking into the controllability of the airplane, I felt like it was safe and I never felt like I was about to lose control.

EBGFN3: That is much better resolution on the terrain. I feel like I've got a better idea on – that I'm at a safe altitude right now. (Your airspeed was a little bit high on that one for a good minute of the flight.) I saw that, yeah. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I'd go with a number two, which is good – negligible deficiencies; pilot compensation not a factor for desired performance. The – I think me losing sight of the airspeed was definitely my fault. It wasn't a simulation problem or the terrain problem. I just was concentrating on something else and – but as far as the terrain this was much better than the first scenario only because when I switched from looking out front down to the display I didn't feel like I missed anything. Felt like visually looking outside the airplane. I had the same detail as I did inside, so it was a much easier transition. (I think there's a little bit of confusion though, because with an adequate performance rating you have to stay down into the five and six range.) Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. It would be minor but annoying deficiencies; desired performance requires moderate pilot compensation for a number four.

PRFN1: Okay. Forgot about toggling through the fields of view. The terrain on the previous scenario seemed to stand out a little bit better. I'm not sure if it was the colors – the colors, but this is more like the first scenario where it's kind of hard to figure out exactly how – visually how high I am above the highest peaks, so so far I would have preferred the second scenario. And it's almost like I have to concentrate too much. The (EBG) I was able to glance down real fast and tell – get a better feel. This one, I guess if I look a little bit closer, but I feel I spend too much time on terrain and not the instruments when I do that. I'm having a hard time, or it seems like through the training and this one, with the lower resolutions, the unity and the 30. It seems like right now I favor the 60 and the 90 more than I do the other ones. And that's more – I feel like I have more control. The wider field of view just gives you a bigger picture and I feel like I can stay in control better. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And then I'd say it's fair. There's some mildly unpleasant deficiencies and minimal pilot compensation required for desired performance for level three rating. And one comment: I noticed I had to concentrate a lot on the airspeed this time. I'm not sure if it was because I went out on the last time, but it seems like the airspeed being over on the left right now is taking some attention away from the display. But I don't think it's a safety problem. It's more of a getting used to the setup of the display.

EBGFN30: The – this elevation based view is – I like this one the best. I feel like I can tell where the peaks are. A lot better than the other views. Photo realistic. The fishnet doesn't – I don't feel like that really helps clarify the terrain any better with (inaudible). It's mostly the coloration is – I think is better for me. The higher peaks being a lighter color of brown, but they kind of stand out a bit more. In fact the – I would say the fishnet on this view on this screen is very hard to pick out. It's almost like I can't see it on this terrain. (On that last run it looked like you were trying to center up on 040 for a few minutes. Did you temporarily forget that your target is 050?) On the last one, yes. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. And deficiencies warrant improvement. It'd be a level four. Minor but annoying deficiencies; desired performance requires moderate pilot compensation. Well the more I'm getting used to the controls – it seems like at first I thought it was just me getting used to the scenarios, but it seems like I'm working quite a bit and then I missed airspeed on the first couple, and then when I started

focusing on airspeed, then I was off a little bit on heading on the last one. So I'm starting to think that maybe I need to – or rather the visualization requires a little bit more work.

BRD BL: (You were a little high at the beginning and during the turn. Got up to over 120 knots.) Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? No. And major deficiencies. Adequate performance not attainable with maximum tolerable pilot compensation. Controllability not in question. I noticed that the VSI, my vertical speed, was difficult to determine other than the gauge compared to the – yeah, elevation based and photo realistic. I didn't have a good feel for that. The altitude was a little bit harder to maintain because I didn't have the blue over brown representation, and I had absolutely no terrain awareness at all.

CCFN30: Again, the fishnet's a bit hard to pick out on the screen. I can see the towers really well. That kind of lets me know where the peaks are, but other than that it's tough to figure out exactly how high I am off the top of the mountains. The blue sky/brown ground definitely helps me make sure that I'm staying upright. I'm not rolling inverted or anything like that. But I don't get a whole lot of terrain awareness. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? No. Deficiencies require improvement. And I would give it a seven. Major deficiencies. Adequate performance not attainable. Maximum tolerable pilot compensation. Controllability not in question. The main problem that I saw with that screen – it's just the inability to tell my height above the terrain. With that display if I were in those actual conditions I'd feel the need to level off a lot earlier and double check charts and make sure that I know where the altitudes are en route.

PRFN30: The fishnet setting shows up a lot better with the photo realistic view. More helpful. In this setting, as far as cruising level at the high altitude, it seems like the 60 field of view I prefer that the best. The 90 looks like you're almost pointing down. I could get used to that I suppose. But 60 seems to be the best at this altitude. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And gave it a rating of three. Fair. Some mildly unpleasant deficiencies; minimal pilot compensation required for desired performance. Controllability I felt was very good still and the terrain awareness was definitely there. I felt like I could – I was clearly able to tell that I was a couple thousand feet at least above the highest peaks and I didn't feel like I was in danger of the terrain in any way. The only recommendation I would have is on this scenario I paged through the different field of views a little bit more than the other scenarios and it's difficult to tell what field of view I am in, as far as 60, 90, 30, or unity. I'm just trying to say I don't have a good feel on any given shot of what level of field of view that I'm in. For instance, whether I'm at 60 or 90 there's – once I compare them next to each other I can tell that, you know, 90 has a higher resolution, but it would be nice to have somewhere on the screen let me know exactly what field of view I'm in instead of having to toggle through them all and compare them all to make that determination.

PR1: The resolution on the photo realistic of one – it makes a big difference. That was the best – that was the best resolution so far as far as getting situational awareness on where the peaks are and whether I was safe. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I give it a rating of two.

PRFN3: This is very similar to the high-resolution photo realistic with the last scenario. I feel like I can tell where the peaks are and as far as situational awareness and terrain awareness it's very high, and very comparable to the last scenario. (Have you noticed light turbulence during these approaches?) Oh yeah, quite a bit. I'm struggling quite a bit with the controls and it feels

like – almost like slow flight. They're very mushy. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of three. I spent a little bit more time looking at the fishnet section of it to try to determine the exact height of the terrain, and so comparing it to the previous one I thought they were both good, but this one was just a little bit not quite as good as far as situational awareness just for that one reason. It was a very minor reason. So instead of giving it a two, I gave it a three.

EBGFN1: The coloration of the terrain – of the mountains – stands out. The contrast is really good compared to the photo realistic. This is by far the best situational awareness of all the different scenarios. This is very good definition of this ridge. This is the best definition so far. (I believe you said that was the best display to this point as far as your preference goes.) As far as depicting the mountains and their height, it's definitely the clearest picture that I've had and I feel like I can go down within – with that picture, you know, 300 or 400 feet above them and feel fairly safe. (What part did the fishnet play in that?) That was my other comment. So far the fishnet hasn't really helped me out one way or the other on any of the displays. It's more of the resolution and the difference in the colors between the terrain. For instance, the mountains there on the elevation based generic stands out better and it's much easier for me to pick out the mountains and the peaks, versus the photo realistic where the mountains seem to be more green. You can still pick them out, but they're not as crisp. (And the fishnet's almost not a factor?) Right. I would say it's not a factor. Okay. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall rating of two. One other comment about this scenario is that it was definitely good as far as the contrast of the mountains, the mountain peaks, being able to pick that out. The only thing that I'll say on the photo realistic is that the photo realistic is an easier transition once you go into the IMC looking forward, when you go to the instruments, since the photo realistic is mimicking what I see on the screen it's an easier transition versus this last one. It's a minor comment, but I thought I'd mention it. But as far as staying away from the peaks this is definitely the better one.

EBG1: Right now I don't miss the fishnet. The peaks stand out very well on this. Definition is very good. It's just as good as visual VMC conditions. Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall of two. This was – this seemed very much like the last scenario with the fishnet overlaid, since on the last one I didn't really recognize the fishnet being there. (So fishnet is again not a factor?) Not a factor. Correct.

Block 2, Low Altitude:

CCFN30: No initial comments other than it's very difficult to tell the height of the terrain with this view if I look down on the SVS. Another comment is that if I was actually flying a plane with this in these conditions, I wouldn't feel the resolution was good enough to be comfortable flying at this altitude. And I'd climb probably 1,000 feet. The fishnet in this case is providing a little bit more information than usual. It does bring out the kind of rolling hills... Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And an overall rating of three. I didn't have enough confidence in the resolution to fly as low as I was; so either, one, the resolution would have to get a little bit better for me to maintain that, or I would take action to increase the distance between what the computer or the SVS was showing me.

EBGFN30: I still like the 60 better. It looks like when I go to the 90 that the fishnet is a little more defined, but I'm not so sure that it really helps – makes a difference. I mean, that one is a

bit distracting. It feels like I'm at a nose-high attitude. The unity and the 30 setting feel like I'm in a nose-high, and then the 90 feels like I'm at a nose-low. And the 60 is the only one that makes me feel like I'm flying straight and level visually. I feel much safer coming to the top of this approach here than I did on the last one, as far as being assured that I'm going to miss the peak of the mountain. I would feel safe maintaining this altitude with this level of resolution here. (I just wanted to point out to you that this resolution is also the 30-arc second, which is the same as you just flew the last time. The only difference is that you have elevation based texturing versus the constant color fishnet texturing on the last one.) It is? Okay, I guess it's the texturing and the elevation base that makes it a little bit better, not necessarily the resolution. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of two. I gave it a two because I felt like it was safe. I could stay – I would fly that approach with this instrument, but there is room for improvement on the resolution.

PRFN1: Although I seem to like the elevation based better, it is a much easier transition from looking up front to going to the SVS display with the same coloration. That's nice. The fishnet, again, I don't think is making that much of a difference on terrain awareness. Going into the top of this range here it is a little bit difficult to figure out where the peaks are compared to the elevation based. When I'm in a nose-down attitude. Once I level off then the peaks become a little more apparent. And it seems also like the fishnet does seem to help on this view a little bit; some of these peaks that are off to the left. (Do you think it's because you're lower to the ground?) I think so, yes. That may be it. They definitely help more than the previous group of scenarios. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And an overall rating of two. I think the only reason why I didn't give it a higher rating on that one is once I started descending it was tough to pick out the peaks in that nose-down attitude and it wasn't till I leveled off that it became pretty clear.

EBG1: Need one of these for my rental. I think the same as the last time. The contrasting colors really help bring out the peaks of the mountains. (Can you see the fishnet?) No. Not right now. (You're still partial to the 60-degree field of view even at the lower altitude?) Yes, I am. There's 30. Sixty still seems to be the best. Even at the lower altitudes the 60-degree field of view seems to be the preferred one. Also on that descent I felt more comfortable with the visual display as far as being able to pick out the tops of the mountains. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it a rating of one. If I was able to get SVS in a real 172, that's the one I would pick.

CCFN1: The fishnet on this view is about the only definition you can tell on the peaks. Without that it wouldn't be much better than a very low resolution. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it a rating of three. The – I think a higher resolution, or not a higher resolution, but the texture would help it out. I guess what I'm trying to say is it was safe. I would have continued that flight, but if there were a lot of turbulence or something like that in real condition I would want a higher resolution or a different terrain like the elevation based, so I gave it a three.

EBGFN3: Again I think the fishnet is not a factor in this view. The three-arc second resolution seems to be just as adequate as the one-arc resolution as far as feeling safely above the terrain. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall rating of one. And again the

fishnet seemed to play a bigger role at the lower altitudes. At 6,500 it didn't seem to make much of a difference, but when I got closer to the mountain it seemed to help a little.

PR1: It looks really good, almost like there's a camera on the front of the plane looking out getting rid of the clouds. Other than that it's very effective. The field of view of 30 seems to be okay in this scenario. Kind of liked that one. (Do you think that that's because of the terrain display that you were using, or because that you were closer to the ground.) It's hard to say. I think it may be because of the photo realistic terrain. I'll have to try it out again on another photo realistic. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall of one. There was – I still noticed on the descent that there was a little bit of difficulty in picking out the contrast between the peaks and the valleys and the mountain, but overall it was still very good.

BRD BL: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give it a rating of three. There was no terrain awareness, so I gave it the lowest score within that section. I would have given it a lower score if that's possible, but I don't think that's possible, unless I'm wrong. (Actually you could go to number four, with desired.) I could go to four? Okay. (Desired performance requires moderate pilot compensation.) Okay, I'll go with a four on that, only because of the lack of terrain awareness and being so close to the mountains, and the higher workload. It did take a lot more work to keep the numbers within limits. (Just out of curiosity, would you have given it an even lower ranking than that?) Yes, after flying what I've flown I'd have given it a – the lowest ranking actually. I mean I wouldn't fly in those conditions. Around the mountains like that.

EBGFN1: The clarity of the peaks of the mountains is really good on this. Again, just the elevation based I think is very clear. The fishnet doesn't necessarily add anything to this at this elevation. Again the fishnet seems to help out at the lower elevations. That's the 30 there. I think on this screen I still prefer the 60. Not sure exactly why, but – feels like I can't see far enough below me. Yeah, right there on the 60. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of one. Just the elevation based contrasting colors really helped pinpoint the high areas.

PRFN30: No comments in particular, other than the fishnet again is – doesn't make much of a difference at this altitude. The fishnet on this view here almost seems to mask the peaks of the mountains here. It's almost like there's chicken wire over the entire range, which kind of dulls out the peaks. This is the 30 field of view and I would be comfortable flying this one as well as the 60, although I still think you need a little bit more of the details of the 60 view. There is one thing that I think would help the photo realistic view. And that is if you could almost play with the lighting on the ground; almost as if there was a sun over it. Right now the ground shows up as if it's a cloudy day kind of. And I think that if there was more light contrast that it may bring out some of the features that are in the elevation based terrain view. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of three. And I gave it a three because of the resolution with the fishnet over it. Again, the fishnet seemed to kind of dull out the peaks of the mountains. Made it seem like the terrain was more flat than it actually was.

PRFN3: (Can you tell much of a difference between the 30-arc second DEM and the three-arc second that you're flying?) At this altitude I can't tell a whole lot of difference, no. Between the 30 and the three. The fishnet on the three-degree resolution doesn't seem to mask the peaks like the 30-degree did. The objects also in the forward view when the towers fly by, seem a lot closer

than they do on the SVS. (The out-the-window objects seem closer to you than what's on the display?) Than what's on the display. For instance, when I look down at the display it appears like they could be 300 or 400 feet away, and then when I see them come up in the forward view it's almost like they're 50 or 100 feet away. If you switch to the unity field of view you might see something more realistic.) Okay. Unity. (And they match a little bit better.) Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall rating of one. Felt like the – all the peaks were identified well enough that I could safely fly it at the altitude that I was: about 1,000 feet above.

Block 3, Approach:

CCFN1: The tower's showing pretty good on this view. And I tried to switch to the unity view to get a better glimpse of the runway, but I think I still prefer this view: the 60. Yeah. And 90's even better. Okay, right now I still prefer the 90. I'll try the unity and see how that works for me. A bit harder to control. Definitely feel like I have better control with a higher resolution, or the field of view – higher field of view. And here at the very end the unity is better. Right on short final. The display I concentrated more on the boxes than I noticed the ground and the terrain, because it kind of just faded of fin the background. The terrain did, so I really didn't recognize it that much. (Just so you know, you did come out of your dogbones, at least one dot outside, but not enough to put you below 90 percent. That was mostly in the turn. You did cut it a little shallow, so I think if you remember to put it on 90 turn that would help you out a little bit.) Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I'll give it a three. And the reason for the three is that the terrain didn't really stand out. I focused mostly on the boxes. And so I'll have to compare it with some of the higher definition terrains.

PRFN3: Much easier to be somewhat stable with the 90 field of – not the 90 field of view, but the more boxes I guess. I noticed when we first started out that the ridgeline – that the fishnet did help with the ridgeline on that one. Identifying without the fishnet it would have been difficult to pick out where the actual peak was. But once I get flying in these boxes I lose track of the terrain. The small ridge out to the left stands out fairly clearly on this for the approach. The towers right there that are going by on my left on the synthetic vision seemed to be a lot farther away than they actually are on the forward view. (That's because you're in the 90 field of view.) Okay. Felt the turbulence, or the decreasing turbulence the 30 field of view seems like it's controllable. Unity it didn't seem like it was stable enough. And then it gets better from there. Sixty and then – then again, the closer you get, if you go to unity like right now this would be a good time to switch to that. (Looked like you held the turn pretty well that time.) Yeah, it was a lot easier that time. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall of two. The ridges definitely stand out a little bit better like the ones on final approach off to my left. I was glad to be able to recognize that, as compared to the constant color scenario previously. And one other comment was the fishnet seemed to pinpoint the ridges a lot better at this low of an altitude.

PRFN30: Again, the fishnet helps out at this point quite a bit. Right there at that peak. I didn't really notice that ridge there on the left this time. I think that would be something that I'd want to be more aware of flying this approach. (Are you using the diamonds at all, or are you mainly flying off the boxes?) I'm mainly just flying off the boxes and then referencing the diamonds. To make sure, but right now primarily, I'd say 80 percent, boxes and then 20 the diamonds. I guess I'm trusting the boxes to be in the right place. And it looks like I'm not sure how high I am, but at this altitude I'm more comfortable switching to a lower field of view. At 1,600 feet or

so it's about – 500 AGL. Still a little bit harder to control though. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall rating of three. Mostly due to not being able to pick out that ridge that's off to my left on final approach.

CCFN30: At this view it doesn't really – it looks like the ground's flat beneath me here. On this run I'm definitely using solely the boxes. The ground is not really playing a factor in – I'm also referencing the diamonds a little bit less this time. (Do you see that ridge on the left there?) No, I thought that was part of the fishnet. I think I caught it there at the last second. Right now the illusion is that I am – I guess I am pretty close to the ground, but it looks like I'm about to land on the ground in this view. Okay, this is better. Even there it looks like I'm shallow. It just was my – if I was still IMC I can see in front of me it'd make me a little uncomfortable feeling I was closer to the ground than I actually am. I think I'm getting a little bit better at it. Let's see. Is it controllable? Yes. Adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall of three. The illusion of being closer to the ground there on final definitely could be improved I would think, but without the boxes kind of guiding me in I probably would have climbed another 500 feet to make sure I was clear of that. So I don't think it accurately represented the height of the ground.

EBGFN3: The terrain stands out a lot better on this one. I think I just passed over a road. That stood out better as a road. And there's a hill coming up here on my left that stands out well. And I can pick out the ridge coming up there in the distance from quite a distance back, so I can be aware of that a little bit ahead of time. And that's mostly due to the brown coloration of the hills. That's nice to know to keep an eye out for here in a few minutes. The roads definitely stand out on this better. Well with the – even the smaller hills. The hills in the background also, I guess since they stand out so well, it kind of gives me the information I'd need to know if I were to have to do a missed approach. At this point I'd be aware that there's mountains straight ahead of me that I definitely need to stay clear of as I climb out. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall rating of one. Everything was really good. I could pick out the peaks and then again the additional awareness, or visibility I guess is the term, felt like it was much further.

EBGFN1: Much better even than the three-degree, or three-arc second. The fishnet seems to help the lower I get. It helps out. Again, the road's easy to pick out, but I think it may be if the road were to happen to be going a different direction in line with the fishnet it would be difficult to determine between the fishnet and the road. The terrain in the distance shows up again pretty good. That's helpful. As well as this ridge that's coming up on my left. If I were to have to do a missed approach the clarity there in the foreground is pretty good. And in background. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I gave it an overall rating of one. Everything stood out really well.

CCFN30NT: Yeah, the terrain doesn't really stand out very clear. It's almost as if there's no elevation difference anywhere on the ground. (Do you miss the tunnel?) Oh yeah. Yeah this is definitely a lot harder to control. Workload is doubled it seems like. (Do you think the no tunnel on a different terrain database would make a difference, or just no tunnel in general?) I think no tunnel in general makes a big difference. With the turbulence. Without the turbulence, like right now it seems like it's gone down quite a bit, it's not nearly as bad. And I have the runway in sight. I can feel a little more stable anyway. Definitely using, obviously, the glide slope and localizer indicators a lot more. And making – not so much now, but back in the turbulence if I

had to switch frequencies and ATC was giving me a little bit of work, it'd definitely be challenging. I wouldn't do that in close. Again, right there I've got the illusion that my wheels are about to touch down on the ground. (I think that's an artifact of the field of view that you're in, so if you would change it to unity it might go away a little bit.) Oh, there we go. Yeah. (At the very beginning you were a little high for 36 seconds or more.) So I could give that as low as a seven, is that correct? Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? No. Deficiencies require improvement. And for an overall of seven. And gave it a seven just because the workload was so much more than the other scenarios and I felt like I was almost saturated as far as workload goes. And anything else about that, like I didn't realize the altitude was off, like you said, till about 30 seconds in, just because I was working on trying to keep my height above the ground.

EBG1: The view seems a little less cluttered without the fishnet on it. I'm thinking I may like this one better without the fishnet. I think the boxes definitely help me at least on the altitude control. I think I have a tendency to climb and it keeps me down where I should be. The roads show up much better without the fishnet. (What's the workload comparison?) Oh, it's about a third of what it was on the last one. These boxes really help with the workload. I feel like I could do maybe two other tasks right now if I was asked to. Look up something on a map and maybe even a few frequencies. Definitely prefer the 90 field of view pretty much all the way down to maybe 300 or 400 feet above ground. I think right over the middle marker going to 30 field of view is good, and then as I got closer I switched it. (You preferred 90-degree field of view until – did you say a certain altitude or a distance?) About a certain altitude. It looks like maybe 400 to 500 feet above ground level. I mean maybe even all the way down to the middle marker and then start switching. Then switched to 30 and then unity there at maybe 100 feet above the runway. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of one. This is the – if I were to win the lottery I would want this system installed in the airplanes I'd buy.

PRFN1: The terrain down there – there's so many different colors it just kind of gets lost. The peaks, even the valleys, become – appears more flat compared to the elevation based. (Does the fishnet give you any beneficial information?) No, not on this view. No, it makes the ridge, I guess, stand out a little bit more on the left, but that's just a minor improvement I think. The fishnet really gets lost down there when I'm over the city. It's almost – I can't even tell there's a fishnet on there. As well as the roads. The roads get washed out also. The different colors that are on this terrain kind of add to the clutter, just like the fishnet does sometimes. As compared to the elevation based, where there seems to be three or four primary colors in there. It actually makes picking out the runway a little bit harder too. And also the mountains in the distance there. You can't really make out the height of them as you could on the elevation based. I'm aware that they're there, but not a whole lot of detail. There's four. At about 400 feet AGL I switched to – I think that was unity I was on. Maybe 30. (It's 30.) Okay. That was about a good time. It seems about 400 to 500 feet above ground level is a good time to switch to that field of view. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of two. I was leaning towards a one, but I think with the realistic photo adds a little bit too much clutter to the terrain.

EBGFN30: The fishnet stands out pretty clearly, but I'm not necessarily sure it helps any with the small hills that are down there right now. The roads are difficult to pick out on this view. Be interesting to see how close those towers really are in a real life approach. At this altitude the roads stand out. You can identify the roads fairly clearly. Let's see. I'm at about 500 feet AGL there. I'm in 60, which seems like a good selection. Now I'll go to 30. It's good. The order in which you toggle through the field of views, if that was reversed that would help out quite a bit,

at least on, you know, the approach section. For instance I'm on 90 as for the majority of that approach, and then when I make one click I go back to unity. If they were reversed I would drop down to 60 and down to 30 and that would kind of – (You want it to cycle down?) Yes. Yeah, definitely that elevation based generic is the way to go. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. For an overall rating of two. I gave it that two – I thought it was acceptable but the resolution could improve and the fishnet seemed to mask some of the ground terrain.

BRD BL: I'm definitely relying on the MX20 more than when using the SVS. A little bit more stressful watching the MX20 go all to red. (At the very beginning you flew a little high for a while.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? No. For an overall rating of seven. And the situational awareness is definitely decreased without the – with an artificial horizon like the one used in the SVS, and that was the first time on the front. Let me see what section. Is understanding of the situation was a lot lower overall with the baseline instruments. And – which caused me to use the MX20 a little bit more. When I used the SVS the MX20 is my secondary instrument, but I hardly ever reference it. Seems to be enough information on the SVS.

PR1: I forgot to switch to 90 field of view there. Had a little bit of trouble there on the turn. Couldn't figure out why I was – what was going on. Again the – all the different colors that are in the terrain kind of wash out all the peaks. You don't get as clear of a picture as you do with the elevation based. Yeah, the details down in the terrain are tough to pick out. Hard to pick out the roads and even the small hills. Switch to 30 field of view. Okay. Go to unity. One hundred feet to go. 1160, okay. 100 feet. Rudder pedals actually work. (This time you were a little high coming in on the localizer.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. For an overall of four. I think that the simulation is good on the terrain it's a little bit cluttered, like I said, and it's hard to pick out some of the details like the roads, but I'm not sure exactly why I was a little bit off on the final approach. I had the glide slope. I don't think that was a, you know, part of the SVS problem. I'm not sure what I was distracted by.

Rare Event:

EBG1: All the peaks stand out really good as far as the terrain. They even stand out better I think in the forward view. Tendency is to use the SVS now, when it's marginal IFR. This picture is really good as far as the definition, the clarity, and the resolution are really good. Right now it looks like I'm about to hit the ground. (Did you notice that you were lower than you were last time?) Yeah, I noticed that, I mean I was indicating 5,000 feet, but it seemed like – definitely seemed like the altitude was off. I didn't take any action. Obviously I would have in a real situation. Yeah, I definitely – I was tempted to, you know, a minute before to go ahead and pull up, but I wanted to stick to the numbers. *4:30 noticed that he was almost ready to hit the ground (t minus 6 seconds).* Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I'd give that a one. Other than I feel like I noticed that the terrain was coming up a lot sooner. I suppose I should have said something, but I thought maybe it was, you know, a problem with the SVS, so I didn't. I just stuck with the numbers basically to see if I would hit the ground, instead of taking action to avoid the ground. Which in a real situation I would have pulled up.

Subject 5 (BSBG Baseline):

On the date of this subject's participation, transcriptions were only available for the first couple of runs, due to a malfunction in the audio recording. The first couple of runs are

summaries of the true transcription, the rest of the text is data that are not actual transcripts, but notes that the principal investigator took real-time during the experiment.

Block 1, High Altitude:

PRFN3: *Blue Screen software crash 6 times on this database, so went to EBGFN30 for the first run. Planned to run this at the end, but the software still crashed at that point. We even tried to load it with the low altitude scenario, and, the software still crashed. So, in the end, we weren't able to run this display concept for this subject pilot.*

EBGFN30: Okay, as far as a simulator, it's very difficult to hold wings level, which I guess that's because of light turbulence, is that right? (Yes that's right.) I guess that – on the unity display, it's kind of a little bit disconcerting to – let's see, no ground down there. I just was seeing all blue. (See the ridge there on your left?) Uh-huh. (You turned a little late on that one.) Yeah, I was messing around with the field of view. (You don't have to correct back to that ridge, but I just wanted to let you know that that was the ridge that we're –) Which ridge is that? (The one on – there – you can see the towers there on the left.) I'm in IFR. I don't see outside of the screen. (On your display. If you look down about to the negative 10 on your pitch scale there are some towers down there.) I don't see them. (Do you see the mountain down to your lower left?) Uh-huh. (See how it – there's sort of a spine there or a crest?) Uh-huh. (When you'd make that fly-by waypoint or turn abeam at, you roll out over that spine. And you'll fly the spine sort of like an axis.) I don't see any towers though. (You will.) But that distraction made me miss my altitude. Yeah, it's just a little too much clutter on this display. It'd be nice if you could declutter the PFD. (Are you talking about the symbology itself?) Oh yeah. Just get rid of all of it. You know, it's like the shading I think we talked about. I think I talked about that during the usability study. The shading I don't think is necessary for the tapes. And all that extra clutter of course, the perfect case here I can't see the towers at all. They could be behind some of the symbology, but I certainly can't see them. Okay. Pilot decisions. Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Now this is a problem. The workload I thought was exceptionally high, even though I met desired performance. So I have to say yes. But it was a lot more workload than I would have liked. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Since I met the desired criteria, I'll say minor but annoying deficiencies. I'd call them more than minor. Desired performance requires moderate pilot compensation. I would say desired performance requires excessive pilot compensation. The ball did not respond well to the turbulence. I was spending most of my time just trying to hold wings level. And that seemed a little bit unrealistic for a real airplane. Of course there's no motion cues and things like that, so you have – you're having to look strictly and concentrate on the display rather than using your peripheral cues that you would have in a real airplane. So that makes it more difficult. The speed stability is not that good. Not as good as I would expect in a light airplane, so I think the model's not that good in that regard either. And I'm not seeing that much help from the different field of views. I expect I will as the day and tomorrow go on., but I didn't feel I had that good of a grasp of the terrain environment. And it may just be a learning curve. I mean I can tell there are mountains down there, but it was – in trying just to control the airplane wings level and meet the other performance criteria I was spending more time actually trying to fly the airplane than I was being able to concentrate on the terrain. So I think that is a problem for me in that I was not able to utilize the SVS cues as well as I would have liked. So I'll give it a four, and say that to meet the desired criteria I spent so much time just flying the airplane that I wasn't able to really use the SVS. So one thing that concerns me off the bat, and hopefully I won't be so concerned as the day goes on, is that just the actual act of trying to control this – trying to fly this is taking away from the ability to analyze the SVS cues.

(Just out of curiosity, if you could forget about the limits that the desired rating gives, would you have chosen a lower -) Most definitely. I would have chosen, for workload alone I would have chosen probably a five or a six. But since I met the desired criteria, I'm obligated really by

Cooper-Harper to put it there, but the problem was just the workload and actually trying to fly the simulator. It took away from my ability to increase my situational awareness from using the SVS displays.

PRFN30: What was the last one I flew again? (EBGFN40) There was a fishnet there? Okay, I didn't even notice that. And there's a fishnet here? I don't see it. There's no fishnet on mine. Oh, okay, there it is. But no, I can see the numbers real well, but the fishnet's very, very hard to see. Of course we're higher above the ground. That's probably the reason. Okay. You see blue-blue with a little white line to give you your attitude reference. So I don't like that. It seems to me there should be, just from my experience flying instruments, there should be at horizon line brown below, or something not just – this harkens back to the old World War Two era, where you just had a white line and a black background. So in this field of view, in the unity, all really I'm seeing is blue with a white line. So I don't care for that. So when I go to the different field of views, then I start getting ground in, which seems to help. So strictly to being able to control the airplane I like – I like to be at the 90 even though I don't really think 90 is my preferred one, but for this altitude the smaller field of views make it more difficult to fly the display. For the higher altitude maneuver like this, you have to be at this wider field of view to see the ground. Either the 60 or the 90. The unity and the 30 don't seem to allow you to see. And I still don't see any towers. (They're right below your speed tape. There's four of them that I can see. That are right – well actually I see two and a half that are outside the shading of your speed tape, just below your speed tape.) Okay, I'm up here about three inches away with my bifocals and I don't see any towers. I think I may see one way – just a smudge down just abeam the minus 15 pitch reference. Is that a road or is that a tower? (That's a road.) Pilot decisions. Is it controllable? Yes it is. Is adequate performance attainable with a tolerable workload? Well, yes. Adequate performance was attainable, but the workload is too high still. Is it satisfactory without improvement? No. Another four. Minor but annoying deficiencies. Mainly the – it's just way too much effort spent just holding the wings level. To the detriment of the other tasks. The higher altitudes I'm not getting a good – as good of a picture of the terrain as I would like. I know there's terrain down there. The fact that I'm high altitude is probably – it's not that important, because I'm safely well above the terrain. But it's difficult to really tell how high the terrain is, you know. I'm over a ridge, but it's just really difficult for me to visualize that on the display I'm seeing. I couldn't really – I never really used the fishnet. It was never, ever a factor. I never even knew it was there it was just so difficult to see. And I don't see a big difference in information conveyed to me from either this one or the elevation based generic. So almost as far as workload performance and situational awareness I would say even though we have two different – entirely different concepts, the net result to me was the same.

EBGFN1: Okay, well obviously the one arc second is much, much better than the thirty arc second as far as giving you an idea of the ruggedness of the terrain. The same comment still applies to the display about seeing all blue. You can't just peripherally scan that and keep your velocity vector where you want it, because there's not a strong enough cue that you actually are on the horizon line. The 60 works out best, as you suggested in the brief. (I just want to make a real quick comment. One of the reasons why it may be so hard to keep wings level and control the airplane is that we're really kind of bumping up against the maximum performance of the model 172.) Okay. The one arc second, because it shows all this sharp relief, it's just peripherally allows you to get a better feel for what you're flying over. The 30 arc second it's just hard to tell you're really flying over mountains. In that case I got off nine degrees just by going to change the scale of my MX20. Because it just didn't hold wings level. (You'll be coming up on your turn.) You are determined that I don't miss this thing. I assume that is the ridge. Still no towers. Fishnet's really not a factor. Totally – totally does nothing for me. Oh, well I see a tower. But I'd never notice unless I was really looking for it. In this thing I see four

of them. One, two, three, four. Boy I tell you, you would never notice those unless you knew to look for them. I was just looking down around the six, like you mentioned, and, but that's just – they're so tiny because you're up so high they just don't stand out. So if it's important to display those, you might want to think about somehow putting them out of scale, you know, accentuating them in some way. Either flashing them or putting them a different, more high contrast color, because I really can't tell that they're red. It's just they are a slightly different contrast than what's around them. Okay, controllable? Yes it was. Adequate performance attainable? Yes. Satisfactory without improvement? No. Again, it's going to be a four. I think the kicker here is that according to Cooper-Harper, desired performance requires moderate pilot compensation. The performance being the PTS standards, that's a controllability issue, so we're really rating here handling qualities based on the actual model of the aircraft and the information conveyed to the pilot, but the effect of the difficulty in maintaining wings level puts such a high workload on maintaining the lateral requirement of plus or minus 10 degrees in heading, and the inability to really trim this thing real well for the descent mode, make the workload high. So I think that's going to transcend whatever display you give me. Basically since this is an IFR task essentially, I am using the attitude indicator and the angle of bank indicator and the heading indicator to meet these performance criteria, and I think we're probably going to have straight fours across the board because I'll meet desired criteria, but it will take a lot of work. And this is independent of the terrain situational awareness, based on the way the task has been defined. So I'm not sure the Cooper-Harper is going to give us that much based on this high – higher altitude task based on the limitations of the simulator. Again, Cooper-Harper is a handling qualities metric, so what I'm rating here is the handling qualities independent really of any terrain awareness. That's not being – the terrain awareness is not really being reflected in my Cooper-Harper ratings. It was – the task difficulty based on the simulation model here far, far out – you know, this just far outpaces the effect of any improved terrain awareness. Now if the task was to fly down a valley or something like that, and not hit the sides of the wall, then certainly the one DEM and the elevation based generic or whatever would certainly be a player in that task, which is not to crash or run into the wall, but in just trying to maintain headings, altitudes, and airspeeds, then the various different terrain displays aren't going to be a factor.

PRFN1: Yeah, see this is fishnet. Again, I cannot see the fishnet at all at 60. Ah, if you look you can barely see it. Okay it's more apparent in 90. Not apparent at all in unity, because pretty much all I'm seeing is blue sky. It's not, it's apparent but not really useful in 30. So my comments so far, since I've seen four, this is my fourth fishnet, fishnet could – I guess when I start seeing some without the fishnet maybe I'll say, "Holy cow. That's not nearly as good," but right now it's difficult for me to see a value for the fishnet. The elevation based generic certainly gives you a better feel for the terrain than the photo realistic in that you see the – you can see the ridge lines, the valleys, and the mountains much more clearly. I've still got a ways to go to get the nose on it (for the turn). Be in just a little bit. I was on the one-mile scale in the MX20 and I turned with the nose about a quarter inch prior to the ray. (We're using the 10-mile scale. Use your judgment - judging the distance based on the 10-mile scale. So it looks like you're maybe just a bit late if you use that gauge on the one-mile scale I guess. Well the 10-mile, I thought you were trying to get like a lateral offset. The 10-mile put me almost headed right towards it. Oh shoot, we're talking. Yeah I can stay on the 10-mile if you like. But that's not how I don't normally do it though, because I want to get – if I was trying to precise the – do this task I would want to get on the small scale, or the biggest scale so I could most precisely make that waypoint. But what I've done is probably defeat your purpose. PR1 did not give as much SA as the EBG. Next time will not play with MX20, keep it at 10 mile. So, hopefully, turn will be ok.

BSBG BL: Lot easier to fly handling qualities task, because less distractions (no terrain). However, you have no TA. Workload is too high. Responds too much to gusts. Laterally, the gust response is too abrupt.

CCFN1: FN helps a little, but still kind of hard to see it. Can see FN better in the FOV90 than the others. Ridge is not discernable at 8000. Can see the towers, though. Software crashed at 4:20, but he felt that he got enough to complete that run. Felt that the towers looked more like they were in a valley, as opposed to on a ridge. Could not tell in any FOV where the ridge was. Very interesting that the ridge was not presented well in this display.

EBG1: Doesn't miss the FN. Gets impression that he's going downhill, due to ridge sloping away from you. Favorite so far is EBG1 with or without FN, because he could take or leave the FN. PR, with the shading of the trees, etc, doesn't give a clear representation of terrain, not like the EBG.

EBGFN3: Not much difference between the 3 and the 1, DEM. FN - can't see at all. Can only really see it against the green, not the brown. If FN would cost more, he'd drop it. DEM1 is not much better than the 3 if there is much more computational power, data storage or money involved in getting the DEM1. EBG for this particular task is superior to PR. Would take EBG3 over the PR1. PR there is not enough color contrast to get the elevation cues.

CCFN30: Unity cannot see the towers. Fishnet always shows up near the airplane. Likes this better than dem1, because can pick out the ridge in this display better, for some reason. Time delay and then a very rapid response for the roll input. Unpredictable response for the input you make. PTS requirements are fairly easy with a bit of work.

PR1: Can't see the towers as well. Don't get as much of a feel for the terrain relief as the EBG. Would still pick EBG3 over PR1. PIO tendencies, etc. EBG is clear preference over PR. Handling qualities of task far dominates the task more so than the different terrain concepts.

Block 2, Low Altitude:

PR1: Lower altitude makes Unity display more useful, as well as the 30. Can't see much difference in the handling qualities, due to the lower altitude. Fixed base, no other motion or body cues, turbulence random inputs that comes across to the pilots. Dominates the task (workload), so terrain display was not looked at. Lower altitude, PR more useful. Provided more terrain awareness.

EBG1: Still prefer this to the PR. Gave us a ride, on performance, but we still think it was within 90%. Handling dominates rating, regardless of display. Still have not come up with a preferred FOV, maybe 30 and 60.

CCFN30: Not bad, towers are pretty clear, easy to see. Really hard to pick out where mountains and valleys are. EBG best of all, regardless. This would still be usable. FOV30 and 60 using the most. All of them seem to work. Would be nice to see this in more rugged terrain, steeper inclines, etc. Workload and turbulence prone to PIO, especially if you try to close on VV (alpha command control system). keeping the pilot occupied, and detracting from the terrain.

PRFN3: FN not easy to see in Unity. If you look at pictures back to back, the 1 is sharper, but for performance, both are about the same. If 1 is more expensive, he would just buy the 3. "Txp cannot load" error came up on the screen. A lot of distractions, with the errors and the discussions, busted altitude for awhile. He knew it, and felt that there was not enough power to

climb. So, kept him at desired. Really feels that a good idea would be to set the scenario up so that he breaks out of the clouds and terrain is imminent. Couldn't tell a whole lot of difference from the DEM=1. Unity doesn't give him enough below the nose information.

PRFN1: Really feels the need to look into the vertical FOV associated with each horizontal FOV. Really concerned about this Unity FOV - is the vertical FOV slaved to the longitudinal access? Some real issues between minified displays and Unity, because you might hit something before you see it on the Unity.

BSBG BL: Easier to fly with no background because there are no other distractions. Actual workload not quite as high, because you don't get distracted by the terrain. Can concentrate entirely on flying the airplane. The MX20, he would have it in the regular mode, not terrain awareness mode.

CCFN1: Towers are easier to spot in this concept. Unity FOV loses some objects supposed to be there. Objects appear to be too far away for the other FOV settings. Actual performance of display concept is poor.

EBGFN3: FN hard to see. FN not much help. FN fades away and hard to see. Not much difference between the DEM1 and this resolution. Cannot see the towers at unity FOV. Difficult to tell between DEM 1 and DEM 3.

EBGFN1: The 60 FOV is the best, can see terrain below. FN does not do much. DEM 1 and 3 are no different.

EBGFN30: Appear to get a lot of terrain details even at DEM 30.

PRFN30: Hard to see towers with PR backdrop.

Block 3, Approach

PR1: The GS was not working properly (still set at 6deg from a previous test flight). But, because subject pilot was pressed for time, we continued on and didn't run it over. Delay between when he makes an input and it registers (500-600ms) - workload is high. So busy flying, that didn't pay too much attention to terrain. Likes FOV60, because he can see what's below him. Doesn't like Unity and 30 for the very reason that you can't see what's below you.

CCFN1: Unity is too hard to fly. FOV60 provides best correlation with the outside view. Same problem. Poor handling qualities, and extra effort with turbulence is too high. Very frustrating because it's so hard to fly with the way we have it set up. Takes away from ability to enjoy the ride and pick up things on SVS display, and you're fixated on the tunnel. Flies too hard, so he suggests making it a little easier to fly - still give some workload. Would rather have the map mode instead of the terrain on MX20. PR was nicer in that he actually saw in his peripheral where the CC can't see anything. So would probably prefer EBG or PR on approach.

BSBG BL: FOV 60 is just right. Unity, with crab angle, puts box way in airspeed tape, so it's annoying. Was on the edge, performance wise, out of path laterally and vertically for some time, but couldn't tell if it was for more than 36 sec. So gave him desired. BL doesn't give any terrain awareness, so found himself checking MX20 more often in this case than the others.

CCFN30NT: Display provided man-made obstacles very clearly. Terrain is not as easy to see. Approach takes you away from all natural high terrain. Used MX20 a few times to double check

SA. Tunnel in a real quick scan tells you when you might diverge. Tells you instantly where you are and how to get back. Would like to have tunnel, but has a high workload in itself.

PRFN30: 30DEM is not too much as far as real precise identification of terrain, but the PR gives you a general idea of awareness. FOV60 the best, because it most closely represents the out-the-window (OTW), in his opinion.

CCFN30: The 30 DEM not helpful but better than baseline (Blue over Brown). MX20 was used more for terrain.

EBGFN30: Like the EBG, 30 DEM is better than 1 and 3. Even better than the PR. FN does not make any difference. Likes EBG. Good feel of where the mountains and towers were. Good contrast.

EBG1: Nice display, good details, good terrain awareness. Did not help workload but is a good picture of the terrain.

EBGFN3: Not different from EBG1. FN did not make any difference. 1 and 3 DEM are both good. Did not notice the FN.

PRFN3: FN does confuse the roads. PR good SA. EBG stands out more.

EBGFN1: Objects outside look closer to you (both OTW and SVS). Nice display. Can not tell between 1 and 3 DEM, good SA. FN does not make any difference.

PRFN1: FOV 60 is closer to the actual OTW view than unity. 30 FOV is more difficult to fly in a crosswind. Likes FOV 60 overall. Good display. FN confuses the road. EBG better. PR good job. Overall comments: Handling quality of the sim is poor. Turbulent is high. Difficult flying the corner of the tunnel. Some clutter on the tunnel. Prefer flight director. It is less obtrusive.

Rare Event:

CCFN30: At 3:55 said that something isn't right. Since it was yesterday when he flew it, he waited awhile, but the OTW view made him check the display again. Checking the MX20, and everything was fine. So, he was thinking that the display concept was just not representative. He also thinks that fatigue played a factor in how soon he picked up on it.

Subject 6 (BRD Baseline):

Block 1, High Altitude:

CCFN1: Okay. I'm supposed to be at 100, not 90 kts. That's my fault. Is it controllable, yes. Is adequate performance attainable with a tolerable workload, I'd say yes. Is it satisfactory without improvement, I don't know. I would say, no. Deficiencies warrant improvement. See, some of this stuff is just because I'm not familiar with some of the graphics on that particular display, so... Okay. I guess we'll go with 5, then. Yes. I guess I should have, should have read. I don't know. The last practice that we had was at 90 knots, so I kind of keyed in on the 90 knots. The graphics here on the M20 or whatever, it is, I think that the reason that I was trying to change the scale is that the display is so small, you have to have really good eyes to see when you hit abeam point. So, that's why I was probably trying to make adjustments – it's just hard for me to see. As far as the ADI display, I'm just, it's going to take a minute to get used to the symbology that you've got.

EBGFN30: Alright. It's better when I have the throttle all the way up there at the start it looks like. You have to. In fact that was my problem last time. Controllable, yes. Adequate performance attained with a tolerable workload, yes. Is it satisfactory without improvement, uh, let's see. My perspective, this relates only to terrain, correct? Meaning, the, your ADI display, am I to encompass that in the evaluation of the whole system or just as it relates to the terrain awareness? (This is related to the whole system not just the display itself. But we'll take the display comments, also.) Okay. I'll go with number 2. The terrain is a good depiction for awareness. I have to use your terminology here, your trend, whatever you call it, but your ADI display, I don't know, until I get used to it, it has some things to be desired just on symbology and things like that. As far as usability it's a, at the moment anyway it's less usable than some of the displays that I've used. Well, for one, it's been awhile since I've operated without a flight director. So, it's raw data here, you know, and to me, the trend vectors are maybe not as large or not as prevalent as some of the systems that I've used. So you've really got to key on very closely as to what to look for. But, the terrain display was good. I'll have better comments when I use this a little more. Right now the display itself, the ADI display, is a little foreign to me as to the symbology, and the trend vectoring information is a little bit hard to pick up on. Yes, as far as manipulating the airplane, altitude and airspeed wise, the trend information is not as bold and as prevalent as some of the ones that I've used before. Let's move on and maybe I'll get used to it. (The MX20?) Yes. The depictions are very small, and you really have to, at least for me, look closely to see when you're abeam. I'm sure it could be adjusted, but the symbology is very small, and I have to, well, I supposedly have 20-20 vision, but I don't know. You really have to get up close to the display to see the relation to the abeam point. It's just difficult to see. In the real world if you were using that, and you weren't focused you could easily go by it without turning without seeing it.

CCFN30: I'm starting to pick up this grid a little more. I don't know. Without the colorization of this it doesn't, it's not the best. Okay. I think straight and level, it doesn't make that much difference. With this particular display it doesn't make that much difference, with this brown color. Yes, the field of view doesn't make a lot of difference with the display, the terrain display the way it is now. Okay, is it controllable, yes. Is adequate performance attainable with a tolerable workload, yes. Is it satisfactory without improvement, no. It has improvements to be made. Deficiencies warrant improvement, so I'm limited in this block to number 4.

PRFN3: *Computer crashed 4 times, so did not run. Ran PR3, instead.*

PR3: I think that this photo realistic is as good if not better than the second one, the EBG. Controllable, yes. Adequate performance attained with a tolerable workload, yes. Satisfactory without improvement, I'm going to say yes, and we'll call it a number 3. Well, the only thing, the only difference would be the display. I like the photo-realistic better than the EBG. This is the best one so far. Everything else remains pretty much the same. I'm getting a little more used to using this display, this ADI display. I don't know, it's a more accurate depiction, probably, of what you're going to see if you're looking outside if you had good visibility, reasonable visibility. As opposed to a cartoon type of display.

EBGFN3: Well, one comment, from here, I don't know if I can differentiate the fish net, at all. I don't know. I can't really – I don't have it side by side with the non-fish net EBG. But, I don't know if there is any difference as far as the depiction of the terrain. Honestly, I can't see the fish net at all. When I see the green upcoming, I may be able to tell it. Now, this top pointer is like opposite than a T-38, so I have to get used to it. Yes, it's just that this top pointer is just opposite, actually, of the one I'm used to. If you don't think about it, you'll turn the wrong way. Yeah. Let's see, I'm going to try and look for the grid. You know, honestly, it's hard to differentiate the

grid. Okay. Satisfactory without improvement... between 2 and 3. I'll say a 3. I can't differentiate the grid. Maybe if I had them side by side, I could tell you which one I like the best. But, I can't remember how this one differed from the one without the grid.

EBGFN1: Okay. So, this one's better resolution. Well, I guess it is a little better. Are the other guys all over the sky like this, or is it just me? (Everyone fights the turbulence. Can you see the fish net now?) Actually, yes. I can see the fish net now. In fact it's the first time that I've been able to really see it. It's just kind of there. I guess that 90 is maybe the best at this point. You can see almost further under the nose. Satisfactory without improvements, um. Well, let's see. I would say it's a 3. Is it controllable, yes. Is adequate performance attained with a tolerable workload, yes. Is it satisfactory without improvement, yes. That's a close one. Yes, but, fair. Mildly unpleasant deficiencies. A three. I could differentiate that fish net, but I don't see how it really added much to the terrain awareness.

PR1: Ah, I mean this photo-realistic is definitely the best depiction. It's more in-line with what you see outside. Maybe I'm getting a little better at flying this thing. This terrain, this pictorial is much better for me than the others. It would be nice to compare them side by side, you know? Because my memory is fairly short. (You couldn't tell between say the 1 arc-sec and the 3 arc-sec?) It's really difficult. Is there any guys out there with really keen eyes that can tell a big difference? (At this high of an altitude, it is fairly hard to tell a difference in the resolution.) Is it controllable, yes. Adequate performance attainable with a tolerable workload, yes. Is it satisfactory without improvement, I'll say yes. I'll again say 3. I hate to pick the same number. You might want to consult with better eyes, because I can't differentiate between them, you know?

EBG1: Yes. This is, as far as being able to differentiate terrain features, as good as the photo, I think. (You're still sticking with the field of view of 60?) You're absolutely right, I need to start playing with it more. This one right here is 90, right? I think that's the best. Because when you're close to the terrain, it enables you to see more under the nose of the airplane. A better field of view closer to the airplane. Yeah, I think that 90's the best for me.

PRFN30: *Crashed twice, so didn't run - added PR30.*

PR30: You know, between this and – I don't know. You know your EBG? Now that I have a little more experience looking at it, I think that may be able to differentiate terrain features better than this photographic. Because it's, the difference between the hilly area and the flatlands, you can't really differentiate the break point of where that starts on this one as much. Is it controllable, yes. Is adequate performance attainable with a tolerable workload, yes. Is it satisfactory without improvement, I'll say yes. I'll say 2. Yes. In fact, just looking at this display, you know. Learning how to... The big thing for me is, well, the terrain displays are similar, but to me, just coming off of different equipment and learning to use this ADI display and the manipulation of the aircraft itself. Just becoming more proficient with that is helping. I've flown for years with the same type of stuff. In fact I flew a 206 project, the WARP project. I did all of those flights, and to me, GA pilots have a more difficult task flying their aircraft because of lack of instrumentation. They don't have RMIs. They don't have flight directors. They don't have all of these things that you become used to using. And, so, take a guy like me who's come from flying the 747 and come back flying this stuff, it's probably a lot more task saturating than a guy with less experience who's flown only this type of equipment.

BRD: To me, just as far as manipulating the aircraft itself, you know, I'm an Air Force guy and trained on steam gauges originally, so it's natural to me. It's more natural even just right now as

far as manipulating the airplane than to use that display, that ADI display that we've been using. As far as adjusting your scan, and you know, where to look for information. Also, they need to on this HSI or this heading instrument, they need to put bigger tick marks. 120 to 150, I have to count. Do you see what I'm saying? This graphic is not displaying... (Not like every 10° like you're used to?) Yes. Controllable, yes. Adequate performance attainable with a tolerable workload, yes. Now, we are relating this, this questionnaire relates to the usability of the whole system, including terrain awareness, correct? Okay. I'll say, is it satisfactory without improvement, I'll say no. I'll use a solid number 4, minor but annoying.

PRFN1: (Can you see the fish net?) Yes, I can. I can see it a lot better, the fish net. This is the best resolution, right, with the fish net that I've seen? Correct? I'm sorry, with the photo realistic. Yes. (Okay, now that we've determined that you can see it, is it giving you any added information?) No. Actually, not really. Okay. I'm going to start toggling here just for... this 90 is, in my opinion is the best. Okay, you know, I don't know if it adds anything, or not. I don't know. It might – it's not that I don't like it. I really like it all. You know, it may add a little because since you're dealing with all of the same color, it may help differentiate higher and lower regions. I don't know. Controllable, yes. Adequate performance attainable with a tolerable workload, yes. Satisfactory without improvement, I'll say yes. I guess a two. They're all seeming to be the same, now. That grid I don't think it detracts from the display, but I don't know that it adds anything. I don't know.

Block 2, Low Altitude:

EBGFN30: This one I like better. The ninety. I see those grids. I don't know that it adds that much, though. I just can't get turned on too much by the differences. I'm trying to, but I can't. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvements? I'll say yes. I'll say the good old number two.

EBG1: I like this. I think so far for the second half of the day, this is probably the best depiction. It looks like I'm over Tucson or something. I don't miss the fishnet. Fishnet is highly undesirable. Lovely display. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Good, negligible, so I'll say 1.5. . That particular display at low altitude was the best I've had, I guess. It's probably the best I've seen after lunch.

PRFN30: Sometimes like right now at the bank, the part of this depiction here is getting in the way. Do you see what I'm saying? Where your bank indicator . . . like right now. (Are you talking about the pitch scale? It kind of overlays it?) Yeah, it does. Overshot the 50 while I was looking at that. Unacceptable. (I know that you had said that still at this altitude you preferred the 90.) Let's look at it here. Yeah, I still think this is the best because you can; like I say, you can see more under the nose of the aircraft. Let's see if we can try something. Yes, for sure. Very nice fishnet. I just don't think the fishnet does anything for me. Doesn't turn me on like it probably should. (How about that texturing concept? The photo-realistic and then with the 30 arc-second, lowest resolution?) This, I would prefer the highest resolution of the, is it EBG? The EBG, I would prefer. Yeah, that's better than this one. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvements? Yes. I would say, let's see . . . that one is a 2.25.

PRFN1: I need to have a piece of tape up here, or something, so I can read it. I'm telling you; I'm all hands without a flight director. It's all thumbs. Thumbs is the word. Like I say, the biggest thing for me about this whole thing is the -- and it probably wouldn't affect other guys -- but it's just the depiction on it, on this ADI instrument. And it's just because it is vastly different

than what Boeing has. That's the only reason. That's why sometimes I lose the scan a little bit. Yeah, yeah, I think you're right. I probably didn't pull it back because this is full power at 96 knots so it's not accelerating, so that's probably why. I forgot to pull it back. I can see the towers. I have a pretty good visual on the towers. I don't know, no specific comments on it. I think they're pretty close to me. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, I'll say two.

CCFN1: This is, you know, it's not, not nearly as acceptable as the other ones. There's no terrain differentiation between, it looks like it's a desert floor or something. It really doesn't give you good terrain information. Fishnet's wonderful. Oh, I don't know. Fishnet's, I don't know; can't really see it that much. Maybe it might be a little bit that it's helping, but it's, I don't know, it doesn't, I'm not really turned on by the fishnet. (Since you're obviously chitchatting, that means that you are not task saturated. Correct?) Not yet, but I probably soon will be. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvements? I would say yes. And let's go with a 3, because I liked the terrain features on that one.

PR1: Yeah, better than the last time. I like it without the fishnet. I'm going with my no fishnet type of scheme. Well, I'll have to auto-roll this like 25 degrees to catch back up to my pathetic flying. Oh, see. I salvaged it; there's the ridge line -- last-minute salvage. I do that all the time. I don't even know what to look at. (So you're still sticking with the field of view 90?) Yeah. If it was my airplane, I would just have it hardwired that way. This one's not bad. Like you say, I like it without the grid, without the fishnet. (Please continue with the desired performance rating, although you did bust your altitude a couple times.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, 2.5. I don't know, the resolution on this one. That was my favorite so far, it was the highest resolution, the photo display without the grid. Well, it was a toss-up for me between the EBG the highest resolution, and the photo-display highest resolution. They're within, to me they're so close, I don't think one is that much better than the other.

PRFN3: *Software crashed.* I've got enough to do my analysis. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, straight two. I'd say do it without the fishnet. Get rid of the fishnet and I'll be a happier person. I don't know, I'm running out of comments. I don't know what to say about this. You know, I'm thinking they're all so close. I'm not a very discriminating person, that's the problem. I don't know, they are all very close to me.

CCFN30: Well, you know, it's a little bit more desirable fishnet. It's more prominent, you know, with this particular resolution, it's probably the best fishnet. See, I'm finally figuring out how to look at this crazy display. See, I'm very slow. I come from the country and I'm finally beginning to get aware of all these things he was telling me at the briefing are finally clicking -- maybe -- on this display. This terrain monitor stuff and I don't know what you guys call this. You have a special little name. I don't know what watermark means. And, in fact, to tell you the truth, I don't know what function it serves. (The waterline is where the nose of your aircraft is pointing, where the velocity vector is your flight path. So if you're in a crosswind, crabbing, you're going to see separation between the two of them.) I understand, but I mean I've never had that on an aircraft. Does it have any other functions, I mean usable functions, that you know about? Do you actually need it? I mean, I think I can do without it. Because it was very similar to the one before.

BRD: With this kind of display I know exactly where to look. I guess I'm getting used to the other one. Well, yeah. I fly a 38 twice a week and it's still the same steam gauges in them. Oh, man, that was the ridge line again somehow. Alright, that was 20. Okay, let's see, I'm going to say no on the third block. Is it satisfactory without improvement? No. Deficiencies warrant improvement. I can't go to 4, right? Oh, I have to go to 4. I'm going with the 4 then. Because it's the only one I could choose in that particular block. Uh, minor but annoying deficiencies. Like I say, in order to be using the scenario, I've got to look at an area chart for terrain, basically. Or, you know, look at -- I mean I don't have anything straight in front of me, you know, that's a one-stop-shop on the ADI. And I've got to look at my SR20 (MX20) or whatever you call this thing.

EBGFN3: I'm going to start my leisurely turn over to the ridge line. I like this display. This is a really nice display. I think it could be with or without the fishnet. I don't think that makes a heck of a lot of difference.

EBGFN1: This looks pretty good also. I think this is, I don't know, maybe, maybe one of the best ones I've seen. Now, tell me. What's this resolution versus the one we just had? Yeah, I like this one. (So you can tell a difference between the two resolutions?) Well, if I had glasses I could. But I don't know, they're real close to me. (How do you like the fishnet?) I can live with it. I think under the high resolution displays you can take it or leave it. It doesn't necessarily detract, but I don't think it adds too much. I'd like to be on record as being a non-fishnet person. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I would say yes. And I'm going to give it a 1.25. (So you liked that display the best.) I mean, you know, yeah. Either that one or the one without the fishnet is fine on that particular display. I originally thought I liked the pictorial, but I think that the -- Which was it, the EBG? Exactly, that's actually maybe a little better.

Block 3, Approaches:

PR1: Okay, did I, all I'm doing is going for the center of the box. Am I lining up fairly closely? (Yes) Really? Okay, thank you. I don't know, this is kind of my first experience. I've been in the 75 and (chief pilot's) flown the same type of system. This is my first experience doing it myself. I don't know, it seemed if you were just going for the center of the box, you were right on, right on localizer and the glide slope without having to use the peripheral gauges. And the FOV control here, I don't know, the one that I was on -- I don't know which one that was -- but that seemed to be really the only one that was kind of useful. I don't know. (Okay, I believe you were on the 90. At least, on this particular one, you think that 90 is the only one?) It seemed like it. It seemed to me. So is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Alright. I mean, I was supposed, I had initially a 90 degree crosswind. Okay. What I'm saying though, is I'm just lining up my airplane, which the ADI instrument represents the airplane, in the middle of the box; which you say I have a 90 degree cross. Should that, with a 90 degree crosswind, should that watermark, that waterline, be in a different position than straight in the middle? (That is always at a fixed location. The other one that has a circle in the center? That is more like the velocity vector where you can tell the direction your airplane's heading.) So, really, really, it would be best to line up the V -- the velocity vector in the center of the -- with the crosswinds, it would be better to line up the velocity vector in the center of the box and not the nose of the aircraft. Okay. Well, I'll take a look at it closer this time and maybe, you know, I've got to kind of squint to see this thing; but, anyway, I'll take a look and see if those two make sense based on the crosswind.

PRFN1: Now the velocity vector's in the box, correct? Right there. Am I right?

You know to tell you the truth, I really wasn't looking so much at the terrain this time. I was just getting used flying these boxes. Alright, I'm slow. So what it's telling me is obviously it's a right cross here. Yeah, alright, I'm trying. To me, it's not a matter of flying, it's symbology. Okay, this -- whatever I'm on now -- may be the way to go on the final. (Looks to me like 30 degree.) I don't know, just maybe the 30 appears to be a better display for the final. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes.

EBGFN1: Now, what I'm on right now, that's 30? (No, let's see. I think you're on Unity. Yeah, you're on Unity.) Is it controllable? Yes. Is adequate performance attainable within a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Again, I'll give it a two, and I think if you're flying these boxes, I don't think you can give as much credence to this terrain display as long as you are in the middle of the box. I'm using this display in MZ20 (MX20), or whatever you guys call this thing. MX20. As long as you know you're on the path and you're within the center of the box, I don't know, I tend to drop out the scan of the terrain behind the ADI. You know you tend to look at that less, I think. Maybe it's not needed as much.

CCFN1: You know what, like I say, I think for me I tend to somewhat drop that (terrain) out of my scan. I know I'm on the horizontal course here and I know I'm looking at my altimeter that seems to me, less important with this other information available. At this point, I'm not really, I'm just aware the terrain is there, but I don't think, at this point in the flight, you know with the scan of the altimeter and your path boxes here, I don't think the terrain really is as important as it would be in other modes of flying. Right. I mean I can look over here on my MZ20 (MX20) or whatever, and tell the horizontal picture and I'm obviously within the boxes, and I can use my localizer glide slope data, so it's really, I don't know if the depiction is that important. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, again, a two. Is there anything, as far as the field of view, that would be worth trying during the turn. Maybe I'm toggling them too fast, but if I slowed it down, there might be a better field of view to make that turn, you know?

EBGFN3: I think this, whatever field of view I'm using now is maybe better for the turns because it displays these boxes at an angle. At least for me, maybe you can see them a little better. I notice where I appear to be hitting the center of the boxes, from my perspective, I notice the altitude creeps up just a little bit on you. I don't know why that is. I mean, I think the one run I was up to about 2,700 feet. As far as I could tell, I was actually hitting the center of the boxes, so I don't know. (And you're flying in the field of view of 90 right now.) Alright. (What about flying a missed approach without a tunnel?) I say once you're in this mode of flying, I don't know that the difference in the terrain displays makes a whole lot of difference. Without the tunnel, I'm sure the terrain in that mode of flight would be beneficial. I mean, the way missed approach is run, it wouldn't be beneficial unless you're in mountainous terrain. If you're in mountainous terrain, yes, but you know, if not, it wouldn't make a lot of difference. (Do you have any other comments on that terrain? I know other than the fact that with the tunnel symbology, the terrain's not that much of a factor.) Right, I don't know. Again I think this terrain is better than the green display, the photo-realistic. The brown, I don't think the fishnet, really does change this one way or the other. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes.

EBG1: Now, I'm on the ninety now, correct? (Yes, that's correct.) I think you may be right about having more boxes to go for in this turn. I think I had it this way the first time and it seemed like it was easier the first time than it was the following times when I tried fewer, lesser fields of view. To me now, if I look at the terrain, it seems this resolution it's on now seems kind

of blurry. Yeah, I think that ninety is a little better until you get a little bit closer in because if you put anything else, you can't really see the depiction of the runway as well. (So what field of view do you like closer in?) This one works pretty good closer in. (Okay, that looks like unity.) This terrain depiction is better than the ... photo realistic. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes.

BRD: Definitely more workload with steam gauges. Much less situational awareness, terrain awareness with steam gauges. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No, and give it a four. I don't know, pretty drastic going from one to the other. The tunnel sure is nice. It merely eliminates a lot of the scan to have that, but you really lose, other than the horizontal view, you don't really have any terrain awareness other than looking at a chart and looking at your MX20.

PRFN30: I believe the ninety degree here is definitely better coming down just a straight and level flight. For me it's only like, I'm using two of them, this one and . . . That's weird, all of the sudden it gets real slow on its own. Anyway, this one and then Unity for the last little bit. There's a fine line between maintaining 90 knots and 91 knots. It's real sensitive, this throttle. I think I could just blow on it maybe and get it exactly right. This box tunnel really, you kind of keep everything else in your peripheral vision for a scan, but it causes or prevents you from having to look at a lot of different places around. Right about here seems to be a good time to switch the field of view. Then I've been placing the thing on the line or about, I don't know, right in the touchdown zone, what appears to be the touchdown zone. I don't know, I like the, I don't like the photo realistic, I like the other a little better. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'll say yes, and I'll call it a 2, or a 1.75.

CCFN30: Yes. You know all of this synthetic vision stuff is very good, but what you've got to keep in mind though, if this was really single pilot operations, a lot of attention span is being spent inside the cockpit and the FAA, the regulations say even under an IFR flight plan, still see and avoid when you have that capability. So, this is good but the scan would need to be here and outside the airplane when you aren't in IMC. You've still got to see and avoid when you're not in IMC. Now if you could come up with a cheap TCAS photo layer plane and superimpose the TCAS on this thing, you'd have it made. Okay, now is about the time, as soon as you can see it, to place the aircraft mark on the touchdown zone. It's probably just as easy this way as opposed to flying the box. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll call it a two. That particular display looks like a desert floor. There's not much differentiation between terrain.

CCFN30NT: Now this is weird. This is strange. I don't now. It's just - it's such a different presentation. For one, using the velocity vector . . . Let me see if I can get on altitude here . . . To me this velocity vector waterline thing is disconcerting a little bit on this particular display. It's just telling you your crab angle basically. But it is a little strange flying this way. Like I say, it's probably just me. I'm so used to a Boeing display. I'm looking for my localizer here. Is that, that's hard for me to see, really. This contrast with this red background is almost impossible to see. It looks like I'm going way past it. That's a bad deal. I don't like this display at all. Not at all. Let's proceed with the undesirable rating. It's just, where are you looking on this thing, for me. It's odd as can be. Yes. The scan is, just on this particular ADI display. (Are you missing the tunnel?) Yeah, I'm coming back to it here supposedly. To tell you the truth, I'd rather have analog instruments than this display with this. This is strange to fly this way. I kind of drifted up to the glide slope. For me that waterline is kind of a pain. Because during your scan you

automatically look up there and you know, it looks like an ADI also, you see? In fact, to me it looks more in the center than anything else. Yeah, this is really weird for me to fly like this. I don't even know where to look. I would rather have an analog than to fly like this. This full scale is missed approach material right here. Not with this ceramic looking . . . This is missed approach material here. It's full scale, it's coming back, but . . . Now let's see if we can salvage this thing. The scan is so out of whack on this thing, to me anyway. Of course it helps when the runway comes into view a little, on the scan. You'd have to get some young video player type people to be able to do that. See, I was looking for the localizer to come in on this red background and I couldn't see it. *A little high at the beginning, but not sure if it was beyond 36 seconds. Localizer turning amber is very hard to see on this background. Missed his turn point* Is it controllable? Barely. Is adequate performance attainable with a tolerable workload? I'll say no, deficiencies require improvement. I'll give it a seven. No, it was probably my fault. I was really looking at the primary instrument, the localizer, and it would be the localizer itself. I couldn't see it with that red on, see it's a red display or orange, and on that background I couldn't even see it.

PRFN3: Blurry. Yes. This looks kind of like, from up here it looks kind of like vomit. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll say 1.5. I'm maybe getting more familiar with the use of this display.

EBGFN30: I think the more boxes, the better, you know. I mean, if you're a weak pilot like I am, you need more boxes. This is the first time I've ever flown this stuff, you know. I was part of that security flying that we did on the 757, but (chief pilot) did all the flying. So this is the first time I've even had any experience with this. Blurry. It could be my eyes that are blurry. Full down with this, all the way to the stop, it's all the way to the stop right there. Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll give it a 1.25. Just because of a little bit more time with the machine.

Rare Event:

PRFN1: To me, this display, the ADI with the waterline with the, what do you call it, trend vector, they're too close together and you get them confused very easily. (Any comments on the terrain itself?) It looks marvelous. I don't know, it's a good depiction. The fishnet doesn't do a lot for me, though. It's pretty realistic with the towers. Am I supposed to be missing them? How close am I to the terrain here? (You're pretty much in the terrain. Oh, my goodness, what are you doing?) Seeing how low it is. Just do a little low level. That's called terrain masking. We used to do this in the Air Force, except in formation. We didn't have any idea we were close to death. (Did you have an idea of your bearings before you mentioned it?) Yes, well, we're below the ridgeline. That's the whole point of it. *Switched to 90FOV before we started. Still having trouble with controls. The ADI, VV, and WL are too close together and are easy to get confused, here. Terrain - a good depiction. FN doesn't do a lot for him, though. "Nice looking towers, am I supposed to miss them?" - mentioned at about 4:30. Kept flying to see how low he was. Did some scud running.*

Subject 7 (BSBG Baseline):

Block 1, High Altitude:

PR1: A little bit of light turbulence, huh? Lordy. Light, huh? *Very off on his numbers (very fast, 40 deg roll, overshot his target altitude). So gave him adequate.* Pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? No. Deficiencies require improvement. Pretty much adequate performance not attainable with

maximum tolerable power. Pilot compensation controllability not in question. A lot of that is me, not what I was looking at. Again, if it had been the brown over blue, I would have crashed it, but . . . No negative comments. It helped not to have to worry about where the terrain was, because, A) I knew it was out of range; but, B) I could see it. I haven't flown in turbulence like that in a long time!

EBGFN30: The terrain is so far away that it pretty much doesn't much matter. Now the nose of the plane to the . . . Okay, actually that visualization on the terrain looks pretty good. I don't know that the level of detail, is all that needed? I guess it might come in handy, assuming I can ever get the plane back to where it needs to be. In the lower altitudes, it may mean a lot. Okay. Oh, left me alone for a second or two. Does the turbulence get lighter down here? No, here it doesn't. Oh, well. Yeah, I actually had time to do that this time. Yeah there's a lot of level of detail there and, again at this altitude, I -- useless. It just shows me where the terrain is; now at a lower altitude I'm sure it will be a heck of a lot more important. At least I hope, anyway, if this was a real airplane. *On the border, speed wise. Due to pilot's problems, not to the displays. At this altitude, level of detail is useless. Thinks he likes the FOV60 - enough to show him what's going. He does not think that FOV30 gives him enough below his nose.* Is adequate performance attained within the tolerable workload? Yeah, the controllers have been a little angry at me, but I'll say yes on that one. Was it satisfactory without improvement? Oh, it could use some improvement, but it has nothing to do with the plane. It had everything to do with my improvement. Alright, we'll have to go with adequate performance requires considerable pilot compensation.; but again, these are for the pilot's problems, not the display's problems. So that was a five.

EBGFN1: Okay, I tried to use this unity display because it gives you the greatest difference -- I don't know how to put this -- it gives you the greatest accuracy on your velocity and acceleration factors. I don't know, it was a lot harder to fly but you also get a lot more feedback into what's going on. In other words, when you see a deviation it shows up instantaneously instead of on some of the other ones, all of a sudden it takes awhile before you actually see it. However, you have to think about it a lot more. Like I missed the, the uh . . . (The turn point.) We'll have to descend like that. Now I see the fishnet part. Okay. No, the terrain pretty much gives you all the cues you need. The fishnet just kind of doesn't do much of anything. The red and green or the browns and greens and things along those lines are a lot more helpful. (Are you pretty much sold on that 60 degree field of view or?) Yeah, for this type of maneuver that seems to be the best. This one doesn't add anything. That one, the unity one, I mean if you're really trying to -- I'm sure if air traffic control really wants you plus or minus fifty feet -- this one would be the best because you've got almost instantaneous feedback as to what's going on. Alrighty, pilot decisions: Is it controllable? Yupper. Is adequate performance attainable with a tolerable workload? Yeah. Is it satisfactory without any improvement? Yeah, I was able to control it a lot better that time, but there were some unpleasant deficiencies in my flying, not in the equipment. So that would be minimal pilot compensation required for desirable performance? No, that's not right. Well, I guess it isn't satisfactory without improvement. I need some improvement; however, it was minor but annoying deficiencies. Desired performance requires moderate pilot compensation, which would be a four. At least I pretty much stayed within the bounds. There were a few times where I would lose control but the airplane was flying me. The fishnet, at this altitude probably didn't add much of anything.

PRFN3: Okay, starting the turn and descending. Stay over there! Turbulence and I are going to have a talk. Well, that was just mediocre. I don't know what that was all about. Well, a little bit of a roundabout way to get there, but we got there. Boy, that just was terrible. *He was out of bounds on speed and heading, but we don't think he was out for more than 10%.* I believe you.

Was it controllable? Yeah, just barely. Is adequate performance attainable with a tolerable workload? I'm going to say, yeah. A lot of that was fixation. Is it satisfactory without improvement? No. Deficiency warrants improvement. Adequate performance requires extensive pilot compensation. On that particular run, yeah. Six. But that was more of a fixation problem than anything else. (Any comments on the display itself?) No, I didn't have time to look at it much. However, most of these go with the same one as before. When I did have time to look at it, it told me where the terrain was, but I was so high above it, it didn't much matter.

PRFN30: Okay, I passed the turning point. I've just been looking at the scenery. Oh, there we are. I'm not too sure that the fishnet, especially with the photo-realistic, is very helpful. I don't know if it's more of a distraction or what. Minimal pilot compensation required for a desired performance, a three. (Any other general comments about that particular display?) No, just the ones that I normally have with this altitude. It doesn't make a lot of difference.

BSBG BL: Oh, okay, that might be useful. Okay, we're abeam of the point. Standard right turn, or try anyway. I've been having problems holding that. Whoa! That's what I get for concentrating on the turn. Good old fixation again. And I'll assume there are no mountains in front of me. (And it's just the same scenario as always. You should be right about the same place on your MX20.) Right, it's telling me that, but I come from a nuclear background and you don't rely on, well I should say you can't rely on computers by NRC regulations. (So, do you miss the terrain at all on your PFD?) No, because I know it's not there. On the low altitude ones I may miss it a lot, but I at least I was smart enough not to go too low, although I missed the heading. Thank you. The direction I'm going. No, it has another name. *Fixated on turn, and overshot, but only out of tolerance by about 12 seconds. Bank angle was +10 for about 5 seconds. So still within 90%. Doesn't miss the terrain, yet, because he knows it's not there. But, he had no idea of terrain awareness. Stayed on 30FOV for this one, so he could get more precise on the symbology.* Okay. Was it controllable? Yeah. Was adequate performance attainable with a tolerable workload? Yeah. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Well, they were minor but annoying deficiencies. I required moderate pilot compensation; that's my own fault. So that's a 4. You absolutely had no idea of terrain awareness except for the MX20, that was it.

PRFN1: I might have to pull power back, a minor detail. And this time we'll watch for the 50 (heading). I'm trying to find one that maybe looked better but I always seem to come back to the 60 degree field of view. It gives you enough of a deviation on the symbology to catch the airplane. A better pilot would want to go here (30FOV) or here (22FOV). Maybe after about three days of this I might be able to fly it accurately. This one also lets me see the terrain enough, which will become important soon. Again, the fishnet is extra added dressing. I don't know what it buys you at this level. Yup. However, after the low altitude one, I might have a different opinion. *Always seems to come back to the FOV60. A better pilot might want 30 and Unity. 60 gives him what he wants to see below the nose.* Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Actually I will say yes, because I assume I stayed within parameters. There was some minimal pilot compensation. I think you guys lightened the turbulence a little. Either that, or I'm getting used to it; one of the two. We'll call that one a three.

CCFN1: I guess the actual thickness of the fishnet is also a function of how high you are above it? (Actually the thickness stays constant.) Okay, it could be a little thicker. Again, the terrain is hard to be aware of because it's a very small feature. On the 30 degree one you can't see the terrain at all. Okay we're beaming the point so we'll nose down and improve a little bit of our air speed. Now 50 degrees bank. Keep it there. Try to remember 50 degrees. Okay, beginning to

roll out a little late. A little air speed. Yeah, well as you get a little closer to it, it gets a little more defined. The fishnet, which tells me the terrain on this one because there are no other cues. Maybe the 90 degree is a little better to get the actual terrain. But then you lose the fineness of your symbology. A little harder to fly. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Well, everything needs improvement, so that was minor but annoying deficiencies, number four, which is desired performance requires moderate pilot compensation. Again, it had nothing to do with the display; it had everything to do with the pilot.

CCFN30: I don't see much difference between the two, especially up at this altitude. The big thing was that I really couldn't tell much difference between the one and thirty (arc-sec) at that altitude. (Any comments on the fields of view you scrolled through?) I was again trying to find a comfortable one, and the 60 seems to be the comfortable one at that altitude, for that maneuver. *Missed turn point.* Well, so that would be the minor but annoying deficiencies, which is desired performance required moderate pilot compensation. Like the display telling me what to do, so that's a 4.

EBG1: I don't know, the photo-realistic one may be the best one, but I like this one. The elevations are just easier to see because they are color-coded. Down at the low level, that may be of little to no consequence. But at this nice high level where everything is safe and I really don't have to worry about it . . . Oh, and the velocity vector is color-coded; I didn't see that before. Okay, coming up on the altitude, air speed. Oh yeah, down here, 1,500 feet lower, it looks a lot better. Everything was just kind of not the brown right below me but the brown off over to the right, but yet now it's a different color brown. It was controllable. It was adequate with a tolerable workload because I did get to talk. Is it satisfactory without improvement? Always something can have improvement. But actually in this particular case, it was fair with some mildly unpleasant deficiencies, which is minimal pilot compensation required for desired performance. (Number three?) Yes, and that was because I was talking and looking and not flying. (Is the field of view still 60?) Yes, again, the same reasons as last time.

EBGFN3: (Can you tell much difference between this display, which is a medium resolution and the one you just flew, which was the highest one?) No, when it gets further out, I notice it gets a little blurrier, but that's far out, and I'm not flying over that. Maybe it was a little blurrier on the other one, but I just notice it more on this one. Mainly because I have time. I guess I do have one question real quick if I can get it in here. Now the actual little contours, are those one and three and 10 arc-seconds or whatever it was, or is it just the fishnet part of it? (It was the actual contours in the appropriate terrain.) I can't determine any difference between that one and the last one. Now, we can start. Woops, what am I doing? Yeah that looks kind of like the same definition, maybe a little more, but I mean whether the little gully in front of me or not has two or three things coming in to it is unimportant. Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yeah, I did okay there. There were some mildly unpleasant deficiencies, but I'm a perfectionist, so you know how that works. So that would be a number three. I couldn't really tell it from the one before.

Block 2, Low Altitude:

EBGFN1: Okay, I think I got the hang of it back again. Let's see, we're coming up on our turning point; I'll go ahead and start to turn. I'm at 5,000 feet and 50 degrees heading. And now the fishnet does help a lot. You can definitely see terrain features a little bit better down there, especially with that wonderful tower. Towers, I guess. They're still there, aren't they? This one gives you a much better perspective of exactly what's underneath you, like that peak that I'm about to fly over. But again, you lose the resolution on the symbology. That's 60 degrees, which

is what I'm normally used to. You lose what's actually underneath you, but everything else seems to work out alright. This one you . . . oh, are there towers coming up on that hill? I guess that's what that is. (Just to let you know, you did have a desired performance. Even though you overshot a couple of things, you were able to adjust and get back before the time.) It was controllable. It was adequate performance attainable with a tolerable workload, although the performance was unsatisfactory, but I got side tracked. So we have minor but annoying deficiencies, so that would be a four. And they're probably only annoying.

PRFN30: Right. Actually I'm coming up on the turn, but you can see a whole bunch. Okay, I'm going to go ahead and start to execute the turn. A little more control on the power anyway. This time I'll remember 50 degrees (heading). Lots of extra. I don't know, the resolution on actually the photo-realistic is also at 30 arc-seconds, right? (Yes.) Yes, I guess it is. It's a lot less resolution of course, than the one before -- the one arc-second, I guess is what it was before. Yeah, you lose a lot because now I can hardly see -- of course that's also the photo resolution -- I can hardly see the towers which are kind of a dark color, like the trees. The green part. So you lose a lot by having the green and the towers be approximately the same colors. It was controllable. Adequate performance with a tolerable workload? Yeah, it was tolerable. There were some mildly unpleasant deficiencies, so we'll go with a three on that one.

PRFN1: Whoa! Yeah, a lot more responsive. A lot better than the last one was! Of course here, more definition might be useful. (At this altitude?) Yeah, for the one arc-second data. I have to make bigger inputs than that. (Comments on the field of view?) The sixty seems to be kind of the best of both worlds. The ability to control the airplane through the symbols and then the ability to see what you've got a hold of. It looks much more realistic as you come up on it, the fishnet, anyway. It's much more visible than at the higher altitudes so, you can actually see the fishnet, where before I was having problems even seeing the fishnet against the background. (Okay, is it providing you any useful information?) At this resolution, yes, although, however if you look over on the right-hand side, you'll notice that it's double what it is in the center. Pilot decisions: Is it controllable? Yeah. Is adequate performance attainable with a tolerable workload? Yeah. Is it satisfactory without improvement? Barely, which is the somewhat mildly unpleasant deficiencies, just because I stink as a pilot, but that's alright.

CCFN1: This one is kind of muddy at this altitude, but I'm sure it will get better as the scenario progresses. (It's a river.) Yeah, with the constant color, the wider the better. You can see more of the terrain that way, especially the important terrain in front of you. (Is the fishnet providing benefit?) Oh, well, yeah, that's the only way I can see the terrain. I am sure that if you take that away I would just see an orange blob. Was it controllable? Yeah, well. . . Is adequate performance attainable with a tolerable workload? Yeah, I can talk! Is it satisfactory without improvement? Yeah, I got to see what I needed to see; but, of course, there was some mildly unpleasant deficiencies. Although not as bad as the last one but still not enough to go to a 2, so we'll make it a 3. The fishnet in general -- I don't know how much control of the programming you're going to have but, maybe if you could just make the fishnet a complimentary color to whatever bit was supposed to be displayed, that might make it a little easier to see. Can you make it a complementary color? Say if you're going to, if you're going to pop up a green bit for that one place where you want to draw the fishnet -- make it red or orange, I think is the complementary color -- -- yeah, the complementary color to whatever was going to be displayed. That might make it a little more intuitive to see.

BSBG: We're supposed to be at 5,000 feet, correct? How come I can see the two towers in front of me in the fog? I'm a hundred feet over them supposedly. *Over thought the BL. Missed the terrain. Worrying about altitude, and overshot heading by 50deg (000deg). But, saw it, and*

corrected during the time required. Saw the Goal Posts (towers) on the OTW, and was very disconcerting, especially since he did not see them on the display. Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Would deficiencies warrant improvement? Yes, and now I'm just deciding between minor and moderate objectionable deficiencies but I was so worried about altitude, I forgot about direction.

EBGFN3: (Any comments on this display or the fields of view that you're switching to?) I like it. It tells me a lot. But when I make the turn will determine how much it tells me. Yeah, with elevation-based coloring, that really tells me what's going on. (Is the fishnet helping you in this display?) That's what I was trying to determine. Yeah, you know I guess in reality, it is. It is showing me more. I don't have to think as hard to see the slopes and things along those lines where, from the higher altitude that we had before, it didn't help much at all; but down here, yeah, it really helped determine exactly what the contours looked like. Pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? In this case, yes. Is it satisfactory without improvement? Oh, man, I'm going to have to say yes on that one. And there weren't even some mildly unpleasant deficiencies. There were some negligible deficiencies, so nothing gets a one. That works. Well, that was a 2. No, I liked it. It was nice.

CCFN30: Okay. It's better than nothing, but the elevation color database, no that's not what you call it – anyway the colored one with elevation, that one's pretty good. Okay, so we'll see what it looks like when I hit 5,000. Up here it's okay; you can kind of get a feel. In fact, for this one it's a little better if you pull out to the 90 degrees because you can get a little better feel for what's going on. Okay, ready to start the descending turn. Not that much. Now, with this one, the 90 degree helps a little more than the 60 degree to see what's coming up. (How about the resolution?) It's enough. I don't know for an approach that it would be enough, but for doing this kind of stuff it would be enough. Pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Minor but annoying deficiencies, so that would be a 4. Because it's hard to tell exactly what the terrain is.

PRFN3: Well, we're just starting out this one just perfect. Okay, back under control. That's what I get for looking out the front window. Well, it doesn't matter if I'm looking out the front window. Oh, missing my turn here so I will start to turn. The fishnet helps. I'm looking at that, I'm not watching my speed. Or my headings, thank you. (So you said the fishnet does help.) Yeah, helps to see the terrain because it's kind of all one jumbled mess down there. And, again, you pull it out to 90 and you get better definition on the fishnet, and you lose on the resolution of the symbology. (So you settled on the field of view 60 on that one?) Yeah. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. It's with some mildly unpleasant deficiencies that were my fault. That was number 3.

EBGFN30: Alright. I'm not too wildly a scourge as last time. Is scourge a word? Alright. I'm trying it on the 30 field of view because I can't quite see the fishnet yet. I'm ready to start the descent. There's the fishnet. I tried that on the 30 because with the colored I can see the terrain. The fishnet helps a little and being able to see the terrain then let me concentrate on getting my symbols where they should be. *Cannot quite see the FN at FOV 30. Saw FN at 5500 ft and FOV 30. Color can see the terrain.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yeah. In fact it's, there were negligible deficiencies and it allowed me to do more than I could do with some of the other ones. So that's a two. It allowed me to do things that I couldn't do with some of the others, like I was

able to look at the 30 degree field of view and fly the symbols a little closer tolerance than I could have with the other ones. Because I didn't need to see what was below me as well. (Did you notice that with the 30 arc-second resolution, did you miss the higher resolutions?) Not really, simply because again, I wasn't getting very close to it. I'm sure on approach that will change.

EBG1: I don't know if I miss the fishnet yet. No, it's just that it's real detailed. And that's I guess, a good thing. I guess if I wanted to and I'm in an F-18, I could fly the trajectory that was flown on Independence Day when the alien was chasing. You can see the two towers coming out of the mist? That was a little disconcerting when I didn't know where the terrain was. I still don't know if I miss the fishnet or not. I guess it is somewhat helpful to determine exactly what's going on kind of in between, it gives you a little more in between information. Yeah, yeah, in between the ridges and making sure the colors really are showing you a cliff coming in your direction versus something that's falling away from you. *He didn't like seeing the Goal Posts popping out of fog on the OTW.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? We'll say, fair. There were some mildly unpleasant deficiencies even though I knew what cliffs were facing toward me and what were facing away from me; it would have been helpful to have the fishnet to determine for me. Not for me, but help me determine that.

PR1: A lot of information missing because it's only fortuitous here – green is the top of the hills. Over in the Rocky Mountains, green wouldn't be the top of the mountains. Yeah, fortunately the bottoms of the valleys are developed, or kind of look like one green blob. Especially, without the fishnet, that does give you some relief as to the . . . I've also found out one very important thing – I can't talk and fly. That does give you some information about, you know, where the valleys are and everything. It actually shows you the hills but the fishnet helps with that. You know, with the photo-realistic between the (FOVs of) 60 and the 90, I don't know if it's showing you much, except at the bottom of the screen the forest is going by quicker than in a 60 degree display. So I'd be more interested in getting the resolution on this symbology worthwhile. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, but there were some mildly unpleasant deficiencies. The fishnet would have helped that.

Block 3, Approach:

PR1: On some of the things I'd given before -- on the flying the boxes out, making the turn and a little ways down until you probably hit the middle marker, at least until the runway becomes visible, it's the 60 degree one that seems to give you enough resolution to fly the boxes. And then when you get down looking at the runway, the unity one is the most helpful. The photo-realistic over the city, it was a lot different than what I had expected, which that was good. Yeah, well, it was different than I expected and I think it actually ended up being better than I had thought. So it was pretty good for over the city. Now over the country, the flights that I flew on Monday, it wasn't very good there. *Was briefed at 90knots, but forgot and flew 100 knots... that's why he was adequate.* Yeah, flew the wrong speed. But it was controllable. It was adequate, attainable with a tolerable workload. Was it satisfactory? No. Let's see, so we'll give it the highest adequate one, which is 5.

CCFN30: Yeah, the 60 degree field of view seems to be better for this one because there are no landmarks or anything like that. And the landmarks out the front window are quickly going away. Well it's turbulence, I would make it turn and it wouldn't respond, wouldn't respond, and then all the sudden it would kick me over 30 degrees. I'm a little better now. (Okay, the comment that you just made, do you think it is a defect of the model?) No, that's just the digital nature of turbulence on a simulator. Without having anything below me and with slowly losing

visualization out the front, it makes it disconcerting. Right as the clouds went away there was a mountain in front of me, even though I was turning. That's the 90 degree one? Yeah. Come on. I'll get to 90 knots yet. There we go. Okay. Oh, that's right, I need to flag to the dog bones, okay, so I am low. Was it controllable? Yes. Was adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No, it could use a lot of improvement. But it was minor with annoying deficiencies like not being able to see the terrain, so that's a four. The little fishnet wasn't enough fishnet to . . . Everything looked flat, especially like this mountain in front of me looked flat. The last one was pretty big. Yeah, the fishnet looked pretty big.

CCFN30NT: Great! The landmark went away! If it tells you anything, I would love to talk but I'm busy. What's that? There it is. Okay, that is the runway. Good. Okay, I've intercepted the glide slope and I'm coming in. So was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? That's a negative. I can't choose five, then? (No, you can't choose five.) So that leaves it with four. (Did you miss the tunnel?) Yes. Mainly because I didn't know . . . what the tunnel gives you is tolerances. So yeah, I could kind of skirt the edge but I'd still be within ATC tolerances. Where without the tunnel, oh, man, you're working like heck to stay on the two diamonds.

EBG1: (What do you think about this terrain depiction?) Again, out here it's not very useful. Especially with the boxes, you're worried less about the terrain than you are about the boxes. As long as you don't see anything looming in front of you, like a large mountain or something stupid like that. (Looks like you're at the field of view of 90 right now.) I wanted to make the turn in that and I forgot. Because the 60 degree field only gives you two boxes and it's awfully hard to make a turn in two boxes and I was going try it with this, and I forgot. So I was going to fly this way a little, because it gives you more boxes per mile, or nautical mile, or whatever you want to call it. Maybe I can fly better that way. But, yeah, for out here the terrain doesn't really mean much because the box is supposed to keep me out of the terrain. You would hope so, anyway. The nice thing about this is the EGB? EBG, yeah, the nice thing about the photo-realistic one was that you were actually able to see the runway. Oh, there's the runway. I'm just now getting up on it. Okay, so we're about at the glide slope. Okay, now we're at the glide slope. Speed back down. The problem with that view is that with the 90 degree field of view, you don't get a lot of resolution difference in your symbology. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Oh, my goodness. No, it could use some improvements, so it was minor but annoying deficiencies, which would be 4. Well, it's awfully tough because with the photo-realistic one, you actually get to see the city. So, you know it's obvious what's out in front of you, where with the EBG you just get green because it's all at the same elevation. I don't know, this would be the first one I've flown with the fishnet besides the first one, which I was actually more worried about the flying than the fishnet. So, we'll see if that helps any.

PRFN1: Yeah, that was a lot easier to stay within the boxes when you did that with the 90 degree because you have more boxes per mile so to speak. It was easier to make a smoother turn, I should say. Instead of a jerky turn like I've been doing before. Ooh, you can actually see the runway at the end of the boxes. This is good a one. Still no glide slope indication. Oh, it gives you -- with the fishnet, it does help a little more than without the fishnet; which I think was the first or second one I flew. -- without the fishnet. A little easier to see. Okay, we're about ready to intercept the glide slope. I'm doing it a little early. Here we go. Okay. Then, once we get to the airport, this view -- which I think is unity, right? -- is the easier one to see. Alright. Are we back to the glide slope yet? No. There we go. Yeah, I was a little low so I was trying to move it up a little. At least I had the chance to do that. Yeah, for the fishnet on the -- you know, when

you get the final approach – it's not going to be too much use. I guess the photo-realistic part of it is a little bit better than the EBG just simply because there's more things to focus on and it gets you to focusing more on the runway instead of, kind of, the other things. *FOV90 makes it easier to make a smoother turn, as opposed to what he was doing before.* Is it controllable? Yeah. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Boy, everything could use improvement, but it was only mildly unpleasant. So we'll say yes.

PRFN30: Yeah, the 90 degree on the tunnels makes it much easier to fly the turn anyway. I don't know about the rest of this. I'll try unity here. There is a little bit of difference but, you know, that's not what we're focusing on. We're trying to keep it within the tunnel or, at least I am anyway. There it goes. The glide slope. There it goes. Okay. Oh, yeah. That's the best one, right there. And now, in reality it doesn't much matter what the resolution for the photo-realistic is. You know, the tunnel keeps me out of the terrain and out of buildings, and as long as I can see it's something and not something I can run into, I guess that's all that's really needed. Okay, yeah, that last little bit I was just trying to see if I could control it to get the watermark and the velocity vector. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yeah, there were some mildly unpleasant deficiencies, most of them were my fault. Three. One of the things that I'm noticing that I'm doing – especially on the short part of the final and I really have to concentrate not to – is to over-fly the airplane. Right. Chasing the symbology when I'm used to flying the 60 degree one; and, you know, you have to make big inputs to get it to move just a little. And on the unity one it doesn't take much, so you're sitting there and introducing oscillations.

PRFN3: Again, out on the inbound leg, the terrain helps some, but again the boxes are telling you that you're safe. When you get inside around the final, short final, it doesn't much matter what the terrain looks like, I guess. It's better than looking out the front and seeing gray. Now where this might be helpful is where we actually, you know, have to perform radio calls and stuff, while we're trying to do this. Was it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. It was fair with some mildly – unpleasant is such a strong word, but negligible is too weak a word, so 2.5, but I'll have to mark three. I guess it's unpleasant in the fact that I couldn't see out the front.

EBGFN30: Yeah, see with the EBG you just get green out there; where at least with the photo-realistic you get some color differentiation even though it's gray. Again, at this altitude and with the boxes, it doesn't make so much difference what the terrain looks like because I can see somewhat out the window but that's slowly going to go away. I know I'm going to miss the mountain in front of me. Okay, glide slope indicator is active coming down. (Any comments on field of view since you've cycled a couple times?) Yeah. Once you've made the turn and get on final, this one seems to be the best one even though the boxes are further apart because now they're just kind of your limit; you don't want to go outside of them but you're not so worried about flying in it because you've got the runway in sight. Or at least in the synthetic vision anyway. Out the front you've got nothing. So, you go to the ninety one, it doesn't buy you anything, even though you've got more boxes. The other ones I've been really skeptical about landing. This one I could land. Oh, you can even see the runway when you look up, now. It is controllable. It is adequate. It is satisfactory. And now that I'm getting better at it, but I still give it a three. Because there's nothing like looking out of the front of the window.

EBGFN1: (That knoll that's right in front of you, is that not a factor right now or are you still relying on the tunnel.) I'm still relying on the tunnel. Now, when I didn't have the tunnel, yes. I was paying attention to it. But that was with the constant color one, too. So that upped my

stress level a lot. But with the tunnel that knoll doesn't bother me a bit. Unless, for some reason if I started flying outside the tunnel and then it would bother me a lot. Hopefully we'll never do that. Okay, still no glide slope. No movement yet. It's activated, but it's not moving. I could land this, too, and at least feel comfortable about it anyway. And again, the terrain right now doesn't too much matter, even though it's all one color versus the photo realistic one, which is kind of out the window. I can see the runway, which is the most important thing, of course. And the resolution doesn't appear to much matter. (What if your tunnel was wrong?) Then you crash into whatever your tunnel flies you into. Hopefully, I can't really answer that, because it's not wrong. But if for some reason, like it failed or something, it started pointing me in a direction that I knew was wrong, then the terrain would mean something and we could go back to the stuff we did on Monday. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Actually without the photo realistic part of it, it was a little easier to see. I'm sorry, the runway was a little easier to see, I guess. I keep changing my mind as I go through this the 15th time, or however many times I've done it. So we'll give that one a good, so a two. Actually at the very, very beginning, I was thinking the photo realistic was a little easier to see, because it gave you more cues about your height but really that's the tunnel doing that, giving you cues about where you need to be and the terrain on the synthetic vision just needs to tell you where the big things are – where the mountains are, where the runway is, etc.

CCFN1: Not too much to say here because it's pretty much the same as the other ones, with the tunnel. Without the tunnel it was a lot worse. (Did you notice that all of this was the higher resolution than the one you flew without the tunnel?) No. I could land this one, too. Give me enough practice and I could land it. A little high but we can fix that. Oh, no, a little low, what am I thinking? There we go. Okay. I guess you could make the needle go either way, but it seems, of course I'm backwards in everything. But it seems a little more intuitive to be low if you're low, and high if you're high, but that's me. Well, yeah, you always fly to the needle, but it always seems to be backwards to me. *Currently ignoring the MX20.* Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Some mildly unpleasant deficiencies, yeah, if something malfunctioned, I would need the terrain. Okay, yeah, I mean if there was some kind of failure with the synthetic vision system, I'm sorry with the tunnel system, then the terrain would matter and then we would want to go back to the EBG and the MX20. Then that would become important. By the way, I'm ignoring the heck out of the MX20. It's not telling me any more information than I have with the synthetic vision display.

BSBG BL: (I'm just curious, you have said all along that terrain is really not a factor for this because of the tunnels. Do you miss the terrain in this particular case?) Nope. Well, I also can see the terrain out the front if I need to. When the terrain goes away in the front, then ask me that question again. The diamond at the bottom actually then becomes a secondary instrument simply because the tunnel tells me where I'm going. So, I fly the tunnel and then check it with the localizer even without the terrain. I think that's a function of the tunnel, not the terrain. Here comes the glide slope. Okay, now I'm beginning to miss the terrain a little because that building or antenna popped up kind of on my left and I didn't remember it was coming. I don't know without having the runway there, if more boxes are going to help or not. I might could land this one. Yeah, I could land this one. I can see the runway now. I appear to be close enough. Okay. Wasn't as hard as I thought it was going to be but it was a lot more, a lot more concentration than kind of mindless, just make sure your little thing's on the runway. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yeah. Is it satisfactory without improvement? No, deficiencies warrant improvement. Minor annoyances, annoying deficiencies. But I was able to get the job somewhat done, but it would have been better with all

the other stuff. Four. Yeah, without the tunnel, it would have been a bear. Well, without the tunnel I would have been probably even illegal in here much less out in the real world. I don't have an IFR certificate, but that's a minor inconvenience.

EBGFN3: Okay, over the other EBG 3 or 30 or one, 3 resolution doesn't make much of a difference, at least at this altitude anyway. Yeah, yeah, especially around airports where they try to make it fairly flat. There are no big mountains in your way or anything like that. It does give a nice drop for the mountains behind you where . . . When they're all green with trees it's kind of just a green blob behind you. Alright, we're picking up the glide slope indicator. The turbulence is a little less. Of course the minute I said that it just knocked me a whole bunch off the course, but that's alright. Here we go. Okay, up to glide slope. Oh, wait a minute. It's low, I'm high. Okay, now we're back at ninety. Alright, so I want to go ahead and line up on the runway. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes, except I'm not really talking to anybody like air traffic control or anything. Is it satisfactory without improvement? Yes, again mildly unpleasant is a strong word, but it wasn't negligible, so we'll go with a three.

Rare Event:

EBGFN3: I don't know if I miss the fishnet or not. I like this because it gives you good cues about gross terrain, meaning there are mountains here, there's a valley here, etc. I don't know if the fishnet . . . There is a fishnet on it? (Yes) Oh, yes, and here come the infamous towers and it appears that I will fly in to one. I hope that's not the case. I am going to fly into one! What is going on here? *FOV60 is so nice. This is good for terrain awareness. 3:47 says it appears that he is going to fly into the towers. The terrain was at the level of the horizontal line. Starting to climb and we stopped him at 4:21. His climb would have cleared the terrain. Coloring helped him a lot.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Well a broken indicator is not a tolerable workload, but that's alright. Is it satisfactory without improvement? Yeah. And I didn't run in to anything! I almost did, but I didn't run in to anything, so that's a yes. And the colors were very helpful, so we'll give that on a good, it's still not a one. Nothing is a one.

Subject 8 (BRD Baseline):

Block 1, High Altitude:

PR1: The turbulence is a new fun thing. Appreciate it, thank you! I was acclimating to it, but then what I found I was doing, is I was focusing on the instantaneous readout for the altitude and not the bar in trying to target the main bar, where they describe the altitudes. I was just focusing on that real bright, big number that was going too fast and not picking up really what it was telling me. *Was a little low at the beginning. 9380 or so. Lasted about 30 seconds or so. On border, so gave him desired. Had "tunnel" vision, acclimating to symbology.* Is it controllable? Yes, it was controllable. Was adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I said yes, at this point. Then I went to good, negligible deficiencies. (So that would be a number two?) Yes. Well, I couldn't get in to the flying level 2 or 3 because I got out of it is satisfactory without improvement at this point, and I think I'm grading myself, maybe there, and I shouldn't be doing that, because it's not me. I was just thinking out loud. *Did not look much at terrain.*

CCFN1: In this where I am right now on 140, my velocity vector and water line are covering up the 140 on the horizontal line. If the 140 could drop down below it and not cover it, that would be neat. My thought was that knowing what I know, I'm about this high, and knowing that turning is no faster, considering what I would know on my charts and whatever else, I wasn't even looking at it. With it being just the brown ground, the fishnet there is helpful. If I was down

lower and obviously, I probably would have paid more attention to it, but I paid enough attention to it that I knew I was high enough that there should have been no conflict or no issues, so I pretty much ignored it. *Waterline and VV covers heading on horizon line - if we could move the heading marker up, so it's not occluded, that would be good. Knowing that terrain is no factor, FOV was not even looking at it. FN was helpful on brown ground.* It shouldn't be in that range. Four was in the range above, right? I think it was telling me what I needed to know. It was telling me everything I needed to know. I only had that one thing I don't like missing, but that's silliness. Yeah, it was telling me what I needed. I mean that comment that it would have been nice to see that RPM deal, but I think maybe a little better job of getting to meet that 1000 down by putting all those, by putting air speed together with the pitch down. Is it controllable? Yes, it was controllable. I didn't crash. Is adequate performance attainable with tolerable workload? Yeah, it was. Satisfactory without . . . See I don't want to say it's not satisfactory, but you're forcing me to. So I did moderately objectionable which was number five. Because the pilot is trying to compensate to the system.

EBGFN30: From last time's run to this time's run, my throttle is all the way forward and I'm just maintaining and that's the 9,500 foot issue. You need a turbo model. The thing I don't like doing is looking to my right or my turn point when it could be here. I was flying the numbers. I guess in my mind, the terrain is not a factor right now because of that altitude and I was flying the vector and the caret at air speed and looking for that target altitude, just factoring the terrain out. The display of it, now that I'm reasonably where I need to be, is awesome. I see the runway sitting out there. I see the runway out there now and the mountains and stuff, but I was not using it. The horizon line was more of an issue for me, I think, than anything else. You've got to get me down in the mountains and then I might look at it. *Rather have waypoint on PFD, instead of MFD. Minor distraction looking over at MX20. Flying the numbers, terrain is not a factor at this altitude. When he was S&L at the end, the display is awesome, but wasn't using that information.* It was controllable. Satisfactory without improvement. It says good, negligible deficiencies. The display isn't deficient. In fact, it has given me at this altitude, stuff that I personally am not even looking at. I'm missing a piece of a puzzle but I don't know what it is. So I want to do good again, two. I'm surprised with my performance because I thought right at the end I went through the bottom on the turn. I went through the turn.

CCFN30: (Has your field of view, you're not scrolling through it because of your altitude?) Yeah, no need for it. At first, prior to the turn, I mean I could see that stuff was down there. I tried to look down at it a little bit but it wasn't, going through the turn, I was more concentrating on making sure that I tried to meet the turn and descend and get those things all in line. Again, I guess ground wasn't a factor. Am I contaminating my view because I'm sitting here and on the seat beside me with the chart, knowing full well what those elevations are? In a normal situation even with all of this information in front of me, if I didn't plan properly, I would have known that en route at that point, at that altitude, that I shouldn't have any conflicts with anything other than traffic. In an IFR condition it would be my responsibility. Of course we're going to lights out and it becomes a shared duty, I guess, with the controllers. So I'm alliterating that ground information, the need for it. I'm not even processing it. I'm starting to put my head down. It's hard to reach. In that other screen, now that I'm thinking about it, when I did roll, when I do roll to the left, the tick marks for the roll get in there and obviously I rolled beyond 20, not by that much I think, because I lost sight of that in that confusion. I looked down for a second and when I came back it was mixed with everything else and that was a little bit tough to get back to. Maybe when you do roll beyond a certain point if that tick mark could extend back to the horizontal line, that might give a better reference and get it off of being confused up in that corner, so high away. In run two, I had a death grip on the yoke. I did relax that a little bit. It's

interesting fighting this thing. It was controllable. Yes, there was a tolerable work load. Yes it's satisfactory. So I'm back up in the one to four group again. Fair, some mild. Three.

BRD BL: Yeah, I want to get rid of this. Oh, I recognize these things. Now, here's the bad part. You're going to give me my RPMs, I'm going to screw it up and you're going to hit me on the head and that's okay. That's alright. Give him what he wants and then tell him to knock it off. On the other scenarios versus this one, my eyes are flitting up more towards the screen outside to get my horizon back. I like the horizon of that other screen a lot better. Now you're going to force me to, stupid little thing here in the middle of my screen. I'm also finding on every situation I'm getting settled in, get the feel of the plane, and then I'm looking over for my waypoint. (You were a little high at the beginning for over 30 seconds, so please continue with an adequate performance.) Okay. It's controllable. Adequate performance is attained. Tolerable work load, yes. Satisfactory without improvement. Adequate performance requires considerable pilot compensation. This scan needs lots of work, I see.

EBGFN1: This thing is nicer in that regard, because your focus is just a single point instead of fixating on seven other distinct points, trying to put them all together. It's a whole lot nicer to have it in one focused straight ahead shot. Oh, I like this display a lot better as far as performance data minus, I still would like to see the throttle or the RPM settings, just to target some thing. I'm still trying to, I need to target the speed, and I'm not, my brain is not going that way. Again, I just got settled in to the display in front of me and you don't have to distract off to the side, but when I come back to this display, everything is right here and I'm picking it up quicker than if I had to scan six different things. The terrain is obviously more phenomenal as far as the detail of it, but I think I'm still back with until I got level here out of that turn and settled back seemingly into level flight again, I was not paying attention to it. I was focused more on performance stuff at that point. *Sees craters and valleys a lot better. Can pick up information much better on this, than scanning BL. Terrain is obviously more phenomenal, as far as detail. But, until he leveled off after descent, did not even look at terrain - was focusing on his gages.* Excellent. I think ultimately the thing that I was thinking about was if, what I do sometimes, even when I'm just flying around, I'll follow VOR and I'll dial one in and there'll be a heading bug there. When this thing all pans out, if I'm going to turn to 050, not having the ability to designate that number and when that comes up on the horizontal bar graft, maybe in that 10 degrees, five on either side of 050, the bar is green. Giving just another little bit of reference at that point because I'm , you bury that one 50 underneath the velocity vector and the water line and it all disappears and I'm finding myself looking back up to the role in that direction.

EBGFN3: I went right to the performance stuff immediately again. It's like I don't care what's below me if it's not a factor. I mean that's one less thing I have to deal with. It makes for a pretty picture, but when you're in the clouds, you're in the clouds, and when you're up high or high enough, what does it matter? I'm waiting for an electric shock in my chair. I do like my heading bug kind of idea on that horizontal line because I would use it here now. I don't know if that's a good thing when you still have the instantaneous readout and that dang distracting MFD is back here again, too. Let's see what happens this time. Supposed to turn. Everybody's ears pop on that one? Why did I do that. I blew that one big time. That was me. I had an idea but it didn't work. What I'm finding that I'm doing, what I tried to do there was to let more, hopefully I did it, to let more off the throttle that time than I did in other previous occasions. But then my descent rate was exaggerated obviously, beyond 2,000 feet a minute. Moderately objectionable deficiencies, five. They want something else there and I don't know what it is.

PRFN1: (Just so you know, that looks like a 30 degree field of view.) Yeah. I know that. I want that just prior to my turn. I'm looking for a bigger bar. Here's the hated turn. Yeah, nailed

that puppy. Yeah, I really liked it. In part of the training deal, one of the things, you're going to have to excuse me because people's names are gone now. When I had my training, hand off the throttle, fly the pitch, and I am a throttle player so I didn't have that hand free. If I would have done anything at all differently, once I got on 050, even though I was still descending, I could have moved that thing so that I was closer in, and I could have minutely held that heading a little better. I think in the beginning I held the heading a little better since I moved it in. Yeah, zooming in. In the turn, I wanted it out because that's where I was getting all my turn and my felt rate of turn around the corner, too. But then move back in when you're steady because you're just trying to make slight adjustments. I think that bigger adjustment, I needed to move away and get closer with less movement. Minimal pilot compensation required for desirable performance. Yeah, I want my green bar, and I want my RPM stuff.

PRFN30: I'm trying to flip through the (FOV) displays a little more too, and I'm settling in on that one, obviously. *FOV60 is perfect for his turn. S&L can zoom in.* Pilot compensation is not a factor for desired performance. Broken record, yeah, I did try to do that, but then I found that I widened back out, I made the turn. Once I got out of the turn, I don't know if it was before I got to the 8,000 or while I was trying to get there, I think I changed it, but I know after I got it I did change it to a different one to take a look at it. But the display that I have right now for flat level flight is perfect. Yeah, when I'm making the turn. I can get straight and level move away. Excuse me, straight and level, I could move it so that I was closer. It was more zoomed in because I'm not worried about 20 extra degrees out there, I guess, on either side.

EBGFN1: This scale for straight and level is perfect. (Okay, that would be your 30 field of view.) Yes, this keeps those, that 10 degrees in my principal point of view here. Trying to synchronize that velocity vector with that deceleration arrow and get them in whatever the right position is, that's what I'm having an issue with right now. Because I drop down in that 2,000 foot a minute area. It's nice that that thing (VSI arrow) changed color because it brought it to my attention. If it had just been that clear outline bar, I probably wouldn't have paid that much attention to it. *Was out of bounds on some parameters, intermittently (altitude), but still well within 90%.* Fair, some mildly unpleasant, minimal pilot compensation required for desirable performance, three. Flip flopping there. I'm more aware that I want something else or I'm missing something myself that this isn't giving me. That other one, I didn't rupture anybody's eardrums on, like I did on this one. I'm rolling over too far. I'll get stable. Of course the wind, weather, or whatever, is taking me where it will. I'll just get into a higher rate of descent than what I really think I've got placed here if I actually do or don't, and I can't get that feeling, and I don't know what I need to see that would smack me on both sides of my face and say hey, don't do that. Or you're getting into a situation where you're descending that fast and the next thing I think about is, can the plane take that stress that I just put on it? Sorry, yeah. I did flip it around and flip it back to where I wanted it for the two different times that I wanted to do it. Yeah, the field of view. It almost would be kind of neat if it, if you had a heading bug and you told it you were going to turn more than 20 degrees that it would go click out one or some preset or some user selected field of view out and then once you rolled back and were within 10 degrees of that course, it would then narrow down and in other words, fine tune you automatically, give you that rate of turn. I guess that's what I'm not really, am I really seeing the rate of turn here? Only by that scale on the horizon flying by me is it giving me any kind of a real rate of turn. A turn coordinator is not here, not that you always fly standard turns, so that rate as it picks up, I'm missing that looking at other stuff. The wing dips down and here I go, because my lift is all gone.

PRFN3: I have no idea how I just did that. I got the vector in the right spot, and my acceleration in the right spot and my air speed didn't go wacko. I'm glad I'm not hooked up to physiological monitoring. That would have been scary. Did I get the altitude? (Yes, you got it.) *He did great.*

Stayed in FOV30 for most of the time. Good, negligible deficiencies, pilot compensation not a factor, desired performance. I don't want to say that it is bad when it's lack of time and my understanding of what I need to put together to make it work while it's giving me the stuff there. The bias is that just because I can't operate it, doesn't mean it's inadequate. Does that make sense?

Block 2, Low Altitude:

EBGFN3: Okay, for grins I am now more aware of the ground. It is more prominent. Oh, yeah, it's a whole big difference from down here. Did I get level long enough? (Did you scan also the terrain to make an evaluation?) Yes, obviously, I spoke up. You didn't get me to speak up the last time. Yeah, all the sudden there is this real light color brown stuff down there with fishnet on it, and I said wait a second, what's this? (Does the fishnet help you?) I don't know yet. Good, negligible. Pilot compensation not a factor for desired performance. (So that would be a two?) Yup. No, that was actually, it was a neat reality check because I didn't think it was an issue at all and I got down here and all the sudden it popped up in my face when I rolled over.

CCFN1: It's neat just to see the performance change. I didn't like it as much as the one prior to it. It had way more detail in that other one. The other one jumped out at me quicker and became more apparent. This is just, the fishnet there is showing me the terrain data better than just brown alone, but seeing the actual undulation in the color gradients at that altitude was a whole lot better than this one. *Did exceed roll rate on turn, but only for about 5 or 6 sec.* Barely some mild unpleasant. I liked that other display better.

PR1: The ground is not a factor. Until I make that turn and put my nose down, then it starts to become an issue. Yeah, right here for the straight and level thing, I think that before I made the turn, before I went back out . . . This is 30 here? No, this is 60. (No, that's 30. You scroll up one so it will be 60.) Yeah, for my turn, things don't jump, the tip for me here is that things don't jump around as much when I'm in the turn and when things are flying in different directions, my pitch attitude and I'm rolling and I see all of that stuff. I'd be even curious to know if I'm holding heading better on this setting than another setting, rather than allowing me to make the decision here. Maybe I should explain that differently. The display froze just for a second but that's back. Oh, okay. I'm real comfortable with where I'm at. I'm a little slow for speed. I liked that first one better. I don't need the photo realism. The gradients in that one made the terrain more defined, I think, versus this. This one has kind of lost it's shading elements, I guess. You could tell there was flat land because you had that color in the trees and such, but it wasn't as distinct as the colors that were used in the elevation data of that first set. *Likes the EBG better. Suggests putting FOV indicator on the display. PR doesn't really do anything for him. EBG gives him better feel for contouring.* Good, negligible. Now that I'm in hindsight, can I change what I answered? Well, I like that, now that I've seen these few other ones, I'm speaking more highly of it than I rated it, because now I'm comparing it to something else. I like that one infinitely better than any other one I've seen so far. (So not that you can, but if you could change your answer, it would be a one?) Yes.

CCFN30: Okay, the field of view that I have right now, is the one I prefer during anything level. (Okay, that's the 30 field of view.) There is some mildly unpleasant, minimal pilot. I noticed that the fishnet was further apart. It actually was a little better from the standpoint that the fishnet was further apart. It wasn't as distracting seeing the towers, than with the fishnet tighter. I noticed the towers in that one, where the prior one I didn't. It was tighter.

PRFN1: The fishnet on here did bring this out a little bit better, but I still like that first one with the colors based on altitude a lot better. It just jumped out at me. This one isn't jumping out and

the fishnet is helping it jump out. The shades of color aren't as far apart and I think as you get lower, if the object of the exercise is to relay some kind of a warning, for lack of a better word, then it needs to be a slap in the face, because it's just your life. (Do you think that the EBG gives you a better slap than the photo realistic?) Yes, I do. *FN here did bring the terrain out a little better, but liked the EBG better. This one is not jumping out at him. If you are close to terrain, you need one to jump out at you. EBG is better at jumping out.* Good, negligible deficiencies.

EBGFN30: Okay, now this display that's coming up is a slap. That's fine, I mean that's what this is about. I like this, even though it's a little lower resolution, I like it better than the photo realistic. (Because of the coloring?) Yes. (Okay, have you determined whether or not the fishnet helped you?) It wasn't here. I'm trying to think of how to tell you. It's not bad, it's okay. I'm finding that I am more comfortable with stuff. I've got better control of the plane, obviously, because the altitude earlier biased my ability to control the plane independent of the display.

PRFN30: I don't like this as much as the others. No, the photo realistic doesn't do anything for me even in that, it makes for prettier pictures, but at the expense of computer speed and processing and other things, the rest of the engine can be used for something else. For me, anyway. The engine meaning the computer, CPU. *Likes FOV30. Changed to 60 in the turn. Doesn't like this as much as the others. Makes for a pretty picture, but not worth the computational power.* Good, negligible. (Have you noticed the difference in resolution between that and maybe the one arc-second photo realistic that you flew?) Oh, yeah, definitely there was a difference in that, but it was no utility to me.

EBGFN1: And it's awesome. The trees in photo realistic, I think, soften the image that you're seeing here. I mean even when I look up at the screen in front of me versus the display. It softens all this up and you need to know that it's not nice down there. And this makes it that way. (I'm just curious, can you see the fishnet, and if so, does it help?) Only in the darker areas, not in the light areas. Like right now, there is very little if anything there. But that's okay, I'm straight and level, so I don't need that bit of just the shading on the contours of the mountains is plenty, really. Now with the darker stuff beneath me, the fishnet is helping in those shaded areas, of pronouncing it a little bit more where on the shaded sides, it's gone away. I think the fishnet here is helping in these lighter areas where there is not much differentiation in color scale right on the beach. (And you're still liking that the 30 field of view during straight and level?) Yeah, in fact I was kind of looking more at the ground, so I didn't even mess with that, cycle through it at all. I've got to get this, excellent, highly. That's what that other one should have been. That's a one. And I'm way more comfortable with not just the displays, but flying the airplane, and the only reason that you knew this is that I got catty. The cattier I get, the more comfortable I am. I have more time to do things. On my first initial flight, I didn't say anything and then I went to lay down on the couch afterward because I was task overloaded, but at the end at least it tells stories.

EBG1: (Do you miss the fishnet?) No, the shading here is sufficient at this resolution, that I don't need it at all. At the lower, at the last one, it was helpful, but here I don't need it. Even in this display like this, those elevations that encroach in a certain area could turn a threatening color, yellow or red, depending upon, I think that that scenario is played out in the MFD later. But since there's, you're using less information for photo realistic, there's space available to process that into those elevations that are threatened. *He was a little high on this one, but still within the parameters.* Excellent, highly desirable. (So pilot compensation is not a factor for desired performance?) Nope. I mean that was obviously, for me, the better one. I didn't need the fishnet because you could see the gradient of the colors in there. So that information was not necessary at that point. So I thought that was, for me, optimally the best. Go back to, I'm still

fighting with getting my turn coordinated and all that garbage and I know I'm sitting here flatfooted, and the people in the rudder industry are mad as heck at me.

BRD BL: Okay, so you're proving your point here. Okay. I sure would hate to see . . . That's pretty good if you were talking turn about a point. Okay, I'm ready for it. Sitting down. Like night and day. *He was so involved in the turn that he didn't start descending. He didn't make his target altitude by the end of the run (5:00, but we let him fly for another 25 or so seconds). Was high by about 300ft.* Very objectionable, but with deficiencies. Adequate performance requires moderate pilot compensation. That turn was a little bit on the severe side, I think. The old standby is the old standby, but my situation awareness as far as the ground was concerned was limited solely to the altimeter and I made that turn so quickly and lost no altitude in that part of the exercise, I mean it wasn't a smooth controlled, it was a saw tooth pattern, I'm certain, in two or three different directions. That was not a flight that someone else would want to have been sitting next to you on. They might have objected, let's put it that way.

PRFN3: The fishnet helped us here. I just, the photo realistic just doesn't do anything for me. It's cute but that's the extent of it. The fishnet on this display helps it. Otherwise, it wouldn't be doing as well or be providing me with what I really want. Without the fishnet I think that it does less. Good. Negligible deficiencies. Pilot compensation not a factor for desired performance. I do like that other better.

Block 3, Approach:

PRFN30: I will tell you this, the green boxes are taking me away from the horizon line, ergo my extra 1,000 feet. Having these boxes here is relieving me and I am trying to look over at the MX20 and I am watching the boxes and I'm not really caring about my magnetic heading or anything at this point. The tunnel is gone. (Have you been able to look at the terrain at all?) It's there, but the boxes rule. The terrain is still not a factor. I can see that it's not a factor, too, because with the display that I have, it is not undulating and it is not taking my attention away. Having that crosswind was neat because that water line was way over there, but it, too is playing a factor. The velocity vector, that's where you're really going. And I'm chatty, so you know I'm comfortable. (You did turn a little shallow, or make a shallow turn, but it was within the parameters.) *300 hundred ft too high. But he was pretty much on his numbers. Did make a shallow turn, but within time frame. Liked FOV 60 the best, he thinks.* Good, negligible deficiency. Pilot compensation not a factor for desired performance.

CCFN30: (It seemed like you were outside of the bounds laterally. I can't remember which way, exactly.) Probably to the right, that's what I've been favoring. Also, horizontal. I mean I know I've been doing that twice now in a row, I've gone up to 2,700, for some reason. I don't know why I'm doing that. I'm not getting my speed in control enough. That's what it is. That just made me think what the problem is. I got better performance out of this thing at lower altitude and the throttle settings, the feeling that I've got on the controls here is, I'm not moving it as much. It's also real sensitive to movement. I'm finding I'm making a bunch of tiny little changes but getting a lot of response out of those changes. It may be too sensitive, let's put it that way. *FOV90 was allowing more time to look at other things.* This makes the decision on selecting a number here a little harder in the sense that it was fine. It was my own, so I have to rate it lower because I stunk on it. It's true. So what's the highest I can rate it in my stinky category? It's a five. I did like that 90 degree field of view like that. It did give me more boxes. That turn should have been a little smoother. I don't know what parts of it you got to see.

PRFN1: Having that 3 degree line is kind of great too, in a sense that the thing that I needed to find to get my air speed in line with my velocity vector to maintain that speed, I'm now flying

that 3 degree line, during this descent, obviously, and I think I'm managing my speed a little bit better because I have a target to look at. (I just want to remind you that the touchdown point for this is 1,000 feet down the runway, so if you see your 3 degree line 1,000 feet down the runway . . .) That's for ATPs. Okay, I got you. Yeah, I was right on the threshold. What I need to do is cycle through that and on that display, because at that setting, I could see the threshold marks better than I could see the 1,000 foot mark, so I was looking at the end of the runway. I'm happy with 60. I think when I turn around and start that descent I'm going to cycle closer and try to give myself a better look at the runway. *Low on GS at the end, but was aiming at the threshold, instead of 1000ft line. Don't know if was more than 36 seconds, or not. So, gave him Desired.* Good with negligible deficiencies. Pilot compensation not a factor for desired performance. It's pretty pictures, but it really was no factor. I'm looking beyond the recorder start thing now, and photo realistic actually softens the environment, while it gives you more detail of things, I think it softens it and I like this view here better, because the harsh reality is once you get through the trees and through grandma's house, you're on ground.

EBGFN30: Relative position of the horizon, whether I'm at 9,500 feet, 6,500 feet, 4,000 feet or right here at 2,600 feet, it's always in the middle of the screen. Well, when you're in the plane, it is different in that, that horizon line is really lower when you're higher, and higher when you're lower. So if this screen could mimic that because I am lower, that might make it more apparent that there's a, -- I don't like using the word, but the threat, the ground -- there. That might be more helpful. *Stayed at FOV60 for the first part, and after the turn. He liked to zoom in at the short final, to get a better view of the RWY.* Excellent, highly desirable, pilot compensation not a factor for desired performance. I like that screen. I think I got my aiming point better because I did cycle through and get a better view of the runway to get my aiming point down. I think right at the end I had that 3 degree line on the right spot, or at least closer, anyway.

BRD BL: I got carried away there with my corrections. Now you're making me use that MX20. That was frustration. I mean I'm glad I got it back to where I did. At least I was on line with the runway and once I started to break out I could see it. I don't like the fact that I did not get on that glide slope. I was constantly high that whole time. *Doesn't like it when we take the SVS display away. Was high the whole time. Adequate performance. Had a hard time picking up localizer and the GS.* Moderately objectionable deficiencies, adequate performance requires considerable pilot compensation. Reality check. In the real world, I probably would have survived that, although it was probably not passable for a test. All my direction stuff came from and had to, from the MX20. Hearing that outer marker go off gave me that point to descend. I think with the SVS earlier, I was actually starting that descent because that box I think is positioned over it, and until I go through it, even though I can see the fact that the tunnels want me to go down, I'm starting to descend at that time. So here I waited longer to descend, but that's a good thing, because terrain is an issue. At that point, that's why the outer marker is where it's at.

EBGFN1: I'm already pushing over and I don't even have that outer marker signal yet. That's alright. It's neat. I flew that other thing high, and I'm flying this one low. That may be, because I'm afraid of the ground with the other one because I can't see squat and this one I can, so there's no fear of the boogey man because he's there. You're just watching him move around. *Flew low on this one, because he was more aware of the terrain. Flew high on the last one, because he had no idea of where terrain was. We counted 35 seconds on being over 1 dot low, so gave him desired.* I like keeping the bar up for myself. Excellent, highly desirable. Yeah, highly desirable. I like this depiction of the terrain a lot.

EBGFN3: This display right here just left low of me because of that color shading. This is the first time that that's actually come out, the fact that there's a little knoll right there just off to my

left. I like that one. *Stayed on FOV60 for most of the time. Can see that knoll on the left, after the turn, for the first time. Was very low at the end for well over a minute. Stayed at Unity at the end. 3 deg line was well short of the RWY. He thinks he may be keying on the threshold, and not 1000 ft point. Really likes this display - gave him everything that he needs. Did lose center line on the GS in the horizon line for a few seconds, and it was disorienting.* Oh, really, well then that's where I have to go, because that wasn't it. It was giving me everything I needed, I just wasn't – that was pilot.

EBG1: Again, very aware of that little mound to the left of me. I'm just for the fun of it, looking over at the MX20 and seeing the red there, too. Just confirming it, but the detail here is plenty. (Do you miss the fishnet?) No I don't, not at all. To me the fishnet was just extra lines. They're not necessary for me. And at this level, I've even got stream set down there obviously looking all over the place right now, because I've got the time to do it. It's just with the navigational data here, the tunnel, which is the navigational data here, I don't need any other instrument. *Did pretty well, still shallow in the turn, and was a little fast for a few seconds at the end. But still desired. Really likes this display. Used Unity at the end.* The answer, excellent, highly desirable. Pilot compensation not a factor for desired performance. I really liked that one.

PRFN3: At this FOV, I just feel less sloppy, although I know I am when I cycle through some of those others, it's like I'm all over the darn place, but this one I seem to be a little bit more in control. And that's relative control. (Just for nice to know, that one is a 30 degree field of view, I think.) Okay. That one there just gives me a better shot at the 1,000 foot mark. Okay. Now what's interesting is that I'm finding that what I'm really flying here is the 3 degree line and trying to get my velocity vector, let it come to that 3 degree line, get my speed right. Yeah, yeah, and the ground again, photo realistic is pretty pictures, but I didn't notice the knoll like I did the other one. It wasn't standing out for me. It might have been high, but it was very green. *Likes FOV30 after turn, on this one. Changed to Unity at about 2250. Likes EBG better.* The answer, good negligible deficiencies. Pilot compensation not a factor for desired performance. Two. (Just out of curiosity, was it a two because of the terrain depiction?) Yeah, yeah. It didn't give me that warning that the other one gave me. Just that silly little knoll on the left, I didn't see it when it was covered with trees.

PR1: I didn't move out one. I think I moved, did I not move out from unity? (Yeah, you were flying unity and then at the end you switched to 30 for that one.) (Did you like the 30 better closer in?) Yeah, I think, now I'm cycling through so I lose count of where I'm at, but I'm looking for a more stable picture because then I don't end up chasing that moving image. If it's a little more stable, even though I'm being erratic, I don't get that much sense of it, so I'm not overcompensating for the way I'm compensating. I like luck, luck is a good thing. Good negligible deficiency, pilot compensation not a factor for desired performance. But I, it was really like 1.5 because I like that display better than the prior one. The fishnet, in that situation, I think is a little distracting.

CCFN30NT: Boy you take away my box and I like all the space I can get between me and the ground. (Are you saying that you miss the box?) That would be an understatement, yes. And having the runway here is great, too. And I waited all the way until then to get rid of some of that control pressure that I was getting rid of maybe earlier. I need that additional load. I'm half back, and I want back now. That's the first time I've flown glide slope down that left side. At that point the screen was just jiggling around more so I came back out to slow that down a little bit if you ever wanted to know why. I know you like the truth. I was flying the diamond. I was not paying attention to that. I knew that if I got the localizer in, hit the glide slope and flew down it, I didn't spend any time looking at mother earth, other than trying to slow that display down

from moving around on me. That to me is a navigational data point, the runway. Those lines there didn't help me. The fact that it was brown as ground didn't really help me. *He's actually doing very well. Went to Unity at the OM. Came back to 30 at the MM, to settle down the jiggling of the symbology.* Good, negligible, pilot compensation not a factor for performance. The attitude stuff was what I really used. The one little piece of information, looking at the runway, but the ground I didn't, I wasn't even paying attention to it.

CCFN1: You could have put a blinder over (the MX20) the whole time. I never looked at it.

Rare Event:

EBGFN1: The color gradation of it. I mean even with the fishnet makes it more apparent at this point, but it jumped right out there and said, "Hello, don't forget". I've got to keep descending. See I didn't want to descend. That's exactly what I did, I went back to level flight because I saw that there. It's a good avoidance tactic. Now see on this situation, seeing I'm down inside this mess, I don't like it. I mean that's just indication for a power up and nose level, get out. Excellent, highly desirable. I like the screen, the fishnets, fluff, but obviously when you took the altimeter out from under me, I became aware. It's weird, it's almost the hair went up on the back of my neck, and that's why I voiced my concern at that point. And I even, I looked at that MX20 and saw the green and saw the towers on there and said, okay, that's okay, and kept on going. *He said that he didn't want to descend (at 3:30) anymore. He still flew until 4:53. He obviously was not on my track (for impact at 4:36). At about 4:45, he mentioned, again, that at this point he would have powered up, didn't like, and time to get out.*

Subject 9 (BSBG Baseline):

Block 1, High Altitude:

PR1: That velocity indicator makes it extremely easy to maintain air speed. That's what I'm liking best about it so far. Okay, the level of terrain awareness for myself, personally, I got caught up in maintaining the altitude and the heading, and manipulating the controls. I almost completely forgot about the terrain there for a while until I jumped back into realizing what we were here for, so I was just focusing on maintaining the velocity indicator and maintaining altitude, and maintaining heading. But again, that's with the first run. I might be able to expand a little bit further and be a little more aware of the terrain than what I was on this first run. *Didn't get to target altitude within the 5 minutes.* Okay, and I went up with number four but the actual SVS display characteristics in the first column: Minor but annoying deficiencies -- I didn't really experience any deficiencies on the first run.

EBGFN1: This terrain is very clear. With the light fishnet on there it kind of enhances the topography. As I get further out with my field of view, it gives me a sense of being a little bit lower than I would actually be. Okay, the reactions, you're almost playing catch-up with the velocity indicators and various other symbology on there. On the unity. And then my preference so far has been the little mix of the 30 and 60 and I think I've stayed mostly at 60. *Terrain very clear. With the light FN, kind of enhances topography. Further out on FOV, gives him a sense of being a little lower. Currently thinks he likes 30 and 60. Unity is a little to hard to fly. FOV60 is probably his most preferred.* And I'm going to rate it with number one, because I feel with conventional instruments combined with the SVS, you're able to cross-reference and double-check your information. It would be a lot easier than just trying to focus primarily on the SVS itself.

PRFN3: Looks good. I'm not experiencing, with this altitude, a tremendous difference from the previous, with the level of detail. I've got real good situational awareness of the terrain below me on this one. I don't know if it's something like becoming a little more accustomed to the

controls; and I'm able to maintain heading, air speed, and altitude a little better, but I'm actually getting a chance to go through the different field of view selectors. I was just (using 90FOV) testing it out to see, kind of getting a forecast of what I had coming up ahead of me because I could see a little bit more of the ground surface. It's getting easier and easier as you progress through the number of runs, so again, number one. This could be implemented in the current condition it is. I have a level of understanding, I guess, with my limited piloting experience, to manipulate the controls just to keep everything in line -- keep you straight and level so to speak.

PRFN1: I'm losing a little bit of the graphics level; it's diminishing just a little bit, but with the overlay of the fishnet, it's kind of helping to keep the awareness of the terrain where you need to be cognizant of it. I'm going to cycle through the various fields of view and see if I can see anything. Oh, this is a very good representation of the surface of the earth below me down there. You can get up a little bit closer to it because, you know, it's very detailed. Very easy to use. For my primary flying I like to back the field of view out a little bit to 60. But if I'm in just say at straight and level cruise and I encounter some IMC conditions, and I need to maintain that current heading, and am confident, I probably would back it out to 90 just to see -- give me a little bit more warning for terrain coming up. *FN does help see the terrain features that he needs to see. For flying, S&L, likes 60 and 30. If he were in IMC, he might widen to 90 to see what terrain is out there. Really likes this display. Very good depiction of what's really out there.* To sound like a broken record, this is becoming easier and easier as the runs progress. The display characteristics are excellent, and the demand on the pilot -- if you're implementing this in the general aviation, making the regulation to obtain training on the SVS with maybe just a few hours, pilots could be proficient and operating with the SVS system.

BSBG BL: With the baseline display I've noticed I'm spending a lot more time outside of the cockpit than I was earlier with the terrain portrayal. Losing the visual reference to the ground (OTW). It's -- without any of the topography -- it's a little more difficult to maintain my altitude when I'm getting down here. *He's doing fine, though. Still well within desired.* Is it satisfactory without improvement? Yes. Negligible deficiencies. Your terrain awareness pretty much dropped off unless you had, say, a sectional map and were able to look at the contour lines to develop some awareness of the topography. But as far as terrain awareness, that dropped off. But the SVS -- as far as maintaining heading, air speed, and if it was an approach -- it would have maintained the localizer and glide slope would have been easy. But as far as the terrain awareness, that's the only thing I would say dropped off pretty much drastically, as opposed to the other displays we've run through already.

EBGFN3: Got good awareness of the ridgeline just below me. (How do you like that field of view?) This one's not bad. Just messing around with this one for a little bit. I'm losing the compass rose on the horizon, whereas when I bring it back in I'm able to determine my magnetic heading as opposed to the actual aircraft in relation to the ground. A little bit easier for rolling out on turns, but it's not bad. Bringing it up like that, I believe that this is the first time I've had the airfield in sight if that is Roanoke off at zero-five-two. *Picked up RWY 6 sooner than any other pilot.* Is it satisfactory without improvement? Yes. This was highly desirable: the SVS display characteristics. And, I am increasingly growing more comfortable with the use of this display. Like I had mentioned in the flight, cycling through the different fields of view, that was the first time I'd seen the airfield. And experiencing that, just sparks the curiosity of what you're missing if you're not looking at a specific field of view. But I'll rate that as a one as well.

PRFN30: Even with the low resolution, any resolution or any depiction of the topography was better than the baseline. The only thing I'm still experiencing just a little bit -- and it's probably just my skill level -- is coordinating all the information on the PFD itself, as opposed to watching

the trend with the analog gauge. But the display is good. Going all the way up again to the top. Excellent for the SVS display characteristics. The demand on the pilot and the selected paths -- that wasn't a factor; so I give it a category one. That one, you said the display was the lowest resolution available with fishnet? (Yes.) Even the low resolution, the actual details, again at this altitude, might not be a factor, but at this altitude where I terminated at 8,000 feet, the resolution wasn't a factor in me being able to operate the system or have an awareness of the terrain, but it might come into play when we get a little bit closer to those peaks.

EBG1: Okay. I was a little sloppy on maintaining the altitude and heading on that one. I don't know, maybe getting a little complacent in here. *Turned a little late, so tried to compensate a little for it. Was flying heading 037 or so, for awhile, flying the ridge line. But we think it was within the time for PTS.* Okay, again this one, any of the topography on there it's hard to differentiate between the different levels of -- what's the term? The contrast or the resolution, rather? Again, that might be with the altitude but they all are excellent representations of the earth's surface up at that altitude, so again I'm going to rate this one as 1, as well. I didn't miss the fishnet, no.

CCFN1: It's a little difficult to see the topography. I can see what appears -- Is that a road or a river below? River? Yeah, as far as identifying the major terrain features, the color is different, but the topography's a little more difficult to interpret than previous ones I've looked at. I can see the towers on top of the ridgeline and they stand out pretty good, if I was to be concerned with their position in relation to where I'm flying. Pretty much I'm sticking with 60; what I like to go with primarily. (Did the fishnet help with this turn?) Yes, with it being just the blue sky/brown ground it gives me just a slight sense of what to expect on the ground but definitely not near as informative as the picture reference. Okay, going up to the top again on this one. If there was a 1.5, I would give it. But I'll just go ahead and continue on down to 2 with negligible deficiencies, not with the actual operating characteristics. But, as far as the information available on the SVS display -- me personally -- I still prefer the photo reference, so I'll give it a 2.

CCFN30: This is amazingly close to just the standard baseline. Not much topographical information to utilize on this particular display. This one being as similar as it was to the previous, again, the flight information is good. Topography's not as good as the photographic version, but still manageable and with that limited fishnet on there, when you cycle through the different fields of view you can identify terrain features a little bit, but not as good, again, as the previous photo version; so I'm going to indicate a 2. *He's referring to all others as the "photo" versions.*

EBGFN30: Yeah, when I just clicked into unity and lost ground reference, I wasn't very pleased with that view. Right at the moment I didn't . . . Yes, this version is easy to utilize, also. I like, definitely appreciate this opposed to the blue sky/brown ground. (The one you just flew?) Yes, all the previous ones regardless of whether they had the fishnet or not -- I didn't want to misname it again with the picture version -- but I like having the green and the brown next to the actual almost representation of what the actual ground would look like as opposed to just that standard baseline color. *Unity - lost ground reference at the beginning and wasn't very pleased with that. Likes the color variations. This was a good terrain, as well. Doesn't like the CC standard color.* I think, because I kept my flight parameters pretty well on that one, I got a good feeling on that display. I don't know if that had something to do with it, but yeah, that one, highly desirable. The display characteristics were good on this one. I'll give that one a 1.

Block 2, Low Altitude:

CCFN30: It's a little more detailed than what I experienced up at altitude, because I'm just cycling through the different fields of view and seeing how that was kind of changing what I'm seeing. It looks pretty good though. (Okay. Have you settled on a field of view that you like?) If I'm coming in close to approach, I like to bring it up to unity, but just for in-flight cruise, I prefer 60. The desired performance rating. Again wanting more of a display of the topography but given that current view I had, it was fine for what I was doing. I rated it number one.

EBG1: I like those as well as the previous ones. Now that I'm getting a little closer to the terrain, I like the information on the unity setting. (I saw that you stayed with 90 for before the turn, through the turn, and just until you changed right now to unity. Did you like the 90 better than the 60 on that one, or are you just testing it out?) Just looking at it. I like the unity when I'm down closer to the ground, doing straight and level. *Now that he's closer to terrain, and in his descent, he likes the Unity FOV.* Yeah, I really like the elevation based at this resolution setting, so I'm going to give this one a 1. Let's see, I don't recall the difference between that and the one with the fishnet. But we'll compare those next. Having a little crab thrown in there increased the mental demand a little bit because I had to rethink about what the symbology was. I was so used to keeping those centered.

EBGFN30: Oh, missed my turn. (Can you comment on the difference between the 30 arc-second and the one arc-second that you just flew just before?) They're really close. This one does have the fishnet, correct? (Yes it does.) Not too much of a discernable difference between the two. This is highly desirable. Excellent, also a one. (Did you see an advantage with the fishnet or can you tell right now whether or not the fishnet will be beneficial?) What was this, let's see, elevation based and the one previous was the color contrast. No, it was also elevation based, just different level. With the elevation based itself, displaying the different colors in the topography, the fishnet really isn't that much of a beneficial factor. As opposed, when we just do the blue/brown, then you need the fishnet for the identification. But, yeah, with the colors; no, it's not a factor.

PR1: I think this is my favorite display, the photo realistic at this level, level one, correct? Right now, well flying earlier I was in 90, correction, 60. And in 90 I'm just getting a general overview of the terrain beneath me. That's a wide variety of information down there and the topography looks real good. This one is nice and clear as well. *Pretty much his favorite. Likes the topography. The FOV90 gives him much info to work with. 60 may be his preference at the beginning of the run. Excellent display. Provides good representation. Likes this and EBG the best. Unity may not give you enough info for reactionary purposes with terrain.* It's an excellent display level. This and the, what was it, two previous, they were my personal favorites. But this one seems to be most clear and provide the most representation of what's below me. Now, as the field of views, I started realizing when I was back out at unity, what's directly below the aircraft I think it's a little reactionary, you know, for what we're trying to display here is what's coming ahead of you. And, I don't know really how to put that into terms, but I think maybe backing it out gives you a little more time to forecast and a little bit more reactionary time to deal with the terrain coming up there than if it was backed all the way out. I was messing with that a little bit and coming in when we were down at 5,000 feet as well.

EBGFN1: I like the photo realistic one a little bit better. MX20, I'm a little embarrassed to say this, but has that been operational with the portrayal of the color on the terrain? (Yes) Because that's the first time I've noticed it as well as the terrain warning indicator on the MFD here. I was focused primarily on the SVS after I made my turn from the waypoint I just was sucked into the PFD here and wasn't aware of what was going on, on this one, so I was starting to mix it up a

little bit and using both of them in symphony together. This is also an excellent display, and now incorporating the display on the MFD, it's going to take a little time to get the two displaying with each other; working together. Initially it was almost not too much information, but I was catching myself getting sucked in on the one display and then jumping onto another as opposed to developing a scan, I guess is what I need to work on with these systems. But again, excellent display for that particular one.

PRFN1: (I'm just curious if the fishnet is providing you any beneficial information.)

Not just yet, I was still focusing outside of the cockpit. Until I started losing that visual reference of the ground I can try to jump back in, but again, this one does look good. The fishnet is helping out in the dark areas of the terrain beneath me in this one. This display is especially clean, especially here at the unity. That photo realistic with fishnet and display one, is highly desirable. Excellent – 1. Same as without the fishnet. I like that photo realistic the best, I believe.

CCFN1: The terrain isn't as defined as the previous, the photo realistic, and with the fishnet on here, I can see some relief but not near as clear as previous ones. When getting down close to terrain using this particular display, you almost need to be in unity to differentiate the relief on the ground. Okay for the back of the chart, the SVS display characteristics, if I'm comparing it to the other displays, then it is not as desirable, but for the situation and what information it is providing me, it is highly desirable considering I am in IMC conditions, and I can't see anything. So if I had the money and had to buy one, of course I'd buy the one with the terrain portrayal and photo realistic, but this one is also a good display. So I'm going to rate it as a number two.

PR3: (And, just out of curiosity, did you miss the fishnet?) No, I sure didn't. *Likes Unity a little closer to terrain - gives him some added info on topography.* That is excellent. The more times I operate this I'm curious as to how the aircraft is receiving this topographical information. It is definitely beneficial for losing visual reference to the ground – excellent. This is really great stuff. *Did not miss the FN.*

PRFN30: (Can you tell the difference between the 3 arc-second data, which you just flew before this, and this one, which is the 30 arc-second data? Do you notice a difference in resolution?) Yes, the resolution isn't quite as sharp in this display as the previous display was, where the addition of the fishnet might help in some of the areas that are darker or a little more confusing as to interpreting the actual relief of the terrain below you. I still like to keep it between the 30 and the 60. I like to take a look at unity, like display it and I can see my airfield off in the distance. But what I don't like is how fast the symbology moves in unity, at least for my skill level. But I like to, when I click it to unity, I like to see that there is an airfield in sight, and of course on my display when I back out to 30 or 60, in most cases 60 to where I'm not chasing all the symbology around with control inputs. Again, a broken record. These are excellent displays. I can't find any negligible deficiencies or any unpleasant deficiencies while operating these. If I had to knock them down a couple levels it would be just the different fields of view, but then again that's pilot preference; but the actual display itself, again, this is a 1.

BSBG BL: Okay, I'm abeam my checkpoint and going to initiate a descending left-hand turn, zero-five-zero. And just with this baseline display, a thought came to mind. You have a tendency to lose that fear factor if you don't see any terrain. You're not really concerned about smacking into anything. You're just looking at your flight parameters. But now seeing the relief on the GPX-20 for the GX-20 display, that's helping out with the terrain awareness. Modifying the field of view in the baseline also doesn't have much of an effect, as well. Yeah, I'd prefer seeing an airfield off in the distance while I'm at unity and IMC conditions. I increased the mental demand on my scale here just a little bit just because of the fact that all the information

isn't contained on the one display and you're jumping back and forth from the ... (The MX20?) Yeah, the MX20 and the SVS. Okay, with the baseline I'm going to rate that a 3, with the minimal pilot compensation required for the desired performance, because of the fact that jumping back and forth from the different displays and not having that representation of the terrain. You increased your mental performance just a little bit using just the baseline.

EBGFN3: Usually what I do when I start the exercise, I verify my altitude, heading, and air speed are correct and I come back outside of the cockpit, pick a point on the horizon and fly to it. I also come back in a little more frequently than what I would, flying an actual aircraft just to monitor the altitude trend or the decline trend. Aright now I'm completely inside the cockpit. I'm abeam my turning point, going to initiate a descending left-hand turn to zero-five-zero. And, normally once everything stops moving, that's when I mess around with my field of view. This terrain is nice. Especially with the fishnet, not as clear as the photo realistic, but much better than baseline. Yes, this is also excellent. My top two favorites are the elevation based and the photo realistic. I gave it a level one.

Block 3, Approach:

EBGFN3: Okay, I can now just see the approach end of the runway on the main screen outside the cockpit. Definitely a lot busier on this run than the previous runs yesterday. Yes, trying to maintain the velocity vector inside the tunnel with the current weather conditions was a little more difficult than it was yesterday. *GPS gave red indication of terrain. Transferring to SVS display thus became more reassuring.* That's up to the top third. Okay, with the relationship between when I was going in and out of the cockpit, absolute zero visibility and the MX-20 was giving me indications -- red indications -- of terrain at my current altitude and then transferring back over to the SVS display is reassuring. It's highly desirable because it gave me an excellent representation of the surface conditions given that I didn't have any visibility whatsoever.

CCFN1: When I back the field of view out at 90 this far out on the approach, it's a little bit easier to navigate the tunnels, it seems. Yeah, when I bring it into unity that far out, it's a little bit much for me to try and keep the velocity vector going in there. When I get a little bit closer I'll cycle it through back to unity and see what I get on final approach. Yes, between 60 and 90. Sixty works best for me; 90, if I was say in a cruise situation, I would want to use 90 a little bit more than I would 60. But 60 keeps the speed and symbology versus my control inputs to a manageable level. *Aimed at 500 ft caused the GS to indicate too low when near the runway.* The level of terrain awareness wasn't quite that of the previous because it just doesn't depict the terrain as well without the input of color on the display. But still the assistance with the MX-20 still made it a usable feature. Without the depiction of the color, the actual detail of the terrain below. Just having the blue sky/brown ground with the limited fishnet, however, the indication of the tall tower that was close to the aircraft bottom left that was identical to that of the other displays.

EBG1: The difference, I just noticed when I cycled through, is the velocity vector between the waterline indicator. That variance gets larger as the field of view gets closer to unity at 30 and that makes it a little more difficult for me to manage, but I prefer sticking to 60 so far. I got the tower out the left window there. With the velocity vector and the longitudinal caret, the longitudinal velocity caret makes air speed management much easier than using the standard analog gauges as well. Line up the glide slope. Have to bring it into unity to get a clear image of the runaway. Airfield in sight outside the cockpit. *When cycles through the small FOV, the offset between the waterline and the VV is larger thus harder to control. Like the VV and waterline make it easier to fly than the standard gauges. Unity is better when closer to the runway. Like this one EBG1 because it display the colors of the terrain.* I like the elevation based because it

depicts the color terrain, actually the light greens, dark greens, and various colors of the actual terrain itself as opposed to just that generic blue sky/brown ground. So I really like that display.

PRFN30: I was able to negotiate that slight, right-hand turn with the field of view in 90 a little bit better than previous view settings. That photo realistic is my best, my favorite of the systems tested so far and I really like the terrain portrayal. The fishnet really isn't a factor. It assists in some of the darker areas. I'm going to rate that as a one. And also the field of view set in 90 for the majority of the flight through the tunnel, I felt my performance was a little bit better going through the tunnel and a little more manageable inside diameter of the velocity vector in relation to the smallest square that pops up. They are almost the same and it's pretty easy to keep those two centered in there. I didn't have as much a problem negotiating the turns as I did previously and then backing right back out to unity when you get close to the airfield. Overall, really good. I like that one.

BSBG BL: Using this particular display for approaches, I'm going to rate this as a number three. When I cycled through down to unity, I didn't have a runway display there, confidence level kind of went out a little bit and I was just waiting for visibility outside of the cockpit as opposed to the previous displays where it had the portrayal of the runway, that made it a little more reassuring. So I'm going to rate this one a 3. Some mildly unpleasant deficiencies and, deficiency not meaning a fault with the system; just would like runway displayed.

EBGFN1: The color representation as opposed to the previous, this is much more enjoyable to fly. It's almost as though you got scenery to look at, but it gives you that very important representation of what's beneath you. Fishnet isn't really that big a factor for me personally. The outer marker is still a little too far out for me to go to unity. It's still just nice and mellow to maintain this flight picture with it at 90. Also noticing down there the departure into the runway, in the event I had to get on this thing -- a missed approach or botched landing or whatever -- I see I've got some terrain to deal with out there as well. (So unity is better at this point?) Roger that. I like that display.

PRFN1: Okay, the photo realistic either with or without the fishnet at that resolution, is by far my favorite. It's a sheer pleasure to fly. Fishnet is not a factor. With or without, I like the photo realistic at the lower elevation.

PR1: The resolution really doesn't diminish too much between one, two, and three. The actual difference between the displays is when I noticed the biggest difference. This is more of a realistic representation, as it states -- photo realistic -- and the other one is more of a simulated and completely all the way out with the blue sky/brown ground. And I like more of that representation as what's coming up below me. You see the urban area, just getting a thorough understanding of what's beneath me, even though when I look out I'm completely unable to see anything. Okay, on the photo realistic at that resolution level, I rate it excellent. I like it. That is by far my favorite. Number one.

EBGFN30: The terrain representation is good on this as well. It's just not quite as detailed as the photo realistic. (Okay. I also wanted to find out, do you notice the roads or rivers at all this particular one with the fishnet?) They kind of blend in just a little bit but not too bad. Now noticing the previous displays where this would have been urban area, the grid or the fishnet might be a little difficult to see in the urban areas. I don't recall paying attention to that on the last run with fishnet, where the color of the city is kind of gray. Okay, the elevation based is also excellent. Very good representation of the terrain below, and no problems with it whatsoever.

CCFN30: I can see that ridge off in the distance outside of the cockpit that comes into play when I lose visual reference to the ground. And it's not represented as well on this constant color as it is on the previous two tested. I was checking the relationship of the tower indicated and the one I just saw pass below the lower left-hand side of the aircraft using various modes trying to establish a scale that I could compare relationship to velocity vector displayed on the screen in relation to where I am actually on the ground. When I'm out there at 90, I've got a lot of room to play with, almost like a forecast of what to expect coming up, and then when I bring it in to unity it's more of what you expect just looking outside the cockpit. Again, when I still had visibility outside of the cockpit I was comparing the relationship between the two as far as the terrain depicted in actual terrain, and it's just not as good as the elevation based and the photo realistic, so I'm going to rate it as a number 2.

PRFN3: Yeah, the relationship between the fishnet overlay going over the urban areas as we're just starting to encounter, it's still distinguishable. It doesn't blend in or lose representation of the actual fishnet itself. Over this densely populated area, I've lost a little bit of the contrast between the fishnet, but it's not a factor. It still seems highlighted enough. Okay, the photo realistic rated as number one; but I'm going to recall back to a question you had asked earlier in reference to the arc-second resolution. I did notice a difference between the one arc-second and this one we just conducted, which was the three arc-second. The three arc-second is just a little bit more, I don't want to say blurry, but not near as detailed as the one arc-second resolution. But it's still a one in reference to the terrain portrayal.

CCFN30NT: I'm misinterpreting my needles here; I'm getting a little turned around. *Pressed the FOV to change to lower FOV momentarily to search for the runway.* Minor but annoying deficiencies. Actually, I'm going to bump it down to a five, the moderately objectionable deficiencies, because without the boxes . . . Yeah, because without the boxes made it a lot more difficult than the previous. But still, in relationship to the terrain awareness, that combined with the MX-20, I'll rate it as a four.

Rare Event:

PRFN30: Okay, currently I'm outside of the cockpit, I picked a spot on the horizon once I established my altitude and air speed and anticipating weather to diminish. The photo realistic has always been, to me, the best one that I've operated with. (Right, but what about the resolutions? Can tell for this same display type – photo-real -- can you see difference between the different resolutions: one, three, and thirty?) Over this vegetation, this mountainous terrain, it's not that big of a factor. As also up at 6,500, clarity isn't a factor either. Maybe when we get a little bit closer to some terrain it might come in to play. Resolution is still good as we're getting down a little closer. The fishnet as well, clarifies any of the dark areas. Let's see, I got the terrain out to the right. MX-20 is not indicating that I am at or below that level. When I was in the unity, it looked as though I was coming into the terrain. It looks a little too close for comfort on the actual display where I'm at now, but I'm continuing to operate trusting the display. *4:11 verified that MX20 is indicating the correct attitude. 4:40 he started a climb because he knew the terrain was too low. He was trusting the symbology and thus did not initiate the maneuver at the correct time.*

Subject 10 (BRD Baseline):

Block 1, High Altitude:

BRD BL: There is something counterintuitive about descending through the goo VFR at a very fast pace. At 8,000? I was a little slow in throttling back to get down to the altitude. I mean the last 30 seconds, I was just sitting nice and stable at about 800 feet a minute, and I was pretty happy with that, but yeah, I was a little slow. I basically did it in sort of two steps. I turned and

then I really started my descent. *Didn't quite get down to 8k, and stopped descending during his turn. Other than that he did very well.* Pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No, deficiencies warrant improvement. I went with moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation, or five.

EBGFN3: Wish every day was that sunny out. I like getting the 60 degree, it is nice in this area at this altitude. This field of view is pretty good. Getting used to the instrumentation was a little bit, I blew through my heading and blew through my altitude.

FOV30 at the end was nice. He did overshoot his heading, and was still a little slow on the descent. But, much better. Had about 30 seconds of S&L at the end. Was very confident with this display, even after entering IMC. Okay, pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Okay, is it satisfactory without improvement? Yes. I'd say good, negligible deficiencies. (So pilot compensation not a factor for desired performance, and that would be a two?) Yup. (Any other comments on that display before we go on?) No, it was actually very reassuring kind of having that sunny, warm feeling of the terrain. It was actually kind of encouraging.

PR1: It looks just like it does outside. It's very green. This might be a little more desirable in an emergency, if I were to lose my engine or something, assuming that the fields and what not are reliable. This one feels like a window, where I guess the last one was more like a video game. Pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I want to say no, minor but annoying deficiencies, number four. It was almost like it was too realistic, given, it was capable on the size, what the screen length is, I almost wanted some sort of more clear visual delineation in terms of elevations and I did, like I said, I did feel that if I were to lose an engine or something, with this display I would have a very good idea of where I might be able to put it down in terms of a field, given the IMC, the meteorological conditions I was in. But it was almost too realistic, some sort of artificiality in terms of a stronger contrast in terms of elevations might have been desirable. Perhaps like a fishnet. I don't know, I haven't had one of those yet.

PRFN30: Another thing that would be nice would be a tachometer, especially for that turn. (Any comments on this display?) I don't have quite the sense of, I like the detail of the last one better. (Okay, can you tell if there is a fishnet in this one?) Yeah, it's not overly delineated for the rest of the terrain. The color contrast isn't that great. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I do miss having a tachometer. I'm going to say deficiencies warrant improvement, minor but annoying deficiencies. The fishnet wasn't overly delineated. Maybe I just had it on a lower or wider field of view for much of that flight.

CCFN30: Very artificial but I got a river in there, I guess. It doesn't tell me a whole lot about what's outside my window other than ground or not. (Okay, thanks, and yes, that is a river. Have you pretty much settled on the field of view of 60?) Yes, for this, yes. Largely because of the instruments. Yes, the unity one is just way too close, I feel, for using the horizontal compass. And really for this, still fairly far out from the airport, yeah, I like it. It's fairly widespread at that altitude. I definitely felt that had one of the lower workloads. Things just get processed if they're quicker. *Doesn't maintain a constant vertical speed, so his descent is slower. He also was out of bounds for about 10 sec on his speed.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'm going to say no, minor but annoying deficiencies. A little more vertical representation would have been nice, but it was very intuitive and very understandable, brown bad, blue good.

EBGFN1: I like it. I like the color contrast within the terrain itself, the greens and the browns. (Okay, it looks like you're on 90 field of view. Are you just testing that out?) Yes. Nice and wide. I figure I got some separation between myself and the ground and yeah, I'll just enjoy the view, especially since it's about to disappear out my window. I like this one. (Does the fishnet provide any useful information?) Yes, it helps, definitely for getting a, since there is no stereoscopic vision, per se on it, yes, it gives a sense knowing that those are 500 by 500 with grids. It gives you a feel for the steepness and the lay of the land. Pilot decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. SVS display characteristics, either good or excellent. I'm going to say excellent. Okay, let's go with a 1.5 then. I like the clarity of it. It's almost like with the photo realistic, it's almost like a perceived, the detail is not quite as, it's not like it's blurry or anything, but things are a lot more vague in this heavily wooded terrain, I should say, whereas I felt that display reminded me more of the mountains in Utah, and the contrast is much more startling. Startling is good, in this case.

PRFN1: The fishnet seems to get lost at this altitude, anyway. The quality here is just about the same as out the window -- actually better without the haze. I like the yoke toggle for the display. I do like that feature. (Okay, thanks. It looks like for the whole last run you used 90 field of view and from the beginning of this run you used 90, but now it looks like you're back on 60.) Yes, just trying something different. Ninety and 60 at this altitude are roughly the same. Things tend to react a little slower on 90, which is kind of nice. The impression is that they react a little slower. That was kind of nice, too, talking to you when I should have been making my turn. A little more realistic. That level of resolution was pretty good, the photo realistic. I kind of liked it with the fishnet as well. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. I want to say two. Good, negligible deficiencies. I didn't quite like it as well as the prior, but it was good. I find the added detail definitely makes a big difference with the photo realistic. (The added detail in terms of resolution or in terms of fishnet?) Both, especially resolution but the fishnet adds an element as well.

EBGFN30: The details aren't quite as nice. (As the photo realistic or as the higher resolution?) As the higher resolution. Especially on this small screen, and the added resolution is a bonus. Flying a head down display is pretty nice, though. Once you get used to it, the scan is very nice. All those quarters I put into the arcade video games growing up I think are paying off. Up at this altitude, I definitely feel very safe. I find myself just concentrating on the gauges more than even really taking in the terrain. Not just for this one but most of the flights I've been doing so far. In just about all of them I'm aware of the degree of terrain separation. And comforted by it as well. Okay. It was controllable. Was adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'm going to give it a three. I just like a little bit more detail, but it's good. I like greater resolution. Other than that it was good.

EBG1: Very crisp. (Just curious if you miss the fishnet?) Not at this altitude, no. (How about at the target lower altitude?) Yes, right as I'm topping the ridge, I definitely notice that's gone. I still have this sensation that the terrain separation is very good. I imagine it will definitely play when altitude shifts, when I start flying at a lower altitude. Up here, it doesn't particularly bother me though. It was controllable. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Up at that altitude I think I might even like it better, well, I'd say it is six with or without the fishnet at that altitude. I definitely love the clarity, though, the resolution. Either a one or two, let's call it a 1.5 as well. It was good. I just love the clarity of it. The clarity was very appreciated.

CCFN1: This high up, the grids, I guess it's nice, but it doesn't do a whole lot yet. I want to get over the ridge. Definitely in an emergency I would have no clue where I would want to be. A little deeper contrast for that grid on this particular region would be great, like a nice bright green or something. It is controllable. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Minor but annoying deficiencies, four. I think they have a stronger contrast to really get a sense of the terrain, the lay of the land. (Okay, so this is mostly based on the fishnet?) Yes.

PRFN3: Three arc-second is just about as good as the one arc-second. I'm thinking about like if I had to put her down somewhere, I feel like I would have about as much information as I had on the one arc-second. It's certainly a lot better than I have out the window right now. This one feels about the same as the one arc-second with the fishnet, in terms of, it feels the same. *Was a little less aggressive this time on his turn and his descent, but still within desired parameters.* It is controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd say good, a solid two.

Block 2, Low Altitude:

BRD BL: (Any initial comments on this display?) No, except there goes my visual. Just like flying at home. Understanding of the situation: I should not be there in VFR. Okay. *Did level out at 6k for a few seconds, but made target alt with plenty of time to spare.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say no. Do deficiencies warrant improvement? Yes. I'll go with five. Requires considerable pilot compensation. It takes away sort of the situational awareness. Once you enter the goo, there is the data coming in from the GPS, but it doesn't tell you a whole lot. It also, when you're flying in the goo like that, I found that most of my attention was spent just maintaining altitude and heading, not necessarily tracking paying attention to the terrain as it would come, if that makes sense. My focus was on flying my heading and my altitude and my air speed, rather than any broader situational awareness. I was flying the gauges. I didn't feel like my margin of error was very large. I guess I'm saying as a pilot, I would feel very uncomfortable being at that altitude in that terrain in those conditions.

PRFN3: Field of view, keeping it at 60 right now. Oh, that was 90 I guess. Well, we'll go at 90, I like the broad field. That's a little frightening. I saw the two towers poke through out the windshield. Actually to be there in this kind of weather would be more than disconcerting. (How do you like the display?) It's good. Yes, I like the fishnet, very much. Okay, very controllable. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd have to say two. Pilot compensation good, negligible deficiencies. Pilot compensation not a factor for desired performance. That was good. I felt very secure, all things considered. I'd definitely question what someone would be doing in those conditions at that altitude in that place, but all things considered, if you had to be there doing that, I felt very comfortable with that screen.

PR1: I'm trying to actually stay outside the window a little more this time, so I'll check it back in 30 seconds. I will just say that it appears to be pretty much the same outside as it does on the screen, or it did until I got into the goo. (Any comments on this display?) It's good. Yeah, I liked it. It was good. I like it a touch better with the fishnet, but that was solid right there. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. I'd say good, two. (Can you talk a little bit about the field of view, if your strategy is changing because you're lower to the ground, or do you sort of have the same strategy as with the high altitude scenarios.) I'm definitely paying a little more,

well substantially more attention to what's directly in front of me. I am a little less concerned about the big picture situational awareness and more focused on what's going to happen in the next 20 seconds directly in front of me, if that answers your question. Sixty is pretty good. I might try, I'm going to maybe play around with 30, but I think the unity view is still a little bit too tight. I don't get quite the field of vision. Ninety is probably overkill at this point, especially once I lower altitude.

PRFN1: I like it. (Does the fishnet add or detract, or neither?) I think it adds. For me it adds. (It looked like at the beginning you stayed on a 60 degree field of view, and then you changed it to a 30 after the turn, I believe.) Yup, 30 offers less terrain awareness and also it's a little touchier on the controls. Things tend to jump around a lot quicker, is the impression. But it's not bad. I don't think I would use 30 much if I was much higher than that. (Is it safe to say though, that your preference is still 60?) Yes, I think it would be safe to say. It was controllable. Adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'm going to give like 1.5.

EBGFN3: It's pretty nice. (How do you like the 90 FOV on this one?) Right now I'm liking it. I felt more comfortable being in a little closer on this one. I felt the detail actually gave me something. Things were just still kind of green on the photo realistic, whereas this time I felt the artificial coloration had added to it. (Okay, so you're saying after the turn, once you got down a little bit closer to the terrain, the 30 degree was . . .) Yes, worked well and yeah, it just sort of, with the artificial different colors, I could very intuitively tell what was going on, whereas with the photo realistic, things just tend to be a mass of green. I like that profile. I'm starting to get the hang of this. It was controllable. Was adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'm going to give that one a one. It was good. I felt like I got a lot. I felt like even when I was concentrating on my gauges, I still out of the corner of my eye, had a very good feel of what the terrain was doing.

CCFN30: Nope, pretty plain. I definitely like the wider view here. Definitely a lot squirlier at the lower altitudes. (Can you define squirlier?) Not nearly the same degree of situational awareness and it's hard to tell exactly how far off the ground you are. (Is the fishnet helping you?) It definitely helps, but I'd say it helps but it is marginally adequate. (Are you settling on the field of view of 90 right now?) For that one (texture concept), yes. I found myself questioning a lot more. Like I wonder how far off the ground I really am, off this one. It was a little less intuitive. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. (Have to give it at least a 4, because of performance rating). Okay. I wanted to give it a five. (But you're saying that if you had adequate, you would have chosen five definitely?) Yes. I was never overly confident with just exactly my degree of terrain separation. I guess it was a, I find it moderately objectionable, but I do only feel it's a moderate pilot compensation, at best. It was more of a psychological thing. Minor but annoying deficiencies. I was very happy before.

EBGFN1: I like 60. Ninety is not bad either, at this altitude. (How about the texturing concept itself?) It's good. I really like the fishnet. Sixty degrees I think is probably my favorite. Thirty is not too bad either, but actually at this altitude, 60 is perfect. I like it all. I like the fishnet, I like the texture. It was controllable. It was adequate with a tolerable workload. Is it satisfactory without improvement? Yes, I'd say it's excellent. I'll give that one a one. Highly desirable. I liked it, I think it's an excellent blend. I really felt comfortable with where I was and knowing where I was. It was good.

EBG1: I like it. (Do you miss the fishnet?) A little bit. I prefer it. Miss isn't the right word, but I do prefer it with the fishnet. (It looks like you are at 30 degree field of view at this altitude for this display concept. Is that what you like the best?) Thirty or 60. I find it kind of a push to get a little closer view with 30 but less field of view, so I find it roughly it's about a push. I like it (the texture). It was controllable. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I call it good, I call it two. (Okay, just out of curiosity, you rated this a two, and the one right before that had the fishnet, and you rated that a one, was that the only difference between the two?) Yes, I would say that would be the difference. At the lower altitudes, the fishnet really gives an excellent scale. It's the difference between are you really close to a small mountain, or are you far away from a big mountain, kind of a thing.

CCFN1: Definitely better than the 30, but let's see when I get lower. Definitely either 30 degrees or 60 degrees. (How about the terrain concept itself?) Much better than the 30 arc-second but not nearly as good as, I'd say this is my second least favorite that I've done so far. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say no, with minor but annoying deficiencies. It is certainly a lot better than the 30 arc-second, but the degree of terrain feel, if you will, is still marginal. About like a 3.5.

PRFN30: Not too bad at 90. Not too bad. The grid definitely helps a great deal. (Any comments on the texturing concept at this altitude?) Adequate. That's about how I would describe it. (So you miss that higher resolution and the medium resolution?) Yup. A much bigger difference between the three and the 30 than there is between the one and the three. It was controllable. Was adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'll say yes, but fair. Three. The whole profile just looked a lot flatter. Why I didn't rank it a four? I felt that the degree of, my terrain awareness was definitely a lot better than with either of the blue/brown profiles, but just not nearly as good as the others. It's adequate. If I was going to buy one for my plane, though, if I owned a plane, ideally I'd want like at least a three arc-second resolution.

EBGFN30: I like it, I do like it. It's not ideal, maybe, but no, it's just fine. The fishnet is yeah, I'd say it's just fine. It was controllable. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd say it's a solid good. The terrain was definitely a touch flatter than with the higher resolution and that low to the ground in that kind of weather, that would certainly be a wonderful addition, but I felt very confident with what I had.

Block 3, Approach:

CCFN30: I like the fact that in a terminal environment, things are very simple, like there was a runway, a couple obstacles, and then just the general ground impression. My focus is totally on the boxes and then the runway once we started the descent. (Okay, how did you like the field of view of 90 through the turn and it looks like you scrolled down to unity at the very end?) Yes, that was the way to go. 90 was beautiful on the approach in that I had the most boxes to line everything up with and you know, at 1,500, 2,000 AGL, whatever I am, plus or minus, within the box I felt very safe and just to get more precise as I got down, as the controls get a lot more sensitive inside, as the field of vision gets narrower, it was great to wind up with all this totally dialed in the whole way. *First pilot who did not shallow the turn.* It was controllable. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. Good. Two.

EBG1: It would be nice if there was a little more color contrast between the tunnel and the ground here. It's not bad, just for intuitive reasons it would be great. It looks nice. I'm very aware of where everything is. (Do you think more so than the last concept?) Definitely, although my focus is still on the tunnel. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. What I liked about this one versus the last one was I felt like if I had to go missed or if there was a problem, if I had goo, I had an excellent idea of where things were. So I'm going to call that one a 1.5. I feel like even if the approach plate fell off my lap, as long as the SVS was working, I could extricate myself, climb and get out of the situation.

EBGFN1: I like it. (Does the fishnet give you any benefit?) Definitely. It's a more objective feel for the topography and land, rather than just shading or artificial lighting. It adds to the display without taking anything away, I guess that's how I'd put it in a nutshell. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd say excellent, highly desirable, one. I'd feel very comfortable making an approach in that kind of weather with that kind of visibility assuming that's a reliable plane and the system is working reliably. Once I'm established on the localizer, tightening up a bit is nice because the boxes don't come at me quite as rapidly and once I'm stabilized it's good. Once I'm stabilized, it's only at the turn that I like the 90, when I'm being vectored in on the turn. Once I'm stabilized, I can tighten it up.

CCFN30NT: I'd take that approach any time. I mean the way I flew it. (Just out of curiosity, did you miss not having the tunnel there?) Um, I think it's a crutch – it's awesome if it's there, but I've been trained to fly if it's not. I've been trained to fly if it's not. Yeah, did I miss it? Sure. I also found I used the MX20 a lot more in that flight for additional awareness. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, I'd say fair. (Minimal Pilot Compensation required for desired performance, so that would be a three?) Yes. Just relative to the - one, I flew it really well. So I can't be too frustrated with it. I'm very happy with how I just flew, and I wish I had flown my check ride that well, but the tunnel definitely adds a whole other dimension to positional awareness and situational awareness and trends and whatnot, than just following needles that does not provide. Just relative to the other ones. I mean there's nothing wrong with that at all, but relative to what's available out of the other approaches that I've flown.

BRD BL: Wow. The things you guys are working on, even the things that I'm not overly fond of, are still vastly superior to round gauges. "Gooned up" - It's when you're flying on your instruments, sometimes you just lose complete situational awareness and you're supposed to make a 180 degree procedure turn and you make a 360, or you're given heading 300 and you turn a heading 030. Something along those lines. Basically when things go down the toilet in a few seconds. You might be doing an approach where there are two VORs, and you're tracking off of one instead of the other. Or you trying to do an ILS and you tune in the VOR frequency, things like that. There are many different ways to "goon things up". (He was a little high for a long time on the glide slope.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Nope. Five, adequate performance requires considerable pilot compensation.

PRFN3: It's solid. I don't like it as well as the EBG. *He was a little low (1 dot high) on this one for a little while, but it was still within PTS.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I want to call it a 2.5. It's solid but it's not inspiring for some reason. It's just like looking out the window, but I guess that's not always a good thing.

PR1: The EBG, there is something totally simplistic to it. With the photo realism I find myself thinking, am I really close to a small hill or am I far away from a large hill? Things aren't quite as intuitively simple. (I'm just curious if you can tell the difference between the one and the three resolutions.) I'd say mostly no. I always like the fishnet. Maybe not missed, but I've always appreciated it. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll give that one a 2.5 as well. That was solid, you know what, let me give it a two. For some reason, I guess the little added detail, that was a one arc-second. Yes, intuitively I guess that helped a little bit in terms of just feeling, having good situational awareness, understanding where I was, where the ground was.

EBGFN30: I definitely need the grid here. It just looks a lot flatter. (He was a little low at the end, but not enough to put him in the adequate category.) Is it controllable? Yes. Is adequate performance attainable with a desirable workload? Yes. Is it satisfactory without improvement? Yes. I call it good, two. A little more terrain awareness would have been nice. I missed that a little bit.

PRFN1: I like it, I like it with the grid. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll give it like a 1.5. That was very good.

CCFN1: (Any initial comments on this display?) I think it needs a little Braille. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give it a three. I didn't feel like my terrain awareness was totally great, but it was adequate.

PRFN30: I thought a 30 arc-second tends to be very flat. Photo-realism is a whole lot clearer. It adds a lot of texture. It makes it a little prettier. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I don't know, 2.5. I liked it. It was mellow. I liked it because it didn't, with a low degree of resolution there just wasn't a whole lot to pay attention to. So I didn't feel like it interfered with me or distracted me, but at the same time it didn't add a whole lot. It was better than the, I enjoyed it better than the constant color, but not as much as some of the high resolution ones.

EBGFN3: I think it was a nice compromise between, I like the fishnet and I certainly prefer the one arc second, but I think the three arc-second is adequate for what I enjoy better. It gave me a detail that I like. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll give it a 1.5.

Rare Event:

PR1: In this mode I like 60 degree view. It's real crisp. I like the fishnet better, but it's good. I'm looking out the porthole. It seems especially low. (Okay, what would you do if it was especially low in real life?) *At 3:55 changed to Unity to see the terrain, but didn't mention anything. Was pretty much lined up between towers. 4:19 says terrain is looking especially low. Then after prompted, pulled up.* Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd say good. What would make it excellent would be like a flashing red light or you know, bright neon, or warning or a voice or something saying . . . Sure, in that kind of a situation, why not? Maybe there could be like a landing switch or something to disable it for an approach or something so it's not annoying you while you're on final, but that would be great in a situation like that.

Subject 11 (BSBG Baseline):

On the date of this subject's participation, transcriptions were only available for the first two blocks, due to a malfunction in the audio recording. The first two blocks are summaries of the true transcription, and the third block and the rare event text is data that are not actual transcripts, but notes that the principal investigator took real-time during the experiment.

Block 1, High Altitude:

EBGFN1: Operate, and I've got the plane. That's the turbulence I'm feeling. I'm used to actually getting bounced around. The way point I'm looking for is going to be obvious on the display, on the right hand one? There we go. Well, I overshot a little bit. The terrain display is fantastic. I have a good ridge line view. Do you want me to toggle through the fields of vision? It seems like for the in or out phase, it seems like 60 or 90, I think this is 90. It seems like 60 and 90 seem to be the best in there. (During your descent in your turn you were a little fast for about 35 or 40 seconds. Actually your average speed during your descent was about 115. So you might want to keep an eye on that next time. I think it's just part of acclimating to the simulator.) Yes, I was noticing that, the airspeed shot way up. I needed to pull throttle way back. Pilot position, is it controllable? Adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Well, I guess, no, efficiencies warrant improvement. Moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation. I guess I'd go with a five there, and the compensation there is learning how much throttle input I need to reduce, and trying to get used to some of the symbology, watching the altimeter tape and the VSI direction indicator versus my standard gauge.

PR1: Operate, I've got the airplane. And we're at full throttle and fine. And I guess I'm just trying to bring into my scan the altimeter tape with the VSI indicator. I don't know if that's the turbulence or a trim thing, but it wants to roll left pretty much continuously. (That's the turbulence.) There we go, now it wants to roll right. On the terrain. I guess I'll have to stop looking at the SVS, it's nice. Now I don't have a choice. I really like it. Yes. I think for cruise flight, at this stage, the 60 to 90 just seems nicer to give you more of I guess a reference. I'm trying to toggle through the screens (FOV's) here, it's kind of nice to have what's down below me. Yes, as I go through like the 60 and 90, I guess I don't have a very good depth perception of exactly how far it is below me, but it's kind of nice to know that you can see down in this higher -- I think this is a 90 right now, that you know there's something right underneath you, and stuff. You toggle through to the forward one, I'm looking straight ahead, and also it makes it a little bit more jumpy in my movements. I'm on the vertical velocity in that. Well, pilot decisions, is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement, I would say yes. And then decision tree, excellent, pilot desirable, pilot compensation not a factor for pilot performance. Pilot compensation required -- I guess I'd go with pilot compensation not a factor for desired performance. I'm still trying to get used to the system, I think, and interpreting some of the data, and learning just where the controls need to be for the desired air speed and rate of ascent, et cetera.

EBG1: Operate, I've got the plane. I'm trying to bring it back down to 95. It seems like a real nice transition from when I start going IMC just to look at the SVS. I seem to get a good outline of the terrain. The photorealistic one was a little bit nicer, because it gave me a more -- the color differentiation, instead of just all brown. I feel like I'm flying in a desert. And now I'm leveling out here. Actually, this terrain is a little bit nice, it has a good contrast to it. Having the velocity vector and the acceleration here is very handy as I learn how to use it, to kind of match everything up. It really seems to me in the center up phase, the 60 and 90 is most favorable. Pilot decisions, it's controllable. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. I would still -- I'm trying to decide between one and

two, excellent and highly desirable. Compensation not a factor for desired performance. Pilot compensation not a factor for desired performance. I don't want to give everything a star rating, but I like the contrast, I guess – 1.5. At first I didn't like how everything just appeared brown. I guess I did kind of like when you're flying along you didn't have just all the green, a green sea, which at first I didn't think I'd like. But, the contrast gave a good contour map of the mountains that I was flying over. It was nice.

PRFN3: Operate, I've got the airplane. I guess I'm supposed to be looking out the window, but it's easier, I want to look at the little screen. (It looks like you scrolled down to 90 right off the bat, so for basically the whole maneuver you think that 60 and 90 are your preferred field of view choices?) I think so, because if I go to -- I think this is the unity, I'm not really getting much information from it. It gives me a horizon, but I get a nice artificial horizon just with my pitch attitude indication, which is what I'd be wanting. It seems like 60 and 90 I can kind of look down to see any terrain that might be below me, according to this, which is what I'm most concerned with is something I'm going to fly into that I can't see. (How do you like this terrain depiction itself.) So far I like it. I'm noticing the fishnet now, I didn't notice it so much before. Yes, I'm just coming up on that one (turn). All right. A little bit more stabilized here. (This is the three arc second, which is the medium resolution. The ones that you've been flying up to this point has been the higher resolution, can you see much of a difference?) Yes, actually there is. Comparing this one to the last one, the last image was a lot crisper as far as following the ridge line, say, that's directly in front of me. On the last one I could really pick out where the ridge was, now I'm getting -- I know there's a ridge there, but I can't really -- I kind of let myself get a little bit distracted here. There we go. The last one it was much easier to define exactly where the ridge line was, it had kind of a fine reference to it. This one I just know it's there. That might be enough information, but it's not as definitive. (Do you think you could have picked up the ridge line better on the last one because the resolution was better, or because terrain depiction was different?) I think mostly because of resolution, a little bit on the contrast, looking at it. Looking at this one it looks like I can see a road along the ridge line, and the fishnet kind of helps define where everything is. I kind of think maybe the brown and the dark -- I think it was the high resolution on the last one that really did it. And I think one this last one I got a little over confident, that's why I blew some of the numbers. Pilot decisions, is it controllable? Yes, it's controllable. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd call it between -- well, like a 2.5, so it's kind of good to fair. Pilot compensation not a factor for desired performance, and minimal pilot compensation required for desired performance. And the reason why I go with that is, everything is nice, it's just a little bit nicer to have a crisper image of the terrain that I was flying above, you get more actual real feeling than this did. This lets me know that it's there, but I don't have the same sense of how high above it.

EBGFN3: The 90 just -- I just like, I guess, having a wider field of vision as I'm flying along here. It just kind of depends, I kind of like 60 to the 90. I like to toggle between the 60 and the 90, apparently. The only comment I'd have, it would be almost nice, you probably can't do it, but to have like an up or down selection, instead of just the one-way cycle through on the toggle. Yes, I'm just getting stabilized here. I think this is the same resolution and that it just has a different contrast. (As the last one you flew, yes.) I like this display better. I guess I like the brown and black kind of -- it just gives an easier contrast to follow than the last one. Seeing the contours is easier for me than the last one on that. It almost seems like it would be easy to just follow that. I'm trying to line up all the vertical velocity indicator and all that, but you could almost see how to fly it over the terrain there. Like this is 90 – (I noticed that you are using the yoke field of view toggle and not the knob. Do you like the position of the yoke better than reaching down for the knob?) I don't know what it would be like if it would be much different in

a real airplane. I think I'd feel the same way, I don't normally like to leave my hand from the yoke for very long, especially to reach over, and try and fly with my right hand. I don't have the same dexterity, and my right hand is normally free, regardless, because it's the throttle hand, and increasingly you just don't need it for much of anything, except for trim adjustments, and we used a mechanical trim. The yoke mounted one is something I would use, the left one I probably wouldn't use. I don't know if I'd like to at all. Okay. It's controllable. Adequate performance attainable with tolerable workload, yes. Is it satisfactory without improvement, yes. And I would give it a rating between about -- I'll give it a 1-1/2, excellent to good. Compared to the last one, I guess, I like the, even at a slightly lower resolution, the contrast between the terrain is a little bit easier to depict. I can't remember the exact definition of the last run, with the green overlay it was a little bit harder to find. (The last one was PRFN3.) Yes, this one was a little bit easier to interpret just where the terrain was. And I kind of like that. I guess I'll go with a 1.5 on that.

CCFN1: Operate, and I'm flying the airplane. I guess that's the river I'm looking out down below, that sticks out really well. Maybe as I get closer to the terrain it will be closer to interpret it. I think I'm in too high a descent rate. Well, it gives me more time. My ears will probably be really popping, but trying to get back up to 8,000 feet. Kind of just off the bat, it's really hard to pick out any kind of terrain. *Software crashed towards the end of that run.* Okay. Looking at this, because there's essentially no contrast in the color. You can pick out that there's some terrain, but I have no -- even trying to cycle through the field of vision I cannot determine where that ridge line is, I just know it's supposed to be there. I can see vaguely that it's on the map, but I can't interpret where it is. The last one at a lower resolution I could pick it out fairly well, and I liked it a lot more. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, on this do I need to be in the top three, or four? Well, I don't know how the other one is going to run, so I'll go with fair, with mildly unpleasant deficiencies. No pilot compensation required for desired performance. And I do that simply because, compared to the other ones I don't have the same terrain awareness, whereas before I could almost just look strictly at the screen, and I'm trying to peg my numbers by using all my other information. But, I feel I could avoid hitting anything with the other symbology on the previous screens. With this one I would have a hard time determining exactly where the terrain was in reference to me. It would be more difficult.

BSBG BL: Operate, throttle back and forth, flying the airplane. This looks almost like a standard VVI. All right, well, I guess flying this I really have no idea where the terrain is, except for -- I would need to have a sectional or something to tell me what's ahead of me. This feels like I'm just kind of flying a standard in route IFR procedure -- I like it a lot. I think flying this as a cruise flight and in the approaches it would be excellent. But, in this I have no concept of what I might be hitting. Pilot decisions. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Compared to the last displays I'll go with no. Deficiencies warrant improvement. For terrain awareness I would say it would need improvement. I guess I'll give that one a four, if it's the lowest I can go. (If you could have gone lower, would you have?) As far as terrain awareness, I would give it basically unsatisfactory. If I'm not using an approach -- an IFR procedure, I don't have any information except for what I would normally have in the planes I fly now. The information is -- once I get a little bit more accustomed to it I know it's much easier to interpret, because I have just one screen to look at. But, I just have a flat screen, I don't know what's ahead of me.

EBGFN30: Operate, forward back, and I'm flying. From a distance, if this was the case I would yank the throttle and get down in a valley where I know where I am. At this stage I'm not actually noticing a big difference (between resolutions). Coming from the last display it's nice to see some terrain. And I think when I descend and turn, and go over the ridge line I can give you

more information on that. And just real quick here, this is a lot better than the last one, but definitely not the same resolution. Yes, as I turned onto the ridge line, I like this much better than no ridge line, but the one arc and the three arc, the high and medium are much nicer, giving a much more positive indication of where I was. I'm kind of picking out the antennas here. I'm not really sure how much the fishnet is helping me define where things are. The color contour is what helps me the most. Pilot decisions, it is controllable. Adequate performance is attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'll go with fair, some mildly unpleasant deficiencies, minimal pilot compensation required for desired performance. And I'll just go with that simply because, this one I could pick out the terrain, and it was very nice, but it wasn't as crisp, I guess, giving me quite as good a feel as the high resolution displays. But, the color contouring, with just the brown and black, giving me an idea of where the ridges are, and that helped a lot.

PRFN1: Operate, throttle forward back, I'm flying. I like this one. As I'm losing the actual visual reference in front of me, I basically still have almost the exact same thing, going from the big screen to the little screen. I'm not sure how much the fishnet is helping me. I like the photorealism at the moment. I guess as I come over the ridge line that's going to be -- I'll have a better feel for it. The fishnet helps a little bit, just getting a little bit of terrain outline. It's kind of nice, as I lose the actual visual in front of me having this little screen just makes me feel like I'm not really (losing the visual). I'm rolling out here. I've got the ridge line, I guess I'm not -- I'm following it, I think I'm just a hair to the right of it from the looks of it. I feel like I'm right on top of it. I see the road there. *Software crashed towards the end of the run.* I don't know, if you want initial comments off that, I'm almost -- I don't know, the photorealism looks nice, but I'm almost thinking just the brown and black and green instead of the photorealism just gives it more -- easier for terrain awareness for me. Okay. It is controllable, yes. Adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. Well, hopefully I get to fly one of the other ones. But, I guess I'm going to go between excellent and good, right in between. I like the photorealism, like looking at it from this display, at this instance, I really like it. And it just seems like when I come over the ridge line, though, that I guess I know I'm over it, but I'm not getting a good sense of contour, as I look at it, at least not as crisp as with a more definitive color differentiation.

PRFN30: Operate, throttle back, forward, I'm flying it. We need to have some floats on this, go land out in the water. At this altitude I don't notice any difference between the high resolution and this low one. I will try and remember (to compare, again) that when I roll out and kind of stabilize, or I feel comfortable. This is the easy part of the flight. I don't know, off the bat I'm not noticing a huge difference, I guess, with the color contour of the photorealism. It seemed like the lines were sharper on the last one, but I'm not sure how much difference it's making for me, as far as realizing where things are. Okay. It is controllable, adequate performance attainable with tolerable workload, yes. Satisfactory without improvement? Yes. I'm just going to simply go with good, negligible deficiencies, pilot compensation not a factor for desired performance, two. And the reason why I chose that is, I like the photorealism, particularly when I'm higher up in elevation, and I guess I need a few more tries at maybe the same or better resolution, but the EBG. That one just seems like when I get down over the ridge line it helps me define where the ridges are a little bit sharper.

CCFN30: Operate, throttle back and forward, I'm flying. Well, I've got some idea where the terrain is looking at this. Only one nice thing is, I guess if I was trying to figure out where the river was I'd know where it is very clearly. And other than that, additional comments on this would be, I like the photorealism much better over this. Actually, the fishnet overlay does help me with some terrain contours, but the river itself gives me more of an idea of how the layout is.

It gives me more of a -- I don't know how to verbalize it very well, but a reference point for looking at the fishnet without the overlay it isn't as easily interpretable. Now actually, as I lose the horizon and go strictly to the gauges it's much more noticeable with this overlay. And toggling through the screens here, I guess I kind of see the antennas, and I can see a little bit of the overlay, but I really don't have much of a feel for where I am in reference to the ridge line here. I think probably the reason why I like selecting the 60 degrees, to get my attitude, I don't know if it's just a comfort level or what, but being able to see 5, 10, 15, to 20 degree ticks. Next one up, it's not as important, but for the in or out phase it just seems a little too touchy for me. This gives also a little bit more of a horizon for me, it's a little bit easier than just looking strictly at the gauges to look at the horizon that's indicated for reference. Is it controllable? Yes. Adequate performance attainable with a tolerable workload, yes. Is it satisfactory without improvement? I'm going to give it -- I hate to give it a no, because you kind of have an idea. But, if we're looking for terrain awareness. It does give me some terrain awareness, but not as much. So I would say, no, deficiencies warrant improvement. I'll go with minor but annoying deficiencies. Desired performance requires moderate pilot compensation. I'm going to give it a four, just simply because it's almost -- it's better than having just no contour, but it's not giving me much of an idea where I am, I guess. So I give it a four.

Block 2, Low Altitude:

EBGFN30: Operate, throttle back and forth, and I'm flying the plane. Okay. Kind of transitioning over to the SVS now. Well, the fishnet I think is helping a little bit. Also I think what's working for me is the dark to the lighter contrast to differentiate contour. And I actually saw the antennas on the big screen a little bit ago. Now, I'm trying to see how it looks comparatively. I'm kind of trying to feel that (FOV selection) out a little bit. It still seems kind of like the 60 degree -- I kind of like the fact that at the 60 and 90 I can still look down at this point. I was trying to see if the other ones were preferable as far as seeing where I am. But, I guess I really like the idea of being able to see what's below me, it gives me a better feel that I'm not going to hit anything. The other ones I look more directly straight ahead, and it's like looking straight over the nose of the aircraft and having no side reference. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. And I have a hard time deciding here. I'd give it a good, a two. I felt like I could differentiate the terrain fairly well as I came closer to it. Like I said, I was toggling through, trying to see which reference looked the best, and 60 degrees field of vision seems to be the best for me, because it doesn't seem to minimize what I'm looking at too much, yet I can kind of have a feel for what's around me.

PRFN3: Operate, throttle forward and back, and I'm flying. I just kind of feel like, having kind of stabilized, and I have about a 60 degree field of vision here. And the fishnet overlay, I can kind of see it -- well, I've got to pay attention -- (Don't forget, you do have a trim on the left yoke.) Yes, I'm trying to figure out what works the best here. *Software crash halfway through the run, so had to re-run.* I seemed to like it (the display). As I'm getting closer to the terrain, it's making it, I think, a little bit easier. Photorealistic might work better for me. I was still more or less flying on the gauges, trying to line everything up and get stabilized. I wasn't looking too much at exactly the terrain, I was starting to look at it, but I was also trying to play with the field of vision there to see how I liked it, especially in the descent, if I toggled down to a lower field of vision if I'd like it or not. Operate, and I'm flying. I had a plane around the big screen for a minute, I thought it was going to show me where to go. It's kind of fun to learn any system. This feels like home now, looking at the screen. Now I'm strictly on the SVS. I think I almost prefer -- it's hard to decide between 30 and 60 right now. I think I'm at the 30. (That's a 60 right there.) Well, I guess I don't know what I'm talking about. I guess I do like the 60. I'm getting a lot better feel for the terrain with this. The fishnet I think is helping. But, the photorealistic, I

have a better -- looking, I can see the terrain right now, where before I think at the higher elevation I really couldn't make out much. Well, let's see. Is it controllable? Yes. Is adequate performance attainable with tolerable -- I don't know why I have such a hard time with that word, tolerable workload? Yes. Is it satisfactory without improvement. Yes. Well, I'll give that one excellent. I really liked it. The photorealism was really nice. As I get lower it does help pick out the terrain. The fishnet overlay, I don't know, I guess I won't know until I fly with some of the other ones. But, it does seem to help a little bit for just contrasting, and kind of going through the field of vision. And the descent, I think having it down to like 30 degrees is nice, but then once I level off I toggle back up to 60, just to kind of see what's underneath me. (Why in the descent did you like the 30 degree?) Well, when I'm in the descent, in the 30 degree I'm still able to kind of see what's below me, because I'm pointed so nose low, and it gives me a little bit sharper image of what I'm looking at, of what's directly in front of me. I guess my big thing is being able to see what's underneath me, instead of what's directly in front of me. I don't know if any other pilots are like that, but I kind of like to know how high I am flying over terrain.

EBGFN1: Operate, and I'm flying. Initially, I really like it like I did in the other ones. It gives me a really good sharp contrast of the terrain. Green, brown, and black lets me really see the ridge line sharply, which I like a lot. Actually, you can see it's enhanced by compared to what I'm seeing outside here. It seems to show me a little bit more definitively where the valleys are. I'll tell you, I don't know about the weather around here, it's consistently icky. I'm trying to see if I can see the towers there in front of me, but I can't. I like it. These radio towers, I don't know how much clearance I actually have over them. It looks like on the big screen I'm right above them. And I guess I'm flying right over them now. (By our estimate, I think that we think the you're just less than 1,000 feet above those towers.) I've got lots of clearance over them. I thought it was less than that. When I get down to the 30 degree I feel like I'm almost going to miss the approach, the gauge is just so jumpy the whole time. (Do you find that the fishnet helped give you some more information?) Yes, I think, looking at it, it does. I'm not sure if it stands out sharply in my mind, but when I just sit and look at it on the screen it does help me get a better idea of how the ridge lines are. Yes, I'd say so. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. I like this one a lot, too. Excellent, highly desirable. Pilot compensation not a factor for desired performance. I don't think I really had to compensate much. I'm trying to compare the different fields of vision and see which one I like the best, for this stage at least. It gave me a real good sense of where I was in relation to pretty much everything. I'm not sure if I liked it more or the same as the photorealism, but I'll go with one.

EBG1: And operate, and I'm flying the airplane. And I wanted to say, I'm just toggling through the screens again, trying to see if I like any one better than the other. (Have you come to any conclusions yet?) It just seems like at this stage 60 degrees is my favorite, 90 is kind of nice, but things just seem a little too compressed there, and unity like this is just a little too -- I don't feel like I'm actually seeing much of anything, except for the very tops of it. I'd rather be looking outside, which actually I would do anyway. But, this one lets me feel like I kind of have an idea of what's going on underneath me, which is my biggest cue that I like. (The only difference between this terrain concept and the one you just flew is this one does not have a fishnet, and I'm just curious if you can tell me along the way if you miss the fishnet, miss any information the fishnet may have been providing you?) I'm starting to go through my airspeed there, I'm trying to interpolate all the data that I'm getting. There's so much information that is very useful. I really like this terrain concept. I like how it -- the fishnet, not having one, I really don't see it affecting much of my terrain awareness. I think it might have helped just a hair, but looking at it I have a good idea of where all the ridges are, and the antenna, and I haven't really been looking at the MX20, to be honest, on this. I kind of want to just get down and play in the valleys and see how

it works. I guess if you wanted a quick comparison, I noticed maybe just vaguely a little bit of difference between the fishnet and this, but I don't see the fishnet adding much to my awareness in this form. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I guess I'd rate this pretty much the same as the last one, as a one. I liked everything it had to offer me.

CCFN1: Operate, and I'm flying. Well, I don't like it nearly as much as the other ones. I can definitely at least get some reference of the terrain down below me, and around me, with the fishnet overlay, and with the river actually -- the river kind of seems to go up and then down. Okay. I prefer the last one, EBG. Well, a little bit closer here, this -- when I was higher up I know I didn't like this layout as much, I still don't like it nearly as much, but the fishnet I'm able to get a vague idea of where the terrain is below me. I guess that's the best I can put it. I can make out where the ridge line would be, and kind of the valleys, the highs and lows. I don't like it as much as the previous ones, where I had more of a contrast between the valleys, to help me differentiate. But, I can see where they should be. Pilot decisions, is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'm going to go, yes, I'm going to call it fair, some mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance. I'd just give it a three. I do have terrain awareness, and I can basically tell where things are, but it's not as easy to understand, and it doesn't give me the same feeling of, I don't know, safety -- not safety, but security, that I'm aware of what the terrain is around me, but at least I have an idea of where it is, a notion.

PRFN1: Operate, I'm flying. I like it, I like being able to -- I'm trying to compare the inside-outside view. It is kind of nice to be able to see well on the big screen, and the little screen. It makes me feel like I'm just basically looking at a smaller window outside. I think on this the fishnet overlay is kind of helping me determine contour of the land. It's giving me a better contrast, I guess, instead of the green. The lines kind of help. Just a second here. (It looks like you ended up at field of view at 30 on that one. Are you still preferring 60, or are you changing your mind on that one?) I'm kind of trying to decide. As I was getting a little big stabilized there I was trying to check out the 30 and 60, and see if I like the 30. I kind of like the 30 getting down at a lower elevation like that. I kind of think if I go lower I'll definitely like the 30. But, I don't know, I was trying to get a feel for it. I was trying to look out the window and see what it looked like, to see if I could see the towers, and kind of place them in reference to what I'm seeing on the SVS. One other thing I just realized, I don't know if it's quite true, but it seems like in a way -- complacency is not the right word, but it's a comfort level. When I'm looking up at the screen, I look at the little one, I tend to not concentrate as hard as I need to, to fly the airplane, until I'm forced to. (Are you saying that at the beginning you're flying out the window, and then when you transition head down you fly a little bit more precise, or did I just miss what you just said?) Well, I'm trying to think of how to phrase it. When I'm flying when the weather is good, and I'm looking at both, I tend not to pay as much attention to my altitude, I guess, I'm not as concerned with what's going on until the weather deteriorates where I have to look strictly at the screen, with the high resolution screen, the SVS being easier to interpret. It's more like just looking outside the window. I don't know how to describe it. I don't know how my performance is on the computer, but it just seems like I'm kind of flying a little bit sloppier until I have to fly on the gauges. Okay. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I'm going to go with excellent again on this one. At this altitude I really like the definition that I'm getting, to look ahead. I'm kind of trying to toggle through the field of vision selector, to kind of see which I like the best, and it kind of seems like it would fluctuate between 30 and 60 most of the time.

CCFN30: Operate, and I'm flying. And initially on this one, I don't know if it's because the turbulence is mild right now or what, it seems to be a little bit easier in this kind of flight just to simply interpret the gauge information, there's less clutter on the screen, but I don't have any terrain awareness. I know it's there, but I don't have a good feel for it, I guess, as far as looking at the SVS. With this display, the two-tone, it's easier to read the instrument symbology. So I can look at my air speed and attitude indicator and all that, and it's easier to interpret that information right off the bat. It's a much higher contrast definition of the gauges, but having a terrain awareness is much lower. Now I'm strictly on the gauges. I'm trying to get a feel for it. I guess trying to look at the MX20, I'm not used to looking at that, but it's definitely nicer -- the SVS is better than the MX20, and I'm trying to get a feel for what I'm seeing here. I think I'm on the 60 again. (Yes) I think particularly for this one, I think I like the 60 better. Right now I'm just trying to compare the fields of vision, how I liked them. I hadn't really come to a conclusion yet. I was just trying to get a feel for if I liked it better. I think I was still mostly preferring the 60 degree. But, when I was going through at, I think it was on the unity on that last one, I could kind of see where the runway was, and that's something I might really like, particularly as I get a little bit closer to that, if I'm following some sort of approach course. Overall, as far as this one goes, I didn't like -- the terrain awareness definitely isn't there, but it's a little bit easier just to interpret all the information, I mean, just like the instrument gauges, just because it's easier for me to at least see it. I don't know how to word that very well. Okay. Is it controllable? Yes. Is adequate performance attainable with tolerable workload? Yes. Is it satisfactory without improvement? It's hard for me to decide here. Let's go with -- I'll go with like a 3.5, fair, some mildly unpleasant deficiencies. I'll give it a 3.5, if that works for your scale. And the only reason why I do that is, it's actually -- the flying part as far as heading and all that is -- I think it's almost easier, maybe not easier, but when I get down, and if I'm worried about terrain, I'd be a little more concerned, because I just don't have the same grasp. Other than that, I'm ready for the next one.

PR1: Operate, and I'm flying. Yes, so far I like it. I'm just trying to -- I still kind of like this 60. If I look at the unity here it's kind of nice, just simply I'm looking farther ahead, I can see I believe where the runway is. And I like the reference to what I'm seeing. I still haven't, I guess, got a good feel for, or a good comparison if I was, say, flying low level with this, in this lower field of vision, like really close. But, I'm trying to get like a depth perception, I guess, where I'm looking ahead. That's what I'm trying to figure out. I think in some ways the fishnet helps a little bit, just identifying some of the ridge lines, and how the terrain will fall off, somewhat like a topographical map. But, right now I feel like I have a pretty good feel. I don't know how much it would enhance it, it might enhance it marginally. But, I kind of like what I'm seeing, a nice sharp, clear image. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I guess I'm going to go with excellent, highly desirable, pilot compensation not a factor for desired performance. I'm going to give it a one. I don't know, I liked everything about it. It seems to me to be very similar to some of the other ones that are high resolution with good contrast, I kind of see where everything is that I would want to.

EBGFN3: Operate, and I'm flying. And I don't know, I'm almost getting to like the photorealistic better right now. At this view, the fishnet I can barely even see it, as far as there's not much contrast with the terrain. I can see it over the green overlay, but the brown I don't really see. On this higher 90 degree, I can see, but I think there's just more green. The fishnet here is kind of helping me. (Are you still preferring the 30 degree field of view when you get closer to the ground?) I think so, yes. I just like the magnification a little bit. It's kind of letting me see what's ahead of me. It doesn't let me see exactly what's underneath me, but since I'm a little bit closer it doesn't really matter. I think the fishnet there at the lower elevation is kind of helping me a little bit. The EBG, I do kind of like it, I think it's -- I'm not really sure. I guess I'm hard

pressed to have a definitive answer, but it almost seems a little bit easier to interpret my instruments and look out at the terrain. It's just -- I don't know if less clutter is the right word, but better differentiation, it seems to me. Yes, the EBG, in this last display the EBG makes it a little bit easier for me to interpret my instruments versus, I think, the photorealism. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. And I'm going to -- I'm going to give it just under excellent, how about a 1.25. It's just I think the other EBG is a little bit higher resolution, but this one with the fishnet overlay and that still gave me a really good sense of where things were. And it did seem to make it a little bit easier just to interpret the instruments versus the photorealism. But, if I do another photorealism maybe I'll be able to think a bit more. And I'm ready.

PRFN30: Operate, and I'm flying it. Well, I do like the photorealism, and at this elevation over the terrain, I guess I'm not really sure -- I don't have a strong feeling one way or another for it, as of yet. (Can you tell the difference in resolution at all at this altitude?) It's a little bit more smoothed over, but I've not seen a big differentiation in the resolution. All right. Well, at this altitude here, I don't like it as much as the last one. I don't have the same contour level, I guess, contrast to give me -- the fishnet helps a little bit here, but I'm not seeing the sharper -- the ridge line images, as well, knowing exactly where they are. (It looked like in your turn that you chose the field of view 30, is that -- have you decided whether or not that's your preference, at least during the turn part, or do you still like the 60 during the turn, or have you decided on a field of view strategy?) I haven't really decided, I guess, in the turn. I've been trying to do new things. And I don't want to screw up what I'm doing too much. When I look at it, since I've been in the 60 mode most of the time, I already have an image about where I need to put the vector indicator, and my attitude indicator, to get where I want to be, and when I change the field of vision -- field of view, it -- I need to put it in a slightly different place. And I think I'd probably like the 30 degree, but I need to play with that more, to learn where you point things. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I guess I'm going to give this a fair, mostly just -- well, simply for the terrain. I can see where the terrain is, and I have an idea, but I'm not getting a very strong sense of contrast to know where the ridge lines are. I have an idea, but I don't have a strong, easy sense of security there.

BSBG BL: Operate, and I'm flying. Well, I'm here, I have no terrain idea, except for maybe to try and look at the MX20, which I haven't really been doing. And we're losing visibility on the SVS. And right now I'm just changing, selecting, I'm just trying to get a feel if I like one better than the other. I think I'd almost go with the 60, just because it gives me a little bit wider -- scrap it, bigger horizon to look at. It's between the 30 and the 60 for me, at least for this in or out phase. I think the 60 is a little bit more preferable. The approach phase might feel a little bit different. Part of it, I think, is it just kind of helps smooth things out. Things aren't quite so hurky jerky at this level. Well, terrain awareness is pretty minimal. I don't like this one very much. It would be nice for instrument approaches, I think, if you're just flying a standard approach. Okay. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'm going to just take this one over to know, deficiencies warrant improvement. I'm giving this one a four, simply because even trying to look over at the MX20 a little bit, which I haven't honestly been incorporating much, but I really didn't have much idea where I was above any kind of terrain around me. I had a little bit looking at the MX20, but comparatively it's negligible information. But, as far as flying on the gauges go, it's pretty nice.

Block 3, Approach:

CCFN30: Likes a lot better than shooting a normal ILS. Pretty easy to interpret. Velocity vector is kind of nice. Focusing mostly on symbology, not really looking at the terrain portrayal. As he flies it a little more, he may be able to divert his attention to pay more attention to the terrain. Flew FOV30 mostly after the turn. Then scrolled back to Unity at 2020ft. Nice to be able to see the runway on the OTW. Very easy to fly box, and to interpret symbology. Had an idea of where terrain is, but will know a little better as he flies some more.

EBGFN30: FOV90 at the start, before turn. Then went to FOV30 after the turn, then Unity. Still not really using terrain. At this point, it doesn't seem to matter. Really likes flying the boxes, though. Had a lot of rudder input. Didn't really notice much difference in terrain awareness between this one and the last one.

CCFN1: Right off the bat, this one seems to give him a better feel for terrain than the others. At this wind angle, FOVs lower than 60, and the velocity vector goes off of the screen. Closer to RWY, goes to Unity. Slightly easier display to interpret, with the color coding (without the green of the EBG). Called RWY in sight when he saw it OTW. Likes, because he can see the buildings, etc. Really likes this display.

PR1: Terrain is giving him a little more info than the previous display, but he's not really sure how much of that new info he's using. Looks just like OTW. Could see the knoll on the left abeam the OM. CC allows him to interpret symbology a little better, but the PR gives a better OTW feeling. Whole time he felt pretty good about where the terrain is.

EBG1: Finds this display a little easier to interpret the peaks. During the turn, definitely likes FOV90, then when rolls out, likes to scroll down to narrower FOV. Lost controls towards the end, 5:10, so had to re-run. Gives him a really good feel for the contours ahead of him. Comparing to PR, he would be seeing cities up ahead, which would be kind of nice to know. Workload is much lower with this symbology, than shooting a regular ILS. Really likes the PR, now that he thinks about the cities. EBG, you don't know if there's a pasture or a city.

PRFN30: Not really sure if the FN helps. Definitely likes going to 90 in the turn... tells him what box he's in better, and lets him know what's coming ahead. Detail is a lot lower on this, versus the DEM1, doesn't nearly have sense of where hills are. It is nice to know that he's over a city. However, he can not see the knoll that is abeam of waypoint Knoll. DEM30 didn't give him the same sense of security as a higher resolution. Simply because terrain awareness wasn't as acute as the higher resolution, but he really did like to know where the city was.

BSBG BL: Doesn't like this one as much. Gives him a really good display for flying approach. It's a good attitude indicator as opposed to a good terrain awareness device. Saw the towers OTW, and would rather have the terrain portrayal on the head-down display. Thought that this would show him the RWY. Missed seeing the ridge lines, and the RWY. No terrain information, more comfortable when able to see terrain & RWY on previous displays.

PRFN1: Right off the bat, he likes this one better. Fishnet helps. Nice to see coming up on the city. Settled on a FOV strategy - 60 straight and level, 90 for the turn, and 30 and Unity (1630ft MSL) further in. Likes this one a lot. FN did help a little. Likes PR a lot, likes to see the city and RWY.

EBGFN1: As far as terrain goes, he likes it. Doesn't know if FN is helping. Gets a good sense for where ridge lines are in front of him. FN does help in FOV90, but not at the Unity. Did see the

towers, but that doesn't seem to appear as sharp or as good as in the other depictions. Did have a good sense of terrain, but missed the city. Without seeing the city, feels like he's flying over green pastures. Having the city there gives him a better environment for what he's looking for.

PRFN3: Pretty good feel for where he is and where the terrain is. Things aren't as crisp, but still feels he can tell where things are. Can see towers a little better on this one than the previous one. Really likes that city. Did like FN overlay on short final, was nice.

EBGFN3: Starting to favor the PR. Compared to the EBG1, this isn't as crisp. And, for this display, likes to have a crisper image. Towers not as easy to pick out, because of lack of contrast. FN is helping. Can see some parts of the FN better than others (on final at around 2200ft MSL). Really misses the city.

CCFN30NT: Already missing tunnel. Was late on his turn, then took him awhile to get lined back up. He was also a little low on the glide slope at one point. Gave him an adequate. Not getting a lot of terrain awareness. Really hadn't been using the MX20 at all. Was very spoiled by flying the boxes. TA was not great, but it was there.

Rare Event:

CCFN30: River outline is helping him see what he has in the form of terrain. Without FN would not have a sense of terrain. This display does give him some information. His normally aggressive descent rate was very tentative. At 3:55 said that terrain looks above us. Then about 4:20 (or a little before) started climbing. Was able to avoid terrain with ample amount of time. CCFN30 did help him, but would have noticed it better if he would have had a higher resolution and the PR or EBG.

Subject 12 (BRD Baseline):

Block 1, High Altitude:

EBG1: Okay, now I see what the turbulence is going to be. That's been the hardest part about this, getting used to it without the rest of the physical view. I can see how it's fairly realistic. You can definitely tell where the ridge is. Doing the 90 gives you more of a feel of when you're actually passing like, that was one thing that I noticed during the training, was when you're passing over a point and so like when you're trying to pass over a ridge or know when you're passing over something, that you want to make sure you miss going over, that's one of the real benefits of the 90 degree, is it gives you a good feel for that. Just playing with the different ones, I'm finding the 60 feels the most natural. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? The system, yes, it's just a matter of getting used to it. Yes, I'd say. The main thing is getting used to the different cues for throttle and power and getting used to the velocity vector. That's the main thing with this particular type of display. I don't know if that's a . . . is that something that's inherent or is that something that time will tell? I'll call it a two.

CCFN30: It's difficult to tell any detail relief. Start our descending left turn at 1,000 feet per minute. Zero-five-zero. Need to go start a level off. Maintaining altitude. I really still can't see much relief; it's so far below us. It's difficult to tell any detail relief. Start our descending left turn at 1,000 feet per minute. Zero-five-zero. Need to go start a level off. Maintaining altitude. I really still can't see much relief; it's so far below us. (Any comments on the different fields of view that you've been scrolling through?) Really, it's a different feeling for what the, without changing the velocity vector, changing I guess the vertical scale and the, you know, just changing the scale is disconcerting. It's almost easier to leave it at one level, because then you can get used to what you're flying. I guess the main thing is that I wouldn't want to try to change the level

while I'm in a descending turn. And I'm not really noticing the fishnet. That's something else on here. *As far as FOV goes, it's difficult to transition between them, so he feels more comfortable just leaving it at one setting, which happens to be 60, because it's the default.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I would put it into the minor but annoying deficiencies, because it's mainly the, it seemed like there was really no, other than right at the horizon, you really had no feel for what the terrain was doing. Yes, four. *He was a little sloppy on this one, but still within standards. Gave it a 4 because other than horizon, doesn't have any cues for terrain.*

EBGFN30: This is better. You can see a lot more of the relief, especially closer in. Especially looking at the long distance, the 60 and the 90, you definitely get a feel for what the terrain is doing, of course, with this altitude. It feels a little bit easier, a little more natural. Coming up on the turn left. Descending left turn, looking for 1,000 feet per minute. Trying to hold 100. Dove right past it. Power back in, bring the nose back up. Once again, on this one, is this with the fishnet? I'm really not noticing it. Yeah, the terrain really, I felt, worked well on this. It gives you a good feel for what the relief is. *Does fly a little "sloppy", but still within the desired range. Can't really see FN. Does like the EBG - thinks it works well.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I think that one was good. I'd say a two. Mainly like I said, I think it's just, I think part of it is just because of the high altitude and it's tough to really tell, but that did give a good feel for it. For instance, if I was dealing with an engine out or something and I needed to look at which direction do I want to try and go with this to give me the most time, in other words, head away from the ridges, that view I felt, gave me a good feel for okay, you don't want to go in this direction, you want to go in toward the valley.

PRFN1: It's okay. I don't feel like it gives you as much valuable information as far as the relief that's there. The greens tend to all blend together and sometimes the darks may or may not mean something. Just looking down now at where the towers and obstructions are. They kind of get lost in the shuffle of the terrain. I can see the fishnet, yes, I can. It gives a little more feel of the relief where the ridge breaks are. Well the thing with the 60 is at this altitude, you do get to actually see the ground. I noticed that the unity and 30, there was almost no ground showing in those views and the 90 just feels like, as far as the gauges and indicators on the gauges, it just is tough to get a feel for it. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. Again, good. I'd give it a two, and basically it's just sometimes the relief tends to get lost because the colors in the shading aren't necessarily consistent and having a meaning. One of the other good things that I noticed is if you were trying to, it does give you some feel for navigational information or like where, at this altitude, where the cities are located, trying to help you, especially if a VFR pilot is operating from a sectional to help get an idea of where he's located.

EBGFN1: A lot of relief in this one, every little ridge and valley. It's almost too much on that. It's starting to look a little buttery on the ground relief. Again, like the towers and things, they stand out just because they don't get lost in the butter background. But the relief, it almost seems like there is too much. Every little ripple on the ground is showing up now and that almost seems to be more information that you need. I am seeing the fishnet now, and that again is giving an additional indication of the relief features. The fishnet is just kind of a subconscious thing that's there. I don't even realize, unless I'm specifically looking for it, I'm not realizing it's there other than it does give me that subconscious little feel that hey, there's something else there. *Gave us a good ride, but still within parameters.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say fair,

yes, fair. The main thing is in some cases, like I said, the degree of detail was a little too high and showing every little ripple on the ground almost tended to overwhelm.

PRFN3: I kind of like this one. It does, at least at the 60 and at the 90, it gives you a good feel for what the terrain and where major geographic features are, so it gives a good feel in both situations. I'm noticing a little bit more of the fishnet on this one. I'm noticing especially down along this area you can get a feel for where some of the ridge lines are and ridge breaks are. This one almost feels like, who needs a windshield! For this model, I almost like the 90 degree. At the 90 degree, it gives a lot of good information on the terrain and relief and also the geographic features. Again, any towers or obstructions at least at this altitude, are getting lost in the background. The other thing, just from a flyability standpoint, again, the only disadvantage I feel like with the 90 degree is it feels a little bit tougher to get a feel for where the level is. I know the line is there but it's just . . . you know what I'm trying to say. Is it controllable? Yes. Is adequate workload attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd say that was good. Again, the only thing at this point is any kind of towers or specific detail features, it just feels like it might be better if there were a way to get them highlighted instead of getting lost in the background clutter of the photo. Yeah, a two.

BRD BL: That was one thing I remember during training, is the ball on this one sits on the horizon and I usually adjust it to where they're lined up. It sure was nice having the other display. I had a feel for what I had as far as terrain. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? For this one, yes. This one, the basic gauges is a standard thing, but as far as situational awareness, I had to almost force myself to bring the other display into the scan to be aware of the full situation. So I'd say fair, three.

CCFN1: Very little terrain information way out at the horizon at this point. I can tell that the fishnet is there, though. Yeah, it's getting a little bit . . . What needs to be in the scan as I'm doing this, is starting to come together on this particular display, and when it needs to come into the scan -- which part of the screen is primary and which is secondary, as you're doing this. Four hundred feet to go. The fishnet is showing up better, the towers definitely show up well on this. Two hundred feet to go. As far as the fishnet, like I said, I see it better in this view, but really I'm not sure what information it's giving me from this altitude. It's hard to tell what the details of the ups and downs are from this altitude. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'm going to say yes. Again, fair. I just feel like the part, and maybe it's just the altitude, but from that altitude, I didn't feel like there was much, particularly closer in, terrain detail to know what you're looking at. Even with the fishnet, it kind of got lost and became a jumble. So I'm giving that a three.

PR1: Well, it's almost, who needs a windshield for the amount of the detail you've got on here. It's very good. It's comparable to what you're actually seeing out front at least in the simulated department it is. Yeah, it's there. Like I said, you can see the little ridges and each little ravine coming down the mountainsides. It's a question of whether it's too much or not. It's almost annoying. You can get lost in the display. (It looks like through that descent, you kept the field of view of 30.) That was conscious. I'm just trying, from the control standpoint now, rather than the terrain standpoint, seeing if that seems to work better, and it does. I don't feel like I'm chasing things. I didn't have to make as big a movement. But again, at this altitude, I feel like I've got enough terrain information in my field of view. During the descent I did. Right now in level flight, it feels like it does. I might try 30 a little bit more. The one other comment I have, and I know this is probably just a result of the setup that y'all have, but the control on the left I don't like just from the standpoint that I'm used to flying with my left hand on the yoke at all

times. So that's just personal. (Do you like the position where it is on the yoke, though?) Yeah, on the yoke it works fine. It might work better if the button were on the left just because then your left hand is on the yoke at all times and the way I was taught was always right hand on the throttle, left hand on the yoke. That's just the way I was taught, but it's a habit I've developed. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes. I felt like I said, it's almost if you can create a windshield that could display that, you wouldn't need a windshield, just fly the screen. It has very good information. About the only thing, again, at the altitude, the towers and things tended to get lost, but I guess we'll see how that goes later. That one, I'd give a one.

PRFN30: It has adequate detail, good detail. The ridges don't pick up every little ravine that it did, but you can still see where the ridges are. Yes, it's good detail. (Do you have any conclusion on the field of view selection?) I'm kind of finding myself enjoying the 30 almost better. I don't feel like I'm chasing it as much. Like I said, just as far as the display goes, it's got, I feel like it's got enough relief to tell you where the major terrain features are without getting too over-cluttered. I'm finding I'm liking the 30 degree field of view better, especially during maneuvering, just because it feels more natural as far as the amount of control input required to keep the velocity vector in hand, rather than chasing it. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give that one a one as well. I felt like I knew where the terrain was, I knew what was there, and it didn't feel overly cluttered, at the same time.

EBGFN3: It gives a really, really decent view of the relief on the ground and where the terrain is, and what it's doing. With the color selection, it almost seems intuitive, flying toward the green. It has a lot of detail to it, though, so it's a question of whether it's almost too much. Other than that, it's good at showing the terrain. At this altitude, it's almost too much terrain featured. It's showing every little ravine and gully. It almost gives a disconcerting effect to the terrain. In this case, at least. It looks like zebra stripes or something. It just doesn't really feel right on that. *Stayed at FOV30 on this one.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, and I'd give this one a fair, three. Mainly because with the level of terrain relief shown and all the dark scallops showing on the ground, in this case, it kind of seemed a little bit disorienting in the way the display was.

Block 2, Low Altitude:

CCFN1: At these altitudes you definitely see some more terrain features to it and some feel for what the terrain is in the 90 degree. It does give some terrain information, but it definitely helps the control. I've found the 30 tends to be controllable. I see the terrain much more at this altitude, like I said earlier. I suppose you don't need that, but I like the fact that it definitely highlights individual features like towers and buildings and so forth. It makes them definitely more apparent. Without the fishnet, there would be very little value to this display. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd say fair. I'd give it a three. It just seems fairly limited in the amount of information that it gave. The fishnet gave some indication of what the terrain was, but really no detail and no, not enough relief to really give you a feel for what's where.

EBGFN1: Yeah, it seems a little bit busy. Good detail, but almost too much and it tends to get a little bit cluttered with what you're looking at. I definitely see the fishnet better, though. Oh, there's a tower. Again, for en route, I'd probably use one of the wider screens. You know, when I'm straight and level. But for maneuvering, I'd stick to one of the closer in – even a 15, or the

unity or the 30. The one thing, with this, and I don't know, at the speeds we're going, it's not as critical, but the obstructions, towers and so forth, tend to get lost in the background on this somewhat, until you're very close to them. The fishnet is there. It provides a little bit of detail as far as more of the shape of the ground, but the color does more to give you the elevations. A feel for what the elevation is. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say good. The only real deficiency is the details such as towers and so forth tend to get lost in the background. I'll give it a two.

BRD BL: Not really, I just miss the other display. Flying gauges again just makes me realize how much I want one of the others. Sloppy. I got focused on one thing and lost my heading. Mental. Mental. The only other comment I would have is that I have very limited information as to terrain, other than seeing the green appear and realizing something's coming up. *Overshot his heading (went to 020'ish), but then came back. Time-wise, was close, but feel he's still within PTS.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say no. And on that one, I'd say the main deficiency is just by having to look at another display for the situational awareness of not having it on the one display just made it that much harder to keep up with. I'd give that probably a five. *Let him choose the 5, since he was very close to adequate.*

EBGFN30: It has got some decent relief to it. Major terrain features are showing up and it shows where the high and low, it gives you a good feel for that. It's not overwhelming. Turn and descend. One thousand feet to go. Five hundred feet. Three hundred. Level off. I'm busy looking at the MX20. It's good, and the towers and obstructions tend to show up a little bit better with this degree of detail. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I would give that a two. Again, about the only few things I would suggest are if there was some way to highlight obstructions a little bit better, especially as they get closer, and also it's just the details seemed a little bit low, especially as you get in closer to the ground. So I give that a two.

EBGFN3: It gives more detail in the individual ravines and so forth, without being overwhelming and looking like a bunch of stripes. Good depiction of the terrain. You really can see where the high spots and low spots are, but not so much clutter that things are getting lost in the background. I see the towers out there. Overall, I'd say fairly satisfied with that. *Doesn't look like a zebra, like he referred to the EBGFN1.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give that one a one, excellent. That one was a good mix of terrain information and detail without being overly cluttered.

CCFN30: On this one, I feel like I'm getting very little terrain information out of this, other than like I said before, at the horizon, but not much up close. Some terrain detail but very little, really. Even with the fishnet, it doesn't feel like it's giving me much other than showing where the obstacles are. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. It's, I'd say again, I'd give this one a four. The primary thing is, I feel like there was very little terrain and the fishnet actually, in this case, increased workload because with it being the only terrain interpretation, it was like having to spend some time looking at it and trying to interpret it.

PRFN30: Alright, on the display, my initial reaction is, I can somewhat identify the fishnet now at the lower altitude, and especially with 90 degree. I feel like it's giving me good information, especially with general horizontal situational awareness. Some good terrain information. I'm

able to identify major features. It's somewhat difficult to identify the terrain relief. I'm kind of getting lost in a lot of the background. It's tough to tell where the ridge lines begin and end. Even with the fishnet, it's difficult to really identify the features. Again, the towers are getting a little bit lost in the background clutter. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd call it fair. Again, I don't feel like the detail was there enough to be able to tell where the actual ridge line was and where the high terrain was versus the low terrain. It just didn't seem apparent and the obstacles appear right on top of them and tend to get lost in the background. I'll give that a three.

PRFN1: On this one I feel like I've got a clearer display in the cockpit than I do out the window, as far as being able to see the detail of what's out there. Both the terrain and the navigational details such as the pond or whatever that is, it looks like a pond, and the river and so forth . . . On this one, the fishnet I think is helping a little bit because some of the ridge lines, it helps identify where the tops are just before it goes into the next one. Good representation of the relief. The fishnet definitely helps on this view. As far as being able to break the terrain features out from the background, different shades of color. The different shades of green, not really depending on altitude, it definitely helps. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give that one an excellent. I'd give that one a one. I can't think of anything other than possibly the towers and obstructions could be a little brighter or highlighted in some way.

PRFN3: Good overall. Good depiction of the terrain features showing the major land marks and ridge lines and so forth. It doesn't really seem cluttered. The fishnet is starting to show some features that help with some of the relief. Very little difference between the two. This one has maybe not quite so many dark shaded areas. A little bit less clutter, which actually emphasizes the major terrain features, the major hills and so forth. I feel like it is adequate detail, not overwhelming. The only thing, again, if there was a way to emphasize the towers, I know they're out there. I see them showing up on the MX20 display and I kind of see them knowing now that I'm looking for the red lines, but if there were some way to accentuate them, that might make it a little more easy. And as far as the fishnet, that does help identify the contours of the relief and differentiate it within the background. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I give that one a one. Like I said, about the only thing I could say is if there was a way to accentuate the towers and other obstacles a little bit more, just to make them stand out from the background a little bit better.

EBG1: It looks good for identifying the elevations and the major terrain features. Not necessarily any detail such as ravines, roads, that kind of thing to help me with any kind of navigation. But as far as definitely, I can tell where the ridges are and ravines and just about everything else. Good details. The colors seem logical for where the high terrain versus the low terrain is. It seems almost intuitive. I can identify the tower features and the obstructions. With the high ground being light in this situation, they do tend to stand out a little bit better and not get lost in the background clutter. (Since this does not have a fishnet, do you find that you miss the information the fishnet may have provided?) Not really, in this particular instance. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give it a two. When comparing it and doing a direct comparison now, as far as the deficiencies, it's really just the minor feel and sense of it. It felt like all the major information was there. It felt like maybe not quite enough detail, I don't know. It definitely was almost there. (So when you're talking about a direct comparison, did you mean the elevation based generic versus like the photo realistic?) Yeah, comparing it to the photo

realistic, about the only thing is, is thinking of it in terms of being able to be aware of where you know, just thinking of it from a standpoint of navigation and somebody who wasn't prepared to deal with instrument conditions right away. And the nice part about it, that's just one of the things with photo realistic, is that it does give you some sense of where you are that way as well as the terrain.

PR1: Well, just initial views on it is I feel like I've got almost a better view on the display than I do out the window in this situation, but it's definitely got the details to tell where you are from a navigation standpoint and a terrain standpoint. You can see a lot of the ridgelines and detail of the ridgelines that are apparent. I can definitely tell that the fishnet is not there, especially in the wider views. (Do you miss the information that the fishnet may have been providing you?) Yes, on this view, to some degree, I do miss that. Because it gives you a definition for some of the ridge tops where they might blend in with the background a little bit to some degree. Well, the detailed information is there as far as the terrain and the land features and so forth, but in some cases you can definitely tell where, until you're right on top of it, you can tell where one ridge line kind of blends in to the ground behind it, so that's definitely a point for the fishnet in this particular view. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I'd give it a good, rating of two. Just basically the two items I have with it are the colors being what they are, some of the ridges and some of the detail can tend to blend into the ground behind it and make you miss where the ridge line is until you're right on top of it and notice the motion, and then also some of the obstructions and details, if there was a way to make them stand out a little bit better.

Block 3, Approach:

EBGFN3: (Do you have a preference on the field of view?) From a controllability standpoint, I like the 30. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes, I'd say it's good. The only real comment I had was a couple of the obstructions would have been nice if they were highlighted a little bit better. I noticed a couple of the towers and things, they don't really become noticeable until you're almost on top of them. Two.

CCFN1: Could see the obstruction clearly. The FN was distracting. Difficult to see the FN and tell the terrain. Liked the EBGFN more than the CCFN. Dashed line (3° reference line) a little long. Should make the line shorter. Dashed line only useful during final. *Lost audio on this run.*

CCFN30NT: It's mainly with the fishnet. It just felt like other than being able to tell that I was in mountainous terrain because of the horizon, it really didn't give me a feel for if I was, if I had to go missed, it would be difficult for me to think what the terrain is doing, to know where I really want to try and get going. *There was no terrain awareness because the FN did not give enough information on what the terrain is. Tunnel was very useful. It's more difficult to fly without it.* The tunnel made a big difference. It took a whole lot more paying attention without the tunnel.

BRD BL: Is it controllable? Yes. Adequate performance? Yes. I'd give it a six. Just mainly it's tough flying just the small indicators of glide slope and localizer and keeping, trying to keep the attention on them took attention from other places that needed to be in the scan. (They were too small, right?) Yeah. It's nice having them in the middle like that, it's just so small and kind of loses the importance with the other gauges.

EBGFN30: (Any comments on the field of view? Which one do you tend to use the most?) I tend to use the one that's on the yoke. (What about the field of view?) Typically keeping it in 30 and then switching to unity in on the final. If there was terrain around that I really wanted to

make sure I made it over, I'd probably put it in a wider field. Controllable? Yes. Adequate? Yes. Satisfactory without improvement? Yes. I'll give that a two. Same one as before. The obstructions tend to get lost in the background. Other than that, everything seemed to go okay. (Okay, what about the fishnet? Any comments?) With that degree, it gives major terrain features but it doesn't really give you a whole lot of detail to it. I get more out of the color gradient than anything else.

PRFN1: A view on the world. (Did you get a chance to compare the front visual and the SVS display earlier? Did you see any discrepancy at all?) No. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I give that one an excellent. Number one. I don't know if it was just the fact that it was the city area so it had the gray background, but that helped the towers show up. (Okay, so basically the photo realistic texture helped you to identify objects?) Right, and also I looked up coming on final looking at the terrain, and you had a feel for where you were, even as you were coming in. It was kind of almost intuitive as far as what was in front of you, what was coming up, looking at, you know. Basically with the photo realistic, it helped. Even the fishnet helped to define some of the contours as you could get a three dimensional depth feel for the terrain. Even coming in on final and assuming, for instance, that I was to go missed approach, I would feel fairly comfortable with that, knowing what the terrain was around me. (Alright, so you're saying the fishnet compliments the photo realistic texture real well?) Yes.

EBGFN1: Controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Yes. I'd give that one a one. (How do you think it compared to the other two EBGFNs that you have seen, the three and 30 arc-second?) It has very good detail, very good terrain relief and so forth. That particular one, the fishnet, I don't really feel like it added very much to it. I got more out of the color differences and the shading than anything else. (So you mean this one is better than the three and the 30 arc-second?) Not necessarily better, it's just with the coloring in general, but as far as the level of detail, it had very high definition of what the terrain was and then with the color, it's kind of an intuitive, once you get used to it, the coloring almost becomes intuitive as far as the various colors, and you can get a feel for the terrain based on the color. But like I said, the fishnet, I don't really feel like it added a whole lot to it.

EBG1: I like the concept of once you get used to the coloring, it does give you a good feel for the terrain. Between that and the shading, you have a real good feel for what the terrain is doing around you. (I was curious if you could repeat why you're choosing the 30 degree field of view for, it looks like it's on the entire run, almost.) Yeah, for approach use, this one just feels the most comfortable in terms of with the controls and being able to follow the controls. It's a good balance of having the fine control and then tentatively what I'll do is I'll switch once, getting in the glide slope, I've been switching it over to unity because it gives a better feel on the controls and on approach, the terrain really isn't as critical. Is it controllable? Yes. Adequate performance? Yes. Satisfactory without improvement? Yes. I'd give that a one. It had good information. The terrain display, I felt, gave good terrain information and it was nice flying with the tunnel in the sky. (At this point, do you feel that the fishnet, which was the run before this, gave you any additional information?) Well, actually with that level and on the EBG, the fishnet doesn't really seem to add much to the EBG.

PRFN30: Is there supposed to be a fishnet with this one? (Yes, there is.) I really don't notice it. It might also be because it's gray and it's getting lost in the city clutter. (Could you tell the 30 arc-second, the difference between that and the . . .?) Yeah, there was really no terrain detail as far as that goes. I mean it gives the major features. It doesn't really give you any detail for those kind of situations. Is it controllable? Yes. Is adequate performance attainable with a tolerable

workload? Yes. Is it satisfactory without improvement? Yes. I'd give it a two. The main thing is I don't know if there's a way to come up with a auto contrasting color for the fishnet or not, but that's the one thing that's going to give any degree of detail at all to the 30 arc-second displays.

PR1: Very real. Definitely, it's like: "Who needs a window? I'll fly looking at the display." (At the beginning when you saw a little bit of terrain, when there were a couple of hills and that type of thing, did you miss the information that the fishnet would have provided you?) It would give a little more detail in this. It gets kind of tough to tell. A lot of the terrain detail does get lost in the shuffle. Really, it almost feels like it's tough to tell the degree in the background with the photo realistic as far as the terrain goes without the fishnet on it. So I guess the fishnet really does provide some help in getting a feel for the depth. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd give it a fair, three. (Is that mainly because of the fishnet, or lack of?) Right, mainly the same comments I had before. Basically, it's really tough to tell. There's no depth perception there.

CCFN30: I can't really get any kind of feel for terrain out there. The fishnet gets washed out and as far as the background, I really don't see much in the way of terrain. I see the obstacles. One thing it makes it easier to do, is pick out the runway. Definitely very little terrain information. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. I'd say a five on that. (Because we gave you a desired performance, the lowest you can go is four.) Okay, we'll go four then. The main thing is, as far as terrain awareness, really, with what little information is there given by the fishnet, it takes a very conscious effort to look for the fishnet and then interpret it. And that takes away from attention to the flying duties. So as far as terrain awareness, that particular view doesn't seem to give good performance.

PRFN3: It's good terrain relief. I like the photo realistic as far as showing what the features are. Again, it gets lost in the city areas. It gets lost in the mountain clutter, but in the forested areas, the terrain region, you can see it. It helps identify some of the terrain features. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. I give that one a one. I find if it's got the photo realistic, even in the three (arc-sec), it has enough detail to give you the information you need without being overly cluttered. And the fishnet does help with that, especially in like the forested areas, as I said before, and things like that, just because it gives you a little bit of ability to identify the differences between where you end up with overlaps and such.

Rare Event:

EBG1: I like the display. I'm trying to get a feel for what the . . . 60 is where I was flying it yesterday -- the headings. Overall, it's fine and for en route, I don't know if it's too much detail or not, but it does give some good detail as far as every little ridge seems to show up. (Were you trying to figure out what field of view you were flying?) Just which one I find I like on this for flying the maneuver. (Well on your block questionnaires from before, you picked 30 as your most preferred field of view.) Yes. Coming up on turn left. Turn and looking at 5,000, 0-5-0. I'm just counting down, 800 feet to go. Seven hundred feet. (Is there a problem?) No, I'm just telling myself to watch my air speed. This one definitely puts me a little bit closer to that terrain. (Yes, it does. It looks like you stopped, about a half a minute ago it looked like you stopped descending. Now you are ascending.) Yeah, the terrain model doesn't match up with the MX20. *Started climbing slightly and steadily at 3:45, and then mentioned that terrain is definitely closer to him on this one and doesn't match the MX20 at 4:15.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement?

Yes. I'd say good. Actually that one, I can't think of anything that I can fault it for other than again, the obstacles don't stand out until you're right on top of them. I'll give it a one.

Subject 13 (BSBG Baseline):

Block 1, High Altitude:

PRFN3: Looks good. *Turn was a little shallow, descent a little timid. Did not make target altitude in the 5 minutes, so gave him an adequate.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? I'd say no, because I need to get to my altitude a little faster. Deficiencies warrant improvement. I would say minor but annoying deficiencies. Desired performance requires modified compensation. (Actually five is the highest you can go with that performance.) So it is moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation.

EBGFN1: Actually, the terrain looks pretty good. The graphics look real good here. The one I'm on right now is pretty good (FOV 90). Actually the fishnet is not really helpful, but the terrain is showing up real well as far as where the ridgeline is right in front of me here. The graphics are showing up pretty good. There are antennas down there showing up. *He was a little off some of the time, but only about 20 seconds worth.* Is it controllable? Yes. Was adequate performance attainable with a tolerable workload? I would say yes again. Is it satisfactory without improvement? I'm going to say no, deficiencies warrant improvement. Minor but annoying deficiencies, desired performance requires moderate pilot compensation. Well, I kind of got my roll into the turn, I exceeded the standard rate turn and I don't think I held altitude that good, either. My air speed got away a little bit, up to 112 knots if I remember right. No, just the terrain showed up real well on there and you could see the antennas and you could see the airport and stuff, so that looked good to me. I liked what I saw.

EBGFN30: It's pretty foggy out there. It (lower resolution) actually looks good as well. I think I like this here the best. This is the 90, right? (Yes.) Actually it looks pretty good. Good definition down here with the antennas and the field again. That's really kind of hard to tell between this one and the last one I was looking at actually. They both look really good. *Had a hard time with speed management - was fast for more than 10% of the time.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement, so moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation.

EBGFN3: It looks good, it looks real good. It looks a lot better than looking out the window, that's for sure. (Because of the weather?) Well yeah, and also it's the graphics of what I'm seeing outside. It would be nice if we had some other checkmarks on the vertical speed there so you could just exactly how many feet per minute you're descending or climbing. I think the display looks real good at this altitude. There again, you've got the depiction with the antennas and the terrain. It's got good detail there actually. *Was a little fast for part of the time, but not for more than 10%, so he received desired.* Is it controllable? Yes. Is desired performance attainable with a tolerable workload? I'd say yes. Is it satisfactory without improvement? No, deficiencies warrant improvement. Very objectionable but tolerable deficiencies. Adequate performance requires extensive pilot compensation. I got carried away there in my bank. I lost situational awareness when I was rolling into my heading. My air speed kind of got out of control as well. The terrain looked real good on that one, actually.

PRFN1: I was going to say that I like this one real good, actually. I like this display. It's kind of high but it looks like the terrain looks more realistic. It looks like the real thing, no doubt. (You

were on FOV 60 and I was just curious if you liked the 60 for this display?) I think it looks good as well. Either one of them is fine, actually. It looks real good, more realistic than the other one. Obviously after that one I just kind of think the fatigue set in a little bit here making me sleep. *FOV60 or 90 works well, either one is fine. He was right on the borderline with his numbers, up and down. He's very tired, and has asked for a break. He had about 3 times when he busted parameters, for about 10 seconds each. He felt that he was terrible. Fatigue is playing a big factor.* Is adequate performance attainable with a controllable workload? No deficiencies require improvement. I'd say major deficiencies, considerable pilot compensation required for control. (Again, do you think fatigue played a big factor in that?) Yes, I'm sure it has. It has gone down hill, you know, if you ask me.

CCFN1: I don't like it as much as I like the other ones, that's for sure. It doesn't really show you the terrain. I've got the antennas in here but that's about it, and the airport. I can see the fishnet. (Does it help you at all?) No, not particularly, no. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Very objectionable but tolerable deficiencies. Adequate performance requires extensive pilot compensation, six. (One comment, because we gave you a desired performance, that kind of forces you to pick one through four.) Okay, I'll go with four. I'm still not happy with the way I'm flying the thing!

PRFN30: I like where I'm at right here. This is much better than the last one because you've got, I can see the terrain, and you can see a lot better as far as its more detail. It looks good and the fishnet really helps out as far as the even like the elevation where it is going off to my left there dropping off in that valley. I like what I see here on this one. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say no, deficiencies warrant improvement. Moderately objectionable deficiencies, adequate performance requires considerable, no I think I'm going to go to the next one. Minor but annoying deficiencies, mainly the air speed. Desired performance requires moderate pilot compensation, four. It actually looked pretty decent, really. Like I say, that fishnet really gives you a good definition there in that one valley, when I was telling you about it, anyway. I think without the fishnet, you couldn't see that it dropped off like it did at that particular arc, I guess it is. That was a 30 second arc you say? (Yes) *He wanted to give it a 4, but changed to a 5, because of his performance.*

EBG1: There just seems to be a lot more depth perception, it seems like. I can see more, so. It's more like looking out the window I guess is what I'm trying to say. I'm getting off my altitude – you're distracting me. It looks good, it really does. I think if you had a fishnet on here, it would really help out as well. But it looks good just the way it is. You can look out the window and see what's out in front of you there. This looks really good looking down across this ridge line here. I see the airport pretty good there, and a couple of antennas. *Still a little fast, but, well within the time limit.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No, deficiencies warrant improvement. Minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four. Actually the display looked pretty good, too. They all looked real good except for the one there (CCFN1). The one that didn't show any terrain really. I mean it just had the brown ground, basically. (I think that was constant color with fishnet.) But the fishnet with the terrain so far has been real good.

BSBG BL: Well I can't see anything on the PFD. There is really just nothing there, but it would be a lot nicer definitely having some terrain there on the PFD in front of me, especially when I'm getting in to this stuff ahead of me here. (You're speed was a little high but it still within

parameters.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No, I would say minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four. There was definitely a lot more workload not having the terrain on there. Having the terrain depicted on there really helps you out as far as keeping the wings level I suppose and situational awareness of where you are.

CCFN30: I see the fishnet, but that's about it, really. And a little bit of detail but not a whole lot there. On this display there is a little bit of terrain but not very much. I can see a little bit dropping into the valley on the left with the fishnet but only because of the fishnet, and it looks like a little bit of an incline across the valley there. *Still a little fast, but within the time frame.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four. No, just that like I say, until I got a little bit lower there, you really couldn't see the terrain and then once I got down to where you could see the valley there, only because the fishnet was depicting it.

PR1: It looks real good. It looks real realistic. No doubt about it, it's real good. (Your speed was a little high for a little too long on that one.) I went right by my heading, too. *He had a hard time with his speed management again on this one. Very fast for a good minute.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation, five. It was real good, real realistic.

Block 2, Low Altitude:

PRFN1: This looks really good. A lot of detail. It definitely enhances the terrain, there's no doubt about that. It looks real good. Really good graphics. Looking outside, it looks like the terrain is actually closer now than what it looks like on the display. Just looks real good. Real good graphics. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? There's always room for improvement, so I have to say no. Deficiencies warrant improvement. Minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four. None other than that was a real good display, actually. Everything showed up real good on the primary flight display as far as what I could see elevation-wise and the towers and everything. I liked it.

BSBG BL: Other than I can't see where I'm going on the primary flight display. I'm getting too used to having that picture on the screen in front of me. Obviously you don't have the situational awareness that you have with the last one. The hill is right there. It looks pretty close. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'm going to say yes, but I'm going to say fair, some mild unpleasant deficiencies, minimal pilot compensation required for a desired performance, three. You definitely don't have the situational awareness that you have when you show the terrain of the PFD. I mean you see a little bit on the multi-function display but it's definitely not as good as having it on the primary flight display.

EBGFN1: It's a lot better than I had the last run, that's for sure. Even with the fishnet, I can't really see the terrain like right in front of me there where it drops off into that little valley there. (Okay, and you're also at the 60 degree field of view, is that a good one for you, or are you still kind of scrolling through, determining what you like?) Actually unity, this one here looks pretty good. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload?

Yes. Is it satisfactory without improvement? Yes. There are some mildly unpleasant deficiencies, minimal pilot compensation required for desired performance, three. Unity, that actually came out pretty good there, with those towers and stuff. You could see them real well. (You also mentioned when you got to your target altitude that, I think you said you were losing some of the terrain that was right in front of you. Is that correct?) Well, it was with the fishnet kind of going down in the backs of the valley. It might have been just because of where I was and the way the terrain went down, but you couldn't really see, it's like the fishnet disappeared basically. I think, you know another thing on this primary flight display with the scale on the left here with your pitch, when you're rolling into the bank it's like its right there on your roll indicator. In fact, if it was a little more over to the left or something, away from there, I think it would help me out anyways. It gets on top of my roll indicator there, you know, and I can't really see how many degrees of bank I have.

CCFN1: I don't really like this depiction because you can't really see much of the terrain. All you've got is just the solid color down there. I can see the fishnet, but it doesn't really give you a whole lot or do a whole lot for me. Right now the ten is on top of my bank indicator there. I'm trying to see the towers are now coming up, so you can see some terrain depiction now where it's dropping off in this valley, but it's definitely not as good as the other stuff. This doesn't really do much for me at all, to be honest with you. It doesn't give you the depth that you get with the other picture, the other stuff. *Was fast again, during descent, for more than 45 seconds.* I was going to say I wasn't that good when the speed got a little high and my descent rate got high. So we're going to go Pilot Decisions: Was it controllable? Yes. Was adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvements. I'm going to go down to very objectionable, actually no, I think moderately objectionable deficiencies, adequate performance requires considerable pilot compensation, five.

EBG1: Without the fishnet, you don't get quite the depth perception. *Without the FN don't get quite the depth perception. Again, was way too fast for way too long. Hasn't really decided on a FOV preference, yet.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? I suppose yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Very objectionable but tolerable deficiencies. Adequate performance requires extensive pilot compensation, six.

CCFN30: I don't like this as well as the other ones. For this altitude, you really can't see much depth perception. It gives you a little bit. I can see a little bit of depth perception now dropping off in these towers, but it's really not a whole lot up ahead. I can see the runway up there and some other towers sticking up, but this one didn't really give me a whole more terrain awareness. It gets me when I start scrolling through this thing and looking at the scale over there, that's when I kind of get discombobulated. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four.

EBGFN30: I really think the best is the photo realistic, to be honest with you. (Is the fishnet providing you any useful information?) The color is not right, right where I am right here now. I can see a little bit now looking at the left but straight ahead I don't see much difference in the terrain. I can see that hill up there on the screen, though, coming up to get me. Pilot Decisions: Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Fair, some mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance, three.

PRFN30: I like this 90 scale from way out there, but once you get closer I like 60, which is the one I'm on right now, right? I think by far the photo realistic is the best one you've got. It's obviously not as good as the photo realistic with the one arc-second. This is the 30 arc-second, right? (Yes. Is the fishnet helping you at all?) Not really. The only place it seems to help is where it's dropping off to the left over there. See what I'm talking about there, down by the minus 10? I think they're fairly close there, and then I gave it a three, I think it's about the same.

PRFN3: At this altitude on this scale I can see right below me now, the terrain elevation is a lot better. (That's compared to the 30 arc-second?) Yeah. Especially right here just to my left below me, the minus 15. See where that hill comes up from the valley? (Is the fishnet helping you on this one?) I can see a little bit better right at the bottom of the screen right now, but looking forward ahead on this scale, it's not too helpful. On this scale, 90, I can see the terrain a lot better up there to the right and actually right below me as well. That fishnet looks really good right here. I can see it real well. I'm paying more attention to that than I am to my other stuff here. This scale right here looks pretty good. It really helps out looking especially on the right and I can see the rising terrain right in front of me as well. *Was a little fast for a little too long.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. Minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four. *Wanted to give it a 4, but since he had an adequate, had to give it a 5.*

PR1: What's this I'm flying right now, is this unity? (Yes.) I think 60 seems to be about the best one to get in close. It's not quite as good as with the fishnet. The fishnet just gives that little added extra depth perception, and you can see all the little valleys and the hills a lot better. Right now looking to the left, just about at minus 10, you can see it's a hill but with the fishnet it actually shows a lot better. I'm flying the plane and talking to you. I think with the fishnet it makes a big difference on top of it, like I said. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'll say no. Deficiencies warrant improvement. Minor but annoying deficiencies. Desired performance requires moderate pilot compensation, four. The reason why I'm saying that is because I flew right past my intersection on the turn and I kind of didn't fly very well after that for a while. Yes, especially after doing it so many times now, you can definitely see a difference and I think the fishnet really adds to your depth perception.

EBGFN3: I think the brown actually maybe gives a little bit more definition, you know, the different color. (Than the photo realistic?) Yeah, I think maybe it does. At least on the 60 to 90 scale anyway, I kind of like it, I should say. On the screen in front of me here, was just that those two towers that went by me on my primary flight display? I'm starting to get an idea of just how far out there in front of me. I think at that point with the photo realistic that the green right in here might show up better than the brown, but when you're further out, like when you first got in to this one, I think from a distance I think the brown shows up better but up close the green is a little better. Is it controllable? Yes. Is adequate performance obtainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. There were some mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance, three.

Block 3, Approach:

EBGFN3: Actually I was more focused on the tunnel than I was on terrain. *Was a little fast at the beginning for a good part of the time and shallowed out the turn a bit.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. I'm going to have to go with the

middle one, I guess. Moderately objectionable deficiencies, adequate performance requires considerable pilot compensation, five.

CCFN30NT: I pushed it to power up and it went backwards on me there. It just doesn't give me a whole lot of terrain features. *Did pretty well on the turn. Seems to be doing pretty well in general on this one. First time someone did better on the NT than with tunnel.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Fair, some mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance, three. Just the terrain depiction didn't do a whole lot for me on that last one. (Did you find it easier to fly without the tunnel than with the tunnel?) Yes. I think it was easier to turn, intercept the localizer using the MX20 and my dot, than just looking at the box or the tunnel.

EBGFN30: How come my tunnel is so far off to the left on the screen? (When you're on unity your horizontal field of view isn't long enough for the horizon.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say no. Deficiencies warrant improvement. Minor but annoying deficiencies. Desired performance required moderate pilot compensation. (That's a four, right?) Yes.

CCFN1: I think it's a problem with the box, that first box there. I was like way out of it there, way to the left. That's where I started. I think having your center-line on your CDI both vertical and for your localizer a different color would pop out, like red or something. You really can't see it when you really can't see it beneath the diamond and the dog bone going in there. Not particularly, I mean you can see some of the terrain, just not a lot of depth. I can see the hill in front of me, but that's about it. The rest you really can't see much of the difference in elevation. Like right now on my glide slope it's pretty hard to tell if I'm, it looks like I'm a hair high, but if it had a different color the center line to shot for I think it would help out a little bit. *His performance was pretty borderline. Gave him the benefit of the doubt and gave him desired, but he disagreed, and went with Adequate. So, we changed our rating.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? No, deficiencies warrant improvement. I'd say moderately objectionable deficiencies. Adequate performance requires considerable pilot compensation, five. No just like say on your center line or vertical line for your glide slope and your localizer I think if that line was maybe red or something so you could see it a little better, so you can get the dog bone and the diamond going together there, it's just kind of hard to tell, you've to real quickly check where you are.

CCFN30: It's kind of like the last one. It's not really giving me a whole lot of information here. (Okay, so you don't see much of a difference between one and the 30 arc-second?) No. It's giving me the brown, I can see the browns down there and that's about it. It looks like I'm about a half a dot off, a little high there on my glide slope. It's really kind of hard, the bottom of the diamond is just touching the line right now, but it's pretty hard to see that. Other than the terrain, it doesn't really do much for me with that particular CCFN30. *Performance is much better on this one. Still shallowed the turn, but most of the other time he was well within parameters.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say yes, but barely fair. Mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance, three.

BSBG BL: (Do you miss the terrain at all?) No, the tunnel is mainly what you're focused on more than anything else, it seems like. So when the tunnel is there, you can see the terrain out there but it seems like I'm focused on the tunnel more than anything else. The tunnel and the dog

bones. You can see right now I'm a little high. I think the tunnel actually, now that I've done it a couple of times, I think depending on the scale you're using, I think it's very helpful. I use the 90 because it seems like you have a lot more boxes and it's easier to keep the, if the boxes are small it's easier to keep it in the box, it seems like, when I'm on the 90, which I'm on right now, is that correct? (Yes, that's correct. However the boxes are still the same, but they appear smaller when you see your field of view and they spread out.) They seem smaller. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'm going to say yes. There are some mildly unpleasant deficiencies. Minimal pilot compensation required for desired performance, three. (Did you miss having the runway on your display?) Yeah, I guess I did, yeah. I was mainly looking down, I wasn't looking out the window, so but I have noticed on other ones that the tower was on the left of the screen out there.

PR1: I like it because I can see the ground, the terrain helps out a little bit. Even though my main focus is on the boxes, the tunnel I should say. I find myself wanting to turn too early in those boxes, too, in the turn, like you were saying before, once you actually get into it there. I think what should happen is maybe once you capture the glide slope and the localizer and the dog bone should go away. The towers with this scale here look a lot closer looking at the screen than they do looking on the primary flight display. (Yes, you'll get that with a 90 degree field of view. Stuff will look farther away.) I do like it better. It's a little more realistic terrain wise. *He seems to be getting the hang of it.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Good negligible deficiencies. Pilot compensation not a factor for desired performance, two.

EBGFN3: (As I said, when you have a chance, I'd like your field of view strategy a little bit. I know you said you use 90 during the turn but how about when you're straight and level or on the short final, that type of thing?) That's what I was going for the unity, when I got down close, actually once I was a little bit closer there, so the crosswind was a factor. The 60 seems to work pretty good too, once you get past the turns, but not quite inside the marker yet on that field of view. As far as the terrain awareness on this, of course I can see a lot ahead of me, but really down below me looks pretty flat on the screen. That may be the case. *Was a little high at some points, and a little low at some points, but we don't think for more 36 seconds.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Good negligible deficiencies. Pilot compensation not a factor for desired performance, two.

EBG1: I'm starting to see the terrain now a little bit better and I see the hills. There's a tower on the left if you get on the outside screen. I don't see it on this one, though. The tower? Yeah, actually I think it was just a hair after the marker. Is that a valley or is that a little lump there. The dark spot there? It would be the threshold there? (Yeah, I think it's a little hump.) I think with the fishnet on there you'd be able to see what's going up or down, right? (Yeah, and you'll, your last run of the day is this resolution with fishnet and you'll be able to see that.) Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Good negligible deficiencies. Pilot compensation not a factor for desired performance, two. (Just out of curiosity, the ratings that you're giving them today seem higher than yesterday. Is that based on your performance or is that based on the fact that you're getting used to the display?) I think it is use of the display and not being as tired as I was yesterday. I'm still a little tired, so I think it's a combination. But I think getting used to the display is probably one of the main factors.

PRFN1: There again, the fishnet really helps out on actually whether it's a valley you're looking at or a rise in terrain. At this elevation you really can't see what, I mean you can see the terrain

down below you but looking ahead, it looks pretty flat. Looking right below me now you can see there's a little bit of a valley or hill that drops off the valley going to the left there. To my left there's a small little hill there, as well. Just checking out the different field of views there. I'm on 60 now, right? (Yes.) It seems like its less sensitive, I guess. Maybe it's not, but it seems like with that field of view it was easier to keep in control if it seemed to be smaller. Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? I'd say good, negligible deficiencies. Pilot compensation not a factor for desired performance, two.

PRFN3: No I wasn't looking at the terrain there, I was using my tunnel. I know that the fishnet does really help you, like I said before numerous times, to try to depict the terrain, whether it's going up or down. (If you happen to be looking at the terrain, can you tell much of a difference between this one, which is a three arc-second, and the one you ran before, which is a one arc-second?) I really can't tell a whole lot of difference from this altitude, to be honest with you. I think it's a lot easier on the 60 field of view than on the unity once you get that close. You can still see the airport, I've got my three degree glide slope line there. Is it controllable? Yes. Is adequate performance attainable with a controllable workload? Yes. Is it satisfactory without improvement? Yes. Good, negligible deficiencies. Pilot compensation not a factor for desired performance, two.

PRFN30: From here I can see the terrain concept and you don't have nearly the contrast and the depth of field that you do with the other ones, like the previous ones. *He did mention that he's not really interested in terrain on the display as much as they are interested in traffic depiction. Before knoll, he mentions that there isn't as much of the terrain contrast as the others.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Good, negligible deficiencies. Pilot compensation not a factor for desired performance, two.

EBGFN1: It looks pretty decent on this one. Yes, the fishnet does help out. I never would have thought that before if I was looking at the pictures before I came down. *Before he came down, when he was looking at the pictures, he didn't think that he was going to like the FN, so he's a bit surprised.* Is it controllable? Yes. Is adequate performance attainable with a controllable workload? Yes. Is it satisfactory without improvement? Yes. Good, negligible deficiencies. Pilot compensation not a factor for desired performance, two.

Rare Event:

EBGFN1: I can see the terrain real well with the fishnet on here, it highlights it. It looks pretty close looking out the window, too, as far as what I'm seeing here. *At 4:21 he said the terrain is looking very close. He started climbing after he said that, but not quite drastic enough, so would have hit had we let him continue.* Is it controllable? Yes. Is adequate performance attainable with a tolerable workload? Yes. Is it satisfactory without improvement? Yes. Fair, some unpleasant deficiencies. Minimal pilot compensation required for desired performance, three.

Subject 14 (BRD Baseline):

Block 1, High Altitude:

PR1: As far as the terrain goes, the terrain where I headed here, I thought was pretty good. That's the display that I thought was useful to me. I had trouble noticing where our heading was. I kept looking up at the top for a heading, but that was roll. You do have the heading digitally displayed up there, but I kept missing that. *Had a little trouble finding heading. And was a little fast for about 20 seconds, but had PTS 90% of the time.* I think what I'd say on this, is it satisfactory without improvement? I would say no, and then I would go to minor but annoying

deficiencies, number four. I had trouble with heading and I seem to have some trouble with holding heading as precisely as with other systems. Wings level attitude, I didn't notice this when we went through the training earlier, but this time I seem . . . maybe it's because of turbulence. The turbulence does seem to be rolling the wings around a lot. And it was kind of like sort of an annoyance. I'm always having trouble keeping this thing on the right heading. I guess it was my sense as to where the horizon is on the screen. Maybe I wasn't looking at things just right. I was watching the flight path marker and I guess in relation to the horizon. It was probably just dealing with the turbulence. Getting used to that kind of a display and tracking the marker with the horizon. Like I say, it was quite easy during the training maneuver, but it was smooth then.

BRD BL: Well, it could be due to familiarity. It seems easier with these gauges. I think I noticed the clocking position for altitude. I'm used to looking at this so the horizon seemed easy. With this, I know my increments and pitch. As I'm thinking back on it, on the other display, I didn't know where my pitch was. I think that was showing them the briefing, but now I forgot. I didn't know where my pitch was supposed to be. This was easier for me because I was so familiar with it. Satisfactory is a yes. I'd just go with a number two. The round gauges seem so familiar, I'm wondering with practice on the other displays if it would be just as good, but at least that's where I'm at right now.

PRFN30: (That's a 90 degree field of view.) Okay, this one doesn't do much for me. Well, wait a minute, let me get down here. There's 30; 60. Sixty seems good for right now. I'm in a little trouble because I'm climbing a little bit. I didn't realize I did that. My air speed is a little slow. I was trying to get back. I'm getting a better perspective on holding my attitude now. The terrain looks good. I mean, okay, I see the grid on there now. I got a ways to go before I get to my waypoint. I'm trying to get down to altitude here. I don't think the grid helps any. Just the terrain features were good. The grid seems to add, I don't know, it kind of looks unnatural over the trees and the features on the terrain, so . . . Start a left turn at 0-5-0, down to eight. It's kind of hard for me to tell how much descent rate. I can see the arrows, the VSI going down, but not much. What is it, 1,000 feet per minute, I guess, or close to it right there. Air speed is really high. Missed my heading. I didn't recognize, I didn't think about it. Okay, there I'm at about 1,000 feet per minute. That's easy to do. Air speed control is pretty good. I mean you can look at it and work with it. The little caret along side the flight path vector is handy. In fact, that's a lot of value if I just use it right. Now my air speed is really high. I'm coming up on altitude. Okay, I'm up to the 90 degree on the screen. I like that but I don't think the grid helps any. Yeah, it's still the same thing as I had before. I still have problem with headings and attitude. I just don't seem to be holding them as good as I did on the old round gauges, or I feel that way. Maybe I just have the wrong perception. I feel like I have to work a lot harder to stay on heading and attitude. I don't know why on attitude particularly, but it just seemed like it. When I say attitude, I'm talking about bank angle. I tend to lose bank angle. On pitch, I can do okay. I lose the bank angle and maybe that's why I'm having problems with heading.

EBGFN3: I like this one the best so far. Yeah, I definitely like it. I guess it's just, it looks more dramatic to me, the green versus the brown on the display. Sense of terrain height change and the shading certainly makes it look, makes it stand out a lot more prominent to me. Okay, I can start my turn now and down to 8,000. That descent rate got pretty high there. Woops, there goes my heading. I guess I still have a little trouble tracking my heading. I think maybe it's just getting used to the right scan. I'm tracking, I'm looking at the air speed and I'm looking at altitude and I'm looking ahead. I'm also trying to find my pitch here. And I'm about to get behind on the heading. Okay, coming up on altitude. I like this terrain real well. This shows a lot to me. I get much more sense of change of terrain altitude with this. I guess there could be some conception

that if you look out the window, you could actually see if this would be a mountain when actually it could be a tree covered slope or it could be totally snow covered, in which case it would all be white. But here I get a good sense of an altitude change. And the little obstacles on top of the terrain here show up quite nice. It does show up well. (It looks like you pretty much flew that one with the 60 degree field of view.) That's true. I guess it just looks the most comfortable to me. Well, here's the 90 degree. You know I cannot ever use this, because normally it doesn't seem to show me much. But now that you mention it, I can look out and see the runway. I guess I'm tending to look for things . . . okay, I should have flipped through screens and I forgot to. When I look at it here, I guess what's in close proximity to me is, I guess I kind of cued in on that. It just seemed like a comfortable screen for what I was doing. I think either the 30, 60 or the 90 would have worked good there. The unity was so far away. I could see the airport but the terrain wasn't as noticeable. *Still has a little trouble tracking heading.* You know, I think the pitch references being at the side somehow is just, I'm just not used to it and I tend not to notice them. I have a hard time relating to them at the side versus if they were in the center.

CCFN1: Am I on the 60 (FOV) display right now? (Yes.) I tried the unity but it seemed like all I've got is sky. The brown is so low that it's hardly useful to me. I feel like I'm pitched way up in the air but I'm actually not. So the terrain comes closer to the actual horizon. Either the 60 or the 90 to me feels, it just looks right to me right here. Well, I guess as far as information, as far as flying and staying away from obstacles, it works fine for me. The grid is of value on this because there's nothing to give a texture to it; nothing to give any depth perception. And the grid gives it a little bit of a feel for depth. Start a turn. It's a little easier for me now to see the 1,000 feet per minute rate of descent. Air speed control is a little easier. I'm noticing my altitude now come up on the tapes rather than just watching a digital window, so that's helpful. I noticed I've got obstacles here fairly close and I can see them on the screen. They stand out better on this display because of the color contrast. I can't see the change of terrain very well; the hills, the valleys. I can tell they're in there and I can tell that I'm clearing everything because nothing comes above my horizon line. But as far as the shape of the actual terrain, I can't, maybe if I get a, okay, this is a little better view. I can tell it's quite hilly. If I go out this far, it's just kind of a general overall view. There's the airport, there's the lake, okay, that's nice. The terrain texture, though, just goes away. There's nothing there for me to notice. I don't know what the terrain is doing in between myself and the airport. You know, I'm thinking here as I'm flying, usually I'm basically looking at holding the aircraft at the right air speed, altitude and attitude. And if I'm in instrument conditions, I guess what I'm thinking maybe, is the photo realistic, the view was more information than I needed. This almost seemed easier, I'm thinking, because the terrain was less there to consider. I could tell where I was flying was going to clear the terrain. I could see the airport symbol, that was good. I could see obstacles. I guess what I'm thinking is the photo realistic distracted me from watching my air speed and altitude and attitude. And this time, although it was a little hard to tell the shape of the terrain, in a sense I don't really care if I'm IMC. I just want to know that I'm below any major peaks and I think this was maybe a little easier for me. The grids, you know if the grids weren't so close together, the grids are so close, well, though, but the grid is effective in giving an overall terrain shape, so . . . I guess just leave that at that.

CCFN30: Again, on this screen, it seemed like all I've got is sky. There's not much to work with, as far as terrain goes. And I get the sensation that I'm pitching up quite a bit, although I realize I'm on the horizon -- just the visual effects. Now I've got more to work with. Here I've got more terrain. This seems like more of a normal display where everything below the horizon is terrain and everything above is sky. I feel like my pitch attitude is more comfortable. I don't know why that is. (Can you tell much of a difference between this resolution, which is the 30 arc-second, the lowest resolution, versus the highest resolution that you flew previously?) This

seems like I'm over fairly level terrain with not much out there. I've got the river. Let's see. I can tell I'm clearing the terrain by quite a bit. There's a slight shape to the terrain in the distance but again, I'm IMC right now. I'm ready to turn. Let's go to heading 0-5-0 own to . . . I'm having a little time here getting the pitch there. Okay, there's 1,000 feet a minute, 20 degree bank. The bank scale gets mixed up in the attitude scale. I get all these numbers. Woops, I went clear through the heading. Let's go back to it. You know I look up there and I think one of the things I do is, I see this heading right below the roll scale and I'm expecting roll, my heading numbers to come through on the roll scale and they're not. They're down here. I tend to watch that heading number and I miss it down here because I'm looking for something to roll past me up here. *Did blow through his target heading by 30 deg, but corrected back in the required amount of time. So, still gave him desired.* You know as far as the terrain goes, I'm thinking that my problems that I'm having with this display is really not so much involved with the terrain at all. It's just reading the tapes and the heading and attitude. I'm getting used to it because I have very little experience with a display like this. And it's just noticing where my heading is and watching the tapes for altitude and air speed. The terrain, I guess it's hard for me to say. I don't know right now whether it helps with one concept of terrain over another. It seemed like on the last ones that not having the photo realistic, not having that there might have been better for me because it didn't draw my eye to all the terrain features. It let me concentrate more on just flying the gauges, you might say. My awareness to where I was in relation to the terrain was okay, as far as knowing that I'm not going to hit anything on the ground. I knew I was above it and I could tell that. As far as whether I was over smooth terrain or rolling very much, I guess you obviously can't tell as well on the terrain we had in the last two runs as you can in the photo realistic. But it seemed like the photo realistic is kind of like an information, not overload, but it's more than I need to see. That's all I've got there.

EBGFN1: See here on this one (FOV Unity), I don't have enough terrain there to see anything. It's not too useful to me in this feature. You know it could be the (FOV) 60 and the 90, I like so much here because I've got so much more terrain to look at while I'm en route. I guess you're looking down more. This screen (FOV Unity) to me, just is, I don't know . . . I just feel uncomfortable with it. I feel like my attitude is off; my attitude is too high. I don't know. The terrain looks very realistic. I'm curious what it would look like outside. I guess, if I recall, the colors change with the altitude of the terrain. So okay, let's start our turn. I can tell very much that I'm entering an area of lower terrain there, and I like that. That looks nice. There's some grid. The grid doesn't seem to be so helpful on this as I had noticed before. There's enough terrain texture that the grid isn't needed. There's my heading again, with 1,000 feet to go. Let me try a different view. I think the terrain would be fine here without, the grid doesn't help me that much. Let's put it that way. You can see the terrain profile well without it. Okay, now I like this view for approach to the runway. This looks quite nice. I've got a lot of terrain here in front of me at the bottom half of the window and I can put my flight path marker on the runway so that makes the heading come out about right. Speed's a little high. This is working well. I get a good feel for what the terrain is and I busted that altitude just a little bit there. I was headed to the airport. There we go. Try a different screen (FOV). Okay, I like the perspective when I'm out here at the 60 and 90 as far as, that's where I get my best terrain awareness whether I need it or not for that final approach. I'm not sure how far away I am. The grid, though, doesn't seem to be of value overlaid on the terrain. No comments. *His turn is fairly shallow. Enough info on this one that the grid is unnecessary. Near end altitude, chose FOVUnity, because he can see RWY, and gets a good view of terrain during descent. Like the perspective at the 60 and 90FOV. The grid doesn't give much info.*

EBGFN30: I liked the last one better. This one has still got the same, I can tell the terrain altitude changed because of the color real well. The shading is nice. I get a good feel for the

texture or the change of terrain. It doesn't seem as clear to me. (It's a good comparison. Before you had the one, that would be the highest and this time you have the 30, so it's the lowest. But it's the same display with fishnet.) Okay, alright. I don't notice the grid on there, the fishnet. Okay, now I can see it. It's very light. See here, that one (FOV) is hard for me. I tend to like to fly with these two, I guess it's the 60 and the 90, because I have so much more down here to work with. My heading is off a little bit. We're coming up on the waypoint so I'll go ahead and start my turn and descent. I think I'm starting to understand and use this cue over here at the left of the flight path vector a little better now. Well, I say I did. I'm trying to come down and capture 1,000 feet per minute rate of descent and I tend to overshoot it. There's my heading. Okay, now this is a good terrain presentation. I got a real good view. This is a valley here. I'm right along the ridgeline. To me with the light and dark shading, I can tell exactly where the terrain contour changes. The fishnet doesn't do much. I get a very good feel of the terrain, that I'm on a ridgeline here, and I'm headed toward a valley. Now as far as the airport, okay, there's the airport. I just about missed my altitude. I was looking at the terrain instead of the altitude. I have a lot more trouble, it seems like with my heading. It is just spread apart on this view and if I get it up here, then it's a lot easier. I guess it's relation of the numbers. That's the best as far as maintaining heading. I can see that definitely the best. Out here it's like wow, where am I? I mean I can see as far as terrain goes, the runway is there, but what's my heading. I got it there but I've lost it on the horizon scale. But then as I bring these views in, it's a lot easier for me. I think my attitude is easier to follow on this view. I think I'm on the 60. (Yes, you're on the 60. Just out of curiosity, were you able to tell the difference between this one, which is the 30 arc-second, and the one arc-second that you flew?) I don't think so. Actually, I thought the one before this one seemed visually a little more real. But this one is very adequate as far as what I think.

EBG1: I think you can tell right off there is a little more, there is certainly more definition in the display in terms of the terrain. You get more crevices. Even into the green now, the green area you can see the shaded contours and the green that I don't know if I noticed before. I tend to drift off altitude here, it seems like. Here I am, well I'm 100 feet high. On your regular old round indicator, that wouldn't be too bad I guess. This gets away from me I think a little easier than it does with a round dial. You know this terrain, it's attractive in that you can tell a lot of detail. I don't know that it's useful for me though, if it's that useful of information. As far as avoiding the terrain of course, it's . . . Okay, we're up on our waypoint. Our left turn. There's 0-5-0. Nice picture as far as the terrain goes. I can't tell if it's a big improvement over the last one. I'm sure it is. Whether it's worth the extra it's hard to. . . I'd have to say I don't think it is. I've got a good perspective of where I am at the ridge. I can see the, there's the runway. I can see the valley there. The color change just happens to be nice at this altitude. I guess if I were at another altitude where the colors didn't, maybe they were all browns, it wouldn't be quite as noticeable to me, but let's see . . . This view is good, but I really have a problem with my heading. It's digitally displayed there, but I feel like I have better control when I back out a ways here. Yeah, it's compressed and for me it's a lot easier for me to interpret it and track it here. But then this is a very nice picture of the runway. *Was a little slow on his descent on this one. Feel he has better control when he backs out to 60 or 90FOV.* That's where I was. (Before you were talking about the fishnet wasn't really providing you much information and this one did not have the fishnet, so I just wanted to make sure that you didn't miss anything that the fishnet may have provided if you had it.) I didn't notice whether it was there or not.

PRFN1: I have a harder time determining what the terrain is. I mean in terms of the contours, I actually think the fishnet helps a little here because without it, it looks like a forested area and it's hard to tell the slope. I mean you can tell it's sloping but actually it helps quite a bit. It certainly does on this view. I'm just going to leave it on this view a while and try this turn with this

heading scale. I'm a little high. Okay, I'm going to start my turn. Heading is a lot easier to track there. I didn't do as good a job with my altitude, I mean my rate of descent. Let the air speed go a little high. I actually noticed the roll on the horizon line. Better it this time. This roll scale is still getting mixed up in the pitch. This terrain is a lot harder for me to tell the perspective of it than in the last series of terrains we saw. I can tell I'm over a ridge and I can tell there's a valley out here. But it doesn't jump out at me as clearly. The fishnet helps on it. The awareness of the terrain, the contours, it's not as easy to understand the terrain on this as it was on the last series. As far as the contour and the shape goes. The relief in this isn't as obvious and needs the grid to bring it out.

PRFN3: It's kind of the same as last time, although the features are starting to come out better. The relief, I noticed the grid, and it's helpful, the fishnet, I'll call it. I do have a good perspective of where the high terrain is and the lower terrain. There is some red, or kind of reddish. I don't know what that is. This view (FOV) doesn't do much. It doesn't help me too much. (That's unity.) I still have a problem with this one. This one does not do much either, it doesn't help me too much either. But this view is helpful now. I can at least see my terrain. I can see the changes in contour as I ready for my turn. There is some, I can tell some what I think are probably shadows on there that help me give some relief to the terrain. I was about ready to say that with the shadows and so on, I almost don't need the fishnet, but I'm not sure that that's a correct statement. The fishnet is still helpful. Now that I'm pitched down I know this view is okay. It's a little blurry, if it's my eyes. I can see the runway because I know it's there now, but this view is like when you're on an approach or pitched down, this would be a good view to use. Oops, just busted my altitude looking at the terrain and flew through the altitude. I'll try to get back on that. I guess I have a better feel for my attitude when I'm on this display, on this view. I don't know, to me, the terrain, I can tell that there's a valley there, I can tell there's a ridge here. It seems a little fuzzy. As far as the terrain awareness, as far as knowing where you are in terms of impacting the terrain and all that, that seems fine. Maybe I'm just trying to look for too much detail in it as far as looking as matching the ground. It looked, it sort of looked better than the view on the large screen. It was more clear because there wasn't any haze in there. It was a little blurry, but that didn't effect my ability to tell whether or not I have a peak in front of me or something like that. It was a valuable, I guess I'd have to say about all of these, you do get a good overall awareness of where the hills are and where the valley is, and where the airport is, in relation to all of that terrain. Whether it's got real good definition of all the trees, you know . . . it looks like trees. As to how good the relief is varies from the different ones, but with all of them I was able to get a good awareness that there is a valley here and the airport is in the proper location in that valley. That came through pretty good.

Block 2, Low Altitude:

CCFN1: About ready to start a left turn. I can tell the terrain is beneath me. I don't have anything in front so far that's going to be at my altitude. I can't tell much about the terrain except I can tell it's hilly, but . . . Now obstacles are showing up real clearly here. These two obstacles straight ahead, and then there are some further away. They contrast well with the color of the terrain. I'm trying to keep my descent rate going a little faster. I'm getting real close to these obstacles and it's showing up on the MFD is we're within 500 feet, I think that's what that means. (You're actually right around 1,000 feet, between 900 and 1,000. What were you seeing, green or yellow?) On the MFD? I saw green. So it's showing me over there that I'm, I guess that's within 1,000 feet. (Green is within 2,000. And yellow is within 500. Now that you're a little closer to the terrain, what do you think of the terrain depiction?) Well, it takes some getting used to. I think if you got used to it, it's probably usable, but it certainly doesn't give me the sense of terrain you get with the other formats. You know for IFR purposes, for normal flying, I think you'd have to say it's useful because I can tell if I'm going to clear the terrain. I can see anything

ahead of me, I can see obstacles and they show up well on there. I didn't notice the airport. I didn't see it at all. I probably should have had the other screen up or something, but I didn't see it at all. *Slower decent rate, but did get to alt by 5:00.* The thing there is that the terrain up at the lower part of the display that's close to you, you get a good feel for its contour, or the relief, as you called it. But if it's further away, you can tell if it's at your height, or where it is in relation to the horizon, but you kind of lose out, you lose your perspective of what that terrain contour looks like out there. If you're just looking at how good the terrain is presented, that's what I'd have to say. The river and other water features like that I guess are really good.

EBG1: En route, this screen (FOV Unity) right here is hard for me to use. I guess the heading is way too far apart, and I don't have much terrain below me to look at. Now it gets better as I go out and almost out here seems easiest right now. Oh, I love it. I have a very good view of a nice clear day of just what I'm seeing on the screen ahead of me. Well, it's a little different view of that, but it's just like a good VFR day out the windshield, all the way to the horizon. I've got good definition right up to the top portion of the terrain that's displayed and I could . . . Now whether I really need that to fly or not, but I guess as long as you've got it, maybe it would be good to be as sharp a presentation as you could make it. Talking here and looking around, I'm a little high. I'm coming up on our waypoint, too. Alright, we'll start the turn. Woops, got a little too steep. Okay, now is when this screen to me is really useful. I get a really good feel for where I'm at, close to the top of those peaks. Yeah, there's obstacles right there. Now the obstacles, you kind of have to look for them. They don't really jump right out at you, because they are red and white colored towers, it looks like. So they don't show up as good as they do on the last display we had, but you can sure tell they're there, and you can tell you're close to them. Coming up on 5,000 feet. And of course I can see my runway out there real well. I can tell that I'm coming down over the edge of all this. Let's see what the other ones look like. Woops, I'm blowing my altitude. This is far enough away that I almost lose sight of the airport, but it's easy to fly it. This is just like looking out the windshield. It really is pretty nice. The only thing you wonder is if the altitudes, if the terrain you're flying over is not at these altitudes, if the colors would be the same, if the valley may not really be green. But the hills are, I guess. This happens to be such that the color changes with terrain altitude makes the peaks look more dramatic. I don't know if they'll do that all the time, at all the different altitudes. I guess they do. You know, I think I'm just going to give it a one. I really liked that last one. Everything about it, I just thought it made things easier, it was easy to see, it was clear and the only thing is that there may be situations where you look out the windshield because it's winter or something and you expect to see a green valley there and it's not really green in real life. But at least on the display, it makes the terrain profiles stand out. And whether the valley is green or not maybe doesn't matter. I guess the other thing is, this equipment, it may be good that it has a zoom control and having the button on the wheel here is really handy. It may not need three or four, but an in and out might be a good feature for this equipment to have. *Comments from EBGFN30, after rethinking the rating method – rating the system, and not just the terrain:* (Okay, and then that one that you gave a while ago (on EBG1), do you want to amend that one?) I'd just bring it down to a two.

PRFN30: This seems to work okay. You don't have a sense of the terrain altitude profile as much as you did on the last one. In the change of altitude, I could obviously see something that looks more like looking out the windshield. You have, it looks like, forested areas and cleared areas. And a sense of their height doesn't really show up so much and the fishnet sort of helps, but the fishnet doesn't show much of a change of profile. Okay, about ready for a turn. Pretty steep there. I still have a little trouble finding my, it seems like I have a little trouble staying on my pitch attitude. Anyway, down to 5,000. There's my towers again. They don't stand out as much as the constant color version does, but you do see them. Here again, it looks like for final

approach, this is not a bad thing to use, although . . . The terrain just doesn't look as dramatic on this display. I don't know, the fishnet tends to look like it's just leveled everything out. I can still tell where I am in relation to it. I can tell that nothing out there is going to, I'm not going to hit anything. You know, it's satisfactory but those terrain features, if you're going to have this kind of display, it seems kind of, I'm kind of coming to the conclusion that if you have this kind of display, it's better to have better characteristics. That one was kind of, things were somewhat rounded off. It could have been because of the fishnet.

EBGFN30: You know flying over this terrain right now, this view (FOV) doesn't seem to be very useful at all. And this (FOV) is, I guess, not real useful either. Now we're getting somewhere, because I can see that valley and everything is closer suited to what I see out the windshield. But also I get a sense of depth perception with it, especially at this one (FOV60 and 90). I guess the 3-D characteristic must be coming out more. The fishnet, oh yeah, I see the fishnet. I don't know that it does much. Okay, we're getting ready to turn. Now that's a nice view. I got my obstacles. I can see that. I can see the runway. Go down to 5,000. And this is still good. This is good. When you're in this situation, you're on approach and you're coming down, this (FOV 60) is a better view to use. At least maybe this one. I can tell where my obstacles are, I can see the terrain, I see the airport. I see it all right here in this view. This is working out nice as far as everything I can see. Now I just looked on the screen ahead of me (OTW) and those towers, it looks like I'm only a couple hundred feet away from them. Yeah, you'll pick them up every once in a while. I just busted my altitude. I was looking out the screen. This one almost seems too far away on this view, and this, this is useful now. Well, if I had to pick one, I'm not sure which one I would pick, if I had to use one screen for everything. I think you could narrow it down to two, though. I'd still have to go with the comments like I had this morning. I still have a little problem reading the altitude, holding altitude and also I miss my heading every now and then, depending on which view I'm looking at. So that's why I think some of that is just transitioning to this kind of a format, but the information is there and it's . . . I'd go, I gave it a one rating a while ago, but I wasn't thinking about all the rest of the display. I was just looking at the terrain. Now this morning I was considering the entire display, so I'll think about that now with the rest of these. So I think I'll just go with a three, is probably where I should go, because I still have trouble with heading and altitude. (Okay, and then that one that you gave a while ago (EBG1), do you want to amend that one?) I'd just bring it down to a two.

EBGFN3: Well this view presentation is working okay. I don't notice the fishnet on there. I hardly even see it. I may see it when we get closer. Now I can see it. Okay, start a turn. It's really close to the one we had just before with this type of thing. I think we've added the fishnet but it's just very useful. It's a very nice contrast. You can see the hills. The shading makes the terrain stand out to you. The obstacles come out very nicely. I can see the runway well. Yeah, it's clear. It's not fuzzy at all. And it's just real nice. I was flying up there with the Capstone program some, and used to having something to tell me where to have the flight path marker, and here you still do, but you've got to watch your altitude. Well, I'm used to having a highway in the sky and it was on all the time. And now it's not here, so now you've got to watch altitude more. And I'm just finding myself a little busier, but it works good. (A two for that, was pilot compensation not a factor for desired performance pretty much?) Yeah, pretty much.

EBGFN1: I still find myself coming back to this view (FOV60). It just seems most comfortable to me. The terrain features certainly look well defined and easy to comprehend. I don't notice the fishnet much. I can see it here (lower FOVs). I don't know as it helps, but I can see it. A little bit there, but you can hardly notice it. Here it starts to show up (higher FOVs). What I was talking about a while ago on this Capstone program, they had the highway in the skies there, so you always put the flight path marker in the boxes, and I never paid much attention to altitude.

Well now I have to here, because the boxes aren't there. This is the way things will . . . this is good. Now I just noticed there's a river in here. Okay, we need to turn. Sorry about that; a little bit late. Okay, the fishnet really shows up now. It's like I've got a different time of day or something. It's like a different sun angle or whatever, but the fishnet really shows up. I just switched it over. You don't notice it so much here. It certainly shows up especially right here and on this view, of course. Yeah, and it's hard to say actually whether it's helpful. It certainly is there and it helps you notice the contour. But I'm not sure you wouldn't see it just as well without it. But it certainly doesn't hurt anything. This is really a nice presentation. If I'm going to have a picture of the terrain out there, I guess it'd be nice to have it nice and clear and that's what this is. I just realized from this view now, I've noticed the motion across the ground. I'm sure I have, but for some reason it just jumped out at me this time. Maybe it's because we're in such close proximity to the terrain. Partly what the fishnet would do, would be to help you see that and it worked very well there. I'll go with a two. (You feel it is satisfactory without improvement, good negligible deficiencies?) Is that what that means, rather than the excellent? Because if I would improve it, I would probably do a little something different with heading and some of the interference with the heading and the pitch scale. I'd probably change pitch, put a normal pitch ladder in of some kind, so if that's what that means, then what I really mean to say then, it would be a three. Because I would make minor changes to it. (Fair, some mildly unpleasant deficiencies. Additional pilot compensation required for a desired performance?) Yeah, let's do that.

CCFN30: It all seems kind of plain Jane. But I'll tell you, that river on there really helps out because the grid pattern doesn't, well you can see some terrain contour change but it's not very dramatic. This view and this view (FOV 60 and 90) are the ones that are really useful to me. This (FOV Unity) isn't useful at all, it doesn't seem to me right now. No, I think it's the timing, it's your flight en route or approach situation. This one seems to be marginal en route, to me. I don't know, I guess I'd like to see more terrain down there. It's useful to have more terrain down there, I feel like on the lower half of the display, like this would be. I suppose it's, you know, you should be using the horizon line for your absolute horizon, but I guess I'm tending to see the actual terrain profile as a horizon, which could be a little bad if you get in to gradually sloping terrain, I guess. I think that river is a good feature. It sure helps bring some perspective into something that's fairly – I don't now, it's just, it's almost like, do you need to even bother with terrain if there aren't any features down there to show up more than this. I'm sorry, I'm a little late. Well you know, I can look at this and at least I can tell where my terrain is and I can avoid anything I don't want to hit, I think. Now this is interesting. I've got the runway out there, it just sure doesn't . . . The other ones kind of spoil you. You can barely tell the runway is there, but I kind of know it's there now, I know what to look for. You know the change in the terrain that we know is there sure doesn't show up on this display. I can see what's directly below me here, or immediately in front. Obstacles do show up nice, the little black marks. They really jump out at you. On the others, they're a little bit of the same color as the . . . Now about 100 feet to go. The contrast to the obstacles show up a lot better than they do on the other displays. For an approach, this one doesn't really show the runway at all. I've got terrain here and obstacles. Same way here. I've lost the runway here. And now of course, I've got it back with this view. When you're talking about pilot compensation, they're just talking about compensating for the display or you're compensating, it's just how hard you're having to work to (It's how hard you're having to work to get whatever level of performance you end up with.) Yeah, it should be between a four and a five. Really, this is still my same problem --- it's altitude control with that altitude tape and hitting. And really, I'm having to work pretty good to stay on that altitude. That's why I drifted off. So I really should say, it's at least a four. I could probably even go a five, but I'd have to say that. Well, I don't know. No, I think the terrain is not so much a factor as just scanning. It's just scanning. Keeping up with scanning the tapes and the heading and the

terrain, I don't know as that effects the ability to stay on altitude, airspeed and heading. *Have to go with a 5, since the performance level was adequate.*

PRFN3: Okay, I'm trying to have a more disciplined scan this time and watch things and maybe it's helping here. We'll see how it goes. I don't think the terrain makes too much difference on how well I stay on altitude or air speed or heading. It's a comforting feature when the view out the windshield like I got right now just disappears. Okay, start a turn. The terrain up here is a little fuzzy in the background. It's pretty good up close. I think the fishnet helps a lot on this. You don't get the sense of the terrain slope as well without the fishnet. It seems to be a little easier to see. It's a nice view. The obstacles show up pretty well. There are red and gray against the green background, which is pretty good. I see the other obstacles are ahead and of course I've got the runway up there. It's all quite visible up there in the valley and the valley being a different color is nice. I just caught the visual of the towers outside the windshield here and they're pretty close. This is all quite useful. I think the fishnet does help this, though. Like I say, the towers stand out nice. Well, that time I tried a little harder. How did I do on staying on altitude and stuff, better? It's because, it's not the terrain, it's just the tapes.

PR1: I guess I should say I'm starting to use that VSI a little better that's on the altitude tape. I watch that a little more closely and don't let that get started. It's easier to stay on altitude. I don't think I'd really been doing that much before. I'd look at the number and then respond to the number. In a sense sometimes the airplane, the pitch indicator and the flight path marker kind of get on top of each other. It seemed like once, maybe if the pitch indicator were a little, not necessarily smaller, but not quite as bright or something. I guess it would make the flight path vector more dominant. I think it's a fight for my attention and I guess it's, well, which one do I look at. Maybe it's just practice. Alright, start a turn. Right here you're really getting the sensation of flying across the terrain, because you're close enough to see it moving by. Where if you get on this, you don't notice it so much. You don't see a sensation of movement. The forward velocity, I don't know if it's a big deal. You see it here kind of like . . . Well, I think I'd leave it at four. Yeah, I've still got to work at it.

PRFN1: I think like I said before, a fishnet helps on this terrain. It gives you a better feel of the change in contours. Okay, starting to turn. I'm trying harder on this one to stay on it and make things seems smooth and it works out if I just really keep the scan going and work on it. I think with a little practice, it wouldn't be such a big deal. The heading disappears behind the flight path vector there sometimes. You know 0-5-0 is digitally displayed above, but behind the vector it disappears. Everything . . . With me anyway, it's just getting a better handle on flying the air speed and altitude and heading tapes, so that's going to be the same. On that kind of terrain display, the fishnet is a little help, but it's not like it's a major deal. (So the fishnet is a little bit of help.) It's an improvement, in seeing the terrain profile. It makes the profile stand out a little more, the relief, but you can still comprehend it probably well, without the fishnet.

BRD BL: You know it seems like I still work about as hard. This VSI is certainly easier for me to catch in my eye and interpret than the other one is, but it still . . . Okay, we start a turn and descent. I'm sorry, I fouled this up. I've got 5,500 on my mind. Yeah, I leveled off at 5,500 because I was thinking. I hope we get down in time to see those towers. Well, we're past one of them. We've got two of them in front of us up here it looks like. According to the MFD, there are a couple of towers. It was a little easier for me, probably because I'm, maybe because I'm familiar. It's a little easier to just use the round gauges. But then I didn't have the terrain to see and all that, which is . . . this seemed to me, a little bit easier. You know, I think maybe I got thinking about what I'm doing here, when I take my eyes off the instruments and look at the terrain and I look at target, I look at obstacles, and identify them and I look in valleys and see

things, and then I look over to my altitude and I'm off. On the other ones, there's nothing else to look at but just airspeed, altitude and heading. I got more information there, and I've probably got a lot better situational awareness with the terrain and everything on there, and the photo type of display. But if I'm just tracking air speed, altitude and attitude headings with regular gauges, that's all I have to put my attention on. There's something about having an indicator, a pointer fixed at either a 12, 3, 6, or 9 o'clock position that I don't have to think about the number, it's just there and that relationship is . . . Apparently it's kind of meaningful. I've never thought about this. I mean I've heard people mention it, but, okay.

Block 3, Approach:

EBG1: It's nice having those boxes. It helps me stay on altitude. Yeah, it's a lot easier to track the ILS with this than the conventional method. Flying through these boxes, I mean I'm not staying perfectly in them, but just the task. I don't know which presentation I like. All of them seem to work good for me right now, I think. You know, I hardly notice it (the terrain depiction), I'm just looking at the boxes and air speed. Yeah, I noticed the terrain, but it's really not too much of a concern, I guess. I'm pretty much just trying to fly the approach and stay in the boxes. The terrain, well now that I think about it, I can see a road down there, or a river or whatever it is. It gives me a feel for where I am in proximity to the airport, I guess if I studied the terrain features. Okay, this view, I don't know which one I've got, but is this unity? (Yes.) These boxes come along so slow. I guess I feel best with this one (FOV 90). There's the outer marker. I think it's the sense of motion. And there's more of them. I can see myself do a lot of boxes. Now I've got a better view of the runway here. I can see it through the last box. This one, too, I see it through the last box. Okay, since we're going down the glide slope, maybe this is the best one. I'll stay with this a while and see how it works. I feel like I'm having to work quite a bit with the wheel here, to keep it in the box. There's a lot of movement. I might be over-controlling a little bit. This 172 is not the most stable. (Do you find that your level of movement, I guess, differs between the fields of view? Do you think that the symbology is a little bit more sensitive in one field of view versus the other?) No, I think the wheel movements I'm making are about the same either way. Okay, that's the middle marker. This one is the best view for final approach, it looks like. I like it better now. I guess when I was out further, the other views, the longer view was good, but now that I'm in, I like switching to this one. I sure like being able to switch with that button. It's handy. *FOV90 - gives him a good sense of motion, and there are more of them. Likes the yoke button. Was out of path at the start up, but came back within the allotted time.* The only thing is, I found my attention, now it was easier. I could concentrate on just flying the boxes and air speed. I really didn't notice the altitude tape because I was depending on the boxes to keep me on my correct altitude. So that task seemed easier in that respect. I didn't notice the CDI or the vertical deviation bars. At least on this last approach, I wasn't totally absorbed with it, but it just seemed like I got relaxed with, or not relaxed, but I was just flying to the boxes and it took care of everything for me. It felt comfortable. Yeah, I was out the left side starting out, and I must have had a . . . Well yeah, that's that right crosswind.

EBGFN30: I like this display because it gives me a nice presentation of my turn. I think that's really handy. Sixty, okay. I'm trying to get my air speed back here. I guess I'm still having a little hard time knowing which box I like better. Everything seems to work. I tend to kind of go with this especially while I'm making a turn. You know, I just don't notice the terrain. I see it down there. I can tell it's got the fishnet on it, but it doesn't seem to be my big area of concern. It's all got to do with the boxes and holding air speed and flying down the course. This one, it seems like the boxes are big (Unity and FOV 30). It's hard to know where the center is, and I guess that's why I use the dog bone. Like in the other displays, here it's easier to find myself in relation to the boxes, especially on this one (FOV 90). It's easier for me to find my position in these without looking at the dog bone. Okay, now we're getting closer to final. (You're at unity

right now.) Yeah, okay. I don't have as good a view of the runway here (FOV 90), but this is an easier box path for me. I can see terrain features. It looks like maybe highways and stuff, but I don't think all of it is fishnet. That's a handy thing to see, especially if I knew where it was in proximity to the airport. But again, it tends to be information that I notice, but I'm mostly just following the course guidance with the boxes. Highways, yeah, okay. I really like this. This is nice. I'm using this, this is 90 degrees, isn't it? I can see the runway coming up. It's much smaller than it would have been the other view. But the skyway boxes are . . . I don't know, to me this is easier to track. Is that the inner marker? The middle marker. You know it's kind of the cue, the air speed cue on the left side of the flight path marker is really handy. I just have to learn how to use it. I guess anybody would. Once you know to get a speed and then track it with that, then it really works nice. You don't have to move your eyes back and forth to the air speed scale as often.

PRFN1: (Just so you know, that's a field of view of 60.) Okay. I noticed when I went to unity and 30 there, I found myself off the boxes and out the skyway and the view here, I was looking ahead into the turn. I don't now why I find this one the easiest to fly. I think, I don't know if it's because there are more boxes, but it could be the size of the flight path marker in relation to the overall width and height of the box. It's closer, it comes closer to filling the box and maybe it's easier for me to hold it in my position. Because with the turbulence, it's easiest to just drive it right out of the box if I don't stay on it. I think if it were smooth, that could be different, but you really need to stay focused for the air speed and to try to be centered in the boxes. If I were en route I don't think I would worry about it so much, but on an approach, you want to be on it. If you were en route I think this would be quite a task, and it really wouldn't be necessary to stay with this precision en route, but for approach you want the precision, but I think it's easier flying this. I guess we'll find out later, but it's easier flying this than it is with the conventional method. Now this is unity? (Yes, it is.) For some reason, it's easier for me to guide down the boxes in this view on the 90. That terrain seemed a little fuzzy. I don't know, again, I guess I wasn't paying that much attention to it. You know, the terrain on the last two, to me, weren't as good as identifying features as the first one. But on a situation like this, I'm tending not to be that concerned with the terrain and following the course guidance. I'm tempted to go with a four, because the terrain features to me weren't as visible. They weren't as good as the other, like this one coming up.

EBGFN3: Well you know, I have to say now that I'm thinking a little bit more about the terrain, this view of terrain is certainly nice. The peaks really stand out. I can concentrate on the course, but I can see the peaks right through the boxes, and it's a very nice view of the terrain. I can see this lower level terrain right now coming up. I like that. It's nice. The fishnet, I guess it's like what we had before except this has the fishnet. But compared to the last terrain, this is much nicer. You know, the fishnet does help you see some motion, although I get the motion with the boxes. But if the fishnet is oriented in the cardinal directions, it's kind of nice for situational awareness, to know which way is north, east, south and west, just by looking at the fishnet. It kind of reminds you of the section lines in the Midwest. This must be 90 (FOV). (Yes.) See this view out here just doesn't seem so handy to me. The boxes are, the one that's really close that we just went through is really kind of useless, but of course, those out further are valuable as far as guidance. This is getting better. It's interesting when you change the views that the velocity vector really moves to the side of the screen a lot more so you've got to switch your, well you follow it, it's not a problem, but it moves to the side further. (I was going to ask you if you found it a little difficult to transition between one field of view to another?) Yeah, in that respect, yeah. You have to compensate for that. I think once you get to know it, it's there and you expect it, it's just okay, but I'll try this view for a while. This is 30, I think. Again, the terrain is nice. The mountains in the background, the highways, this is very nice, even though I'm watching the

boxes mostly, I'm starting to spread out my scan now, and I'm noticing the terrain more. This is very nice. Here, unity is working okay for me. Yeah, I think here, like in this view (FOV 60) there are more boxes ahead of me. I can put the vector right there in that and it's easier to hold it, it seems. Air speed is high. I guess it's a better target or something. Maybe it's more from something more to aim with. I can put the vector, like in the last box, it nearly fills that box and that's, I guess I got more to, it's just easier to locate the vector, I guess, right where you need it. *Really does not find a use for FOVUnity - on short final stays on FOV60. Feels its easier to track where you want to be and where you want to go.* I like that one the best so far, with that terrain.

PR1: This terrain, you can see it's there, but it doesn't have the contrast for the . . . I don't notice the terrain relief as well as I do with the last one we had. I don't think it's to do with the fishnet so much, it's just maybe this has got more detail in it. It's just, there's too much detail perhaps, with all the different colors of ground and stuff. On this one, I don't see much. I don't find myself noticing terrain characteristics like the high level terrain that's in the background behind the airport and it just doesn't stand out to me, or the peaks that I've just flown over. I guess I see them there, but they didn't strike me. I had to look at it and think about it, and oh yeah, that's a higher level. That's a high hill versus this low level stuff I see right ahead of me. (So that last one was a little easier to interpret you think?) Oh, yeah. I didn't have to think. It just jumps out at you because it changes color. That unity view is still harder for me. Even this 30 degree is easier. See right in there, the last box, the flight path marker actually exceeds the ends of the box top and both sides. It's easier for me to place it in there and hold it, it seems like. Certainly to see the runway, I would have found the runway in either view, I think. This one is easier for me to track. This is the 90. Now this is a great view of the runway, but the boxes are large and I can move around in there a little easier. We're getting close in. I guess as you get really close in, then this unity view becomes more valuable. Especially in putting the marker on the touchdown point. I have a little trouble deciding which view would be the preferred. *At FOV30 (2100), the VV is outside the box and helps him target, as opposed to the Unity. Maybe once you get on short final, Unity becomes more valuable.* Because the terrain isn't as easy to understand.

PRFN3: I see what's happening. When you go to the unity view then the flight path marker is clear over here on the air speed scale and the boxes are real wide. Okay. To me, I like it better where you have more boxes in the view and you can see the . . . (Right now you're in 60, so during the turn, do you like the 60 better or the 90?) Certainly the 60. The 90 is fine. It's probably may be more boxes than I need, but yeah, I like this the best. The fishnet does help the terrain. You can see a little more of the curvature of the terrain features. Again, the fishnet if it's oriented north, south, east, west, it's handy. Okay, and I can see it looks like a highway or something going into a city. That's kind of a nice cue. It gives you a nice situational awareness. I think, I guess I like having this longer, tighter tunnel, at least the perspective of it. Of course now I've got the boxes over to the left side because of the crosswinds, but I don't find that as easy to use. I like it. Like this is 60 . . . at least this. I know what it's doing. It's making the crosswind look less apparent, because now the flight path marker is closer to the pitch reference. Yeah. Let's see, am I on 60? Yeah, I was. Yeah, I get a lot more motion with the turbulence. I notice the motion of the plane more and the vector flying around in the box. When I go out here to at least here, maybe it's because of a longer narrower tunnel, it seems like I can counteract the turbulence better. I don't know what's going on for sure, but it feels like I can fly it better here. The terrain is getting kind of fuzzy here, but with the fishnet, you still get a good perspective of the cardinal headings. I think that's good for situational awareness. You know it could be that if I had the choice of two, maybe unity and 60 or 90, maybe unity and 60 might be the ones I'd pick right now. Because right here on short final, this is probably good. Of course, I'm at minimums, so I really should be looking out the window and seeing the runway visually, but it's a good

display. Say we're trying to go down below, say to 100 feet or try to get down like a Cat 3 landing this is certainly the view. I can try to put that marker right on the touchdown point and not worry about boxes any more. *Can see the turbulence more in the Unity, and it's a little harder to control.* The fishnet really was of benefit to that terrain.

CCFN1: It doesn't really do much for me except I see some terrain that's fairly uneven. I don't see any major . . . well I guess there is a peak right here to my lower left screen, but you kind of have to look at it and think about it. This really makes the highway in the sky stand out well because you've got good contrast to the terrain in the sky. The terrain features just don't show up much. Now if it's above my horizon, which it does look like it is just a little up there to the left of the screen, well I can see that. I don't notice too much else. I was about ready to say the fishnet is the only way you can see any kind of terrain variation in terms of the relief. And of course, it does give the cardinal headings like we talked about before on the others. It looks like there's a bit of, perhaps a river or highway maybe, on here. That is handy if you know if it's supposed to be there or not on your approach. You get some situational awareness. Now I notice the obstacles and they do show up well on this type of screen. They're dark and they stand out against that terrain color. Sixty does, I believe 60 would worked out pretty good. Ninety has got more boxes and the tunnel seems a little busier and tighter. But 60 would be a good compromise. We've got enough boxes and the tunnel is tight enough that I can navigate through it, it seems. And then I could plan on switching to unity after I get real close in. But to me, this works really nice. Just in terms of the size of the flight path marker and the size of the boxes and the shape and the number of boxes in the tunnel. I don't know, there's some place along the approach I could switch to unity and I think it would be fine. I'm not sure that this is still a good place to be for a while, a little closer in. The terrain, well I can see peaks and so on above my horizon out there, so I know that's ahead of me. I can tell there's terrain I'll run into if I stay at this altitude. I guess that's an important feature. You can certainly see it here. The terrain is actually starting to take shape at this view. I guess that's a city or town up ahead on the right there. Oh, the airport, okay. That's nice to know. At least that's a good situational awareness cue. Now the terrain here, I can make sense of. I can actually see what's happening to the terrain and it's useful. But I can't fly this view all the time, so . . . Because the terrain really only was helpful to me in the unity mode. The other views were not that helpful in really anything, except I could tell that the terrain was near my altitude on the horizon. If I hadn't been looking for that high hill that I just flew over, even though it had the fishnet over it, it didn't jump out at me. If I had gotten much closer maybe it would have, but it didn't really jump out at me. I knew it was there so I kind of looked for it, so that's not real good.

PRFN30: Let's see how this 90 takes me through the turn. I can't see the boxes ahead. I know there's a turn coming up here, but we'll see what it does. That's the advantage of the other views, at least on 60 and I'm sure on 30. Yeah, see this gives you a good view of the turn. Yeah, the 60 did. The 90, you get it, but it's . . . see this is working out. I'm only doing 90 knots. If I were having to fly this at say 150 or 160, it might be a little different. These boxes could be whizzing by if you were doing that. Yeah, I guess those folks (air carriers) aren't interested in this, but you know this will find its way into small jets like Citations. Yeah. You'd have this 172 maxed out trying to do that. Well this terrain is fuzzy. Again, at this view, it's the same thing. You get better perspective of low altitude and peaks. As far as anything ahead that's a major obstruction to me, it doesn't jump out right now because this view, especially this one . . . This is still nice to navigate with as far as I'm concerned. Here, now I can see that hill back there real well. But with the crosswind it's over to my side, it seems a little awkward. Holding the flight path marker in the boxes is what I really mean. That air speed cue at the left is nice. That's a handy feature. There's the big tower. Obstacles, you know, that's one thing. Obstacles, this is a photo realistic, so you actually see the obstacles. I don't know if the obstacles jump out at you so much on this.

I guess the 90 view helps me get around the corner better. On this one, I don't stay in the boxes that well going around the corner. When I try to match the bank angle of the box, then I turn inside it. Well, I'm trying this view. I can use it. I do get a good sense of the tunnel. I can see the runway. The terrain features are showing up a little better in terms of the field out there beyond the runway. I just see the obstacle, I see it on the screen ahead of me, but it's not on the display, I guess because of this view. Okay, there's the obstacle. I think this 60 degrees is still easier for me. The terrain is a little fuzzy. The fishnet, though, is helpful. Having the different colors, I don't know. It seems a little, the photo realistic seems to me it would be kind of seasonal. I see some green and I see some lighter colors. That doesn't necessarily represent high or lower terrain, I don't think, anyway. Now, even on this view, I can see the terrain coming up above my horizon out there. I've got the runway, it's just a lot tinier than it would be in that other unity view. See if I could use it right on down. Yeah, I think I can. I think this works. Right down to the touchdown point. *Terrain and obstacles are not as apparent as in the EBG.* It's just the terrain is the reason it's a four and would have been higher, the terrain is not as apparent, the relief or the obstacles.

EBGFN1: Wow, that terrain really stands out. That's really something. I never noticed that peak until we had this type of terrain before. I don't notice it on the other types of terrain formats. I'm just realizing too, looking at terrain and looking at the boxes and trying to hold air speed and all this, I don't pay attention to the MFD, but now I decided to look over there at it, and yeah, okay, there's my course. If I got off the boxes I could find my course by looking at the MFD. And of course, the terrain that's a problem for me shows up real well on MFD. But then okay, I was going to say I could see it pretty well on the PFD, but you can't . . . I guess I don't find myself needing the MFD so much. Of course it's still good for the overall course situational awareness, because I can only see a certain ways ahead on the PFD, but there I can see my entire course on the MFD. The terrain, the fishnet does help here, while you're in the lower, flatter area as well as to show going over the curves of the contour changes. All in all, a good combination, I think. One arc-second, okay. Well, this is just a really good picture. With the terrain changing color in the background, it really is nice. It's so easy for me to see it. Just the color difference is enough to tell me something without having to look at whether it's sloping in one direction or see what the fishnet's doing. The color makes all the difference. These roads or highways really stand out nice. Obstacles, I don't remember now if I've seen one. I'm sure they are. I guess I passed them already. Let's see, they're on the MFD. Alright. One thing you do, you start looking around at your other equipment and you find yourself deviating out of the box more. It's not terribly bad. I don't know that it's harder than flying a flight director or obviously a conventional CDI and a glide slope. I'm leaving it on 60 here because that seems to work good, especially with the view of the hills in the background. I've got the runway. This is just, to me, it's just a nice perspective right here without needing anything else. You look at the display and you kind of wish every day looked this nice outside. I think I mentioned once before that I liked that display so well. I think this one now is the most preferred, from what I've seen so far. It was just the easiest to use.

CCFN30: The impression is that it's a big, flat terrain. Not much out there. I do see the obstacles showing up in the distance. I guess the fact that the fishnet does appear wider to me, it should tell me, I guess with some knowledge of it, you know, that that's a lot closer, so that's a higher terrain feature. Now the terrain looks like it goes down and it's further away. That's about the most I can make of it. The peak that I flew over just didn't jump out at me at all. On this wide view, you get a nice picture of the highway or river or stream down there. The obstacles show up well. Okay, but I really don't have a sense that there is anything, any terrain up ahead of me that's much higher than me. I can tell it comes up to the horizon, though. It doesn't stand out like a cloud or something up there, you better watch out. I'm in the 90 now,

aren't I? (Yes.) It seems to be the best view for the terrain awareness; the fishnet, obstacles and whatever features are on here, like rivers. They're just closer in. Well, there's the airport environment there. We had the same view (terrain) a couple of scenarios back, I think. This is just a different arc-second? (Yes, this is a 30, whereas the one previous to this was a one arc-second.) I don't notice much difference so far, from that one. Okay, I guess now, yeah, it's the same as before. Now the terrain on the unity scale is really apparent to me. Now it slopes up back there and it's obviously above my horizon and the situational awareness is kind of there. You have to study things in order to understand it. It doesn't jump out at you like it does on the enhanced, the ground elevation based. Okay, on constant color, even with fishnets, this unity view is good to use for final approach, where the others, I thought I could get along with the other views on the 60. If I used 60 on constant color, I don't know if I'd have good terrain awareness.

CCFN30NT: Wow, that's certainly harder to do. Yeah, and there's my localizer. Yeah, I really miss that tunnel. The inbound was about 334, right? I'm trying to recapture here. Actually, you're a lot busier now, and it's harder even to pay too much attention to the terrain, but I do notice the obstacles. The obstacles jump out real good. It's a good thing there's a fishnet and that they put these rivers on there, or highways, whatever they would be, because other than that, it's just kind of a big, flat terrain. I'm trying to catch it back. There we go. The flight path vector I think is certainly a nice feature in terms of being able to hold altitude. I think it's easier than using the pitch. Of course, I'm still a little high. And there's the glide slope coming in. Now I've got my runway out there now, and there's the glide slope. Now I guess I can use the unity view a lot better. My air speed is really high. Doing the flight path vector on the runway and having the three degree slope there is a big, big help. It sure takes a lot more concentration without those boxes. I do have the runway up there. I see the obstacles. The terrain does give me all that. I've got the situational awareness of the river again and the airport area there and the buildings. The sense of the level of the terrain, or the height or anything doesn't really stand out too much. Of course, I could look on the MFD and that shows up real good, there as far as proximity to the terrain. Okay, my glide slope is coming in. I'm just about on the glide slope. Okay, now just put the vector down on the runway and see how that works. Here, this unity scale is nice. It's handy because I can zoom right in and put the velocity vector right there at the runway and use that for guidance and it seems like it's holding me on course, if I can just keep it over there. I'll try this view. Yeah, this 30 degree works maybe a little easier. Of course, the situation of the terrain is back there. You have to well, you can tell it's obviously above the horizon. You can tell it's sloping up but you have to look at it pretty close. The fishnet doesn't jump out at you too much in that area like it does up close. This is holding me on the glide slope and localizer. Actually this is working out. It's okay, I think. Okay, using the vector on there, I was actually just going by that and the dash line across the screen and the runway, and it seemed like it was holding my localizer and glide slope right where they need to be. That made it easier. I just don't have that en route, so en route is harder than approach. That's kind of backwards. *I think he was high for a while, but not long enough for Adequate. But, am not sure if he was really too high. Changed back to FOV30. Likes it better.* You know, I found the en route much harder than the approach because I had a place to put the flight path vector on the runway. Of course, I can't separate them here, but I guess I'd have to go with a four. I think if it were en route, I would like to say a five. And I could almost go for a three for approach, but I guess we'll use a four.

BRD BL: It's nice to have the MFD over there to see what the ground sort of looks like. Otherwise, you'd really have to work at this. I really miss that big wide horizon. I see this little small gauge. It's harder for the bank to get off because you don't notice it in your peripheral vision. I guess that's what it is. There's the glide slope coming up. There's the outer marker. I got way down too low. It's getting a lot harder to hold my heading. I'm a little below the glide

slope. I'm off course here, too. *He was out of bounds on altitude for a bit, but within the allotted time frame.* I'd like to give that a five or six. Can I get in to that area? (Not with a desired performance) I didn't think I could. I'd go with at least a five, but I'll use a four.

Rare Event:

PRFN1: You know, at one arc-second, it really is a good picture. It looks so realistic. I can actually tell the terrain features pretty well here, as far as the curvature of the land. As far as how close I was to any peaks, I didn't really jump out at me. I can tell the terrain is uneven. Okay, start a turn and descend. Down to five. I'm getting a pretty good sensation here of the terrain ahead of me as being very high. In this view, I get a good feeling that I'm very close to these hills. In fact, it looks like the hills are above me on my horizon. Am I supposed to go to 5,000? (Yes, that was the original intent of this.) Okay, because it looks like I'm going to fly into the hill. (Basically what we did was, we failed your altimeter and the same data that drives your altimeter also drives your MX20, so the only true elevation data that you were getting was from the picture on your PFD.) Well you know, that really worked well. I could tell by that, that I was going to hit that, and I could tell how to skirt around it, and how far to turn and now that MX20 didn't turn red. Actually, I guess it should have turned red there. I can see this well enough to fly around the hill. Actually in real life, I guess I'd probably get further away, but I'm just skirting the edge of it rather than trying to get way far away. So . . . It definitely works. That worked real well. I think the enhanced other one might work even better, but that worked real well.

Subject 15 (BSBG Baseline):

Block 1, High Altitude:

EBG1: It's a little different with the turbulence going. Am I on 60? (Yes) *Thinks he likes the FOV60.* All outside terrain is gone. Now I'm coming up on TURNL. Oh, I way over-flew that. No the terrain looks good. Pretty bad flying job, though. *He was very fast for a majority of turn and descent. He also overshot his target heading.* I think everything was good. I just let it get away on me. It was happening a little too fast for me and I don't think it had anything to do with the equipment.

CCFN30: Just a little shy of my turn. Air speed is still a little high. I'm on my altitude. I think it (this display concept) was actually a little simpler. It was not as busy. It was a little easier to follow. *Did better, but still fast, went below his altitude. Outside of these parameters for more than 10% of the time.* I didn't see a whole lot of terrain. I was not really concerned about the terrain. Was there fishnet on this one? (Yes) The fishnet doesn't mean a whole lot to me. I was more, I liked it. Actually without the terrain it was a little clearer and a little easier to see.

EBGFN30: I believe the terrain looks good at 60. I like the field of view of 60, and I definitely like the altitude. It doesn't bother me having to cycle through each view in order to get to where I want to go. Outside terrain is gone. Coming up on TURNL and going to make my left hand turn and start my descent. (It looks like you're at field of view of 90 right now. How do you like that field of view compared to the 60?) I like it in this version. Once I make my turn and stuff, I level off and I like to see the terrain below, but not during the turn. I really can't see the fishnet. The fishnet is really not doing me a whole lot of good. (How do you like the color variation for the elevation based generic? Is that helping you determine the different elevations or the peaks and valleys and that type of thing?) Yeah, the color variations are realistic. It's looking real, more so than anything else. (Any other comments on why you chose a two or about the terrain concept or anything like that?) No. I guess how I'm reading this is, I didn't see a whole lot of deficiencies other than possibly just in my performance. Is that how I'm reading that? (Yes, that's correct. But was the display or the actual system a part of why you feel your performance wasn't as good as you think it should be?) No, actually the display helped my performance be better.

PRFN1: I actually kind of like the one before (EBG). The photo realistic doesn't really give it as much detail as the display. I can see the fishnet, and again, I don't believe it does me a whole lot of good. My air speed was starting to climb a little bit, but I think I had it under control. I don't see it with the system other than with my ability, other than there's some things on there that I don't think I would need, but . . . The fishnet doesn't do me a whole lot of good.

PRFN3: Yeah, this terrain matches a little closer to what's outside. It's a little bit more realistic. On this one, I believe I like the 90. That's what I'm currently on? Ninety? (Yes, that is 90. Just a reminder, the one arc-second, which you flew before, is the highest resolution, where this is the 3, which is the medium resolution.) I actually like this a little better. Okay, outside terrain is disappearing. Coming up on my waypoint and TURNL and going in to a descending turn. Yeah, I don't know if 30 is much help. Maybe it's unity and 60, 90, but you can almost see I think, with possibly two, if not the three. The fishnet came in to play a little bit more. You can see it a little bit more but it still doesn't help me. (Down at the lower altitude or with that resolution?) With that resolution.

EBGFN1: I think it's a little sharper looking – the display is. (A little sharper than the photo realistic that you just flew? Is that what you're comparing it to?) Definitely. My outside reference is just about gone. Coming up on TURNL. Going to start my left turn and descent. (Now that you're closer to this terrain, do you have any additional comments?) No, it's pretty sharp resolution, though. I can do without the fishnet. I think the color variation is showing me some decent terrain variation. No comments. *Has not used the FOV knob, strictly uses the yoke. Doesn't mind the toggle being on the right hand at all.*

BSBG BL: Okay, outside view is about gone. It's pretty simple. I like this in the 30 FOV. It would be nice if you could almost kind of switch some of these around, but you're really stuck with what you have to deal with. Well, I think the display was excellent, highly desirable and I would almost put number two; pilot compensation not a factor for desired performance. But you can't really do that. (Did you find that you missed the terrain information on this, the head down?) No, not at all. I think actually it's making it a little simpler, although I know that I'm in a controlled flight, too, so the terrain is not as important to me as maybe it would be in real life.

EBGFN3: Yeah, I like the 60. I think it's realistic to what's outside. And I think again, it's got a little better resolution than photo realistic. Not resolution, but at least detail. No comments. I think I had the zoom in a little too tight and it was rotating a little too fast for me, but other than that it's back under control. (So you stayed at 30 throughout your turn and descent and you think that you might need it at 60? Is that what you're saying?) Yeah, I think I should have maybe been in the 60. *Had a little trouble with descent (stopping and starting) but was within parameters. No comments. Stayed on FOV30 through turn, and thinks he should have been at 60 instead, would have been a little easier to control.*

PR1: Well, it's pretty accurate to the outside terrain. No, no comments. Just that it's fun to fly.

PRFN30: This field of view matches pretty good with the outside and it must be 60 again. It's pretty realistic looking. The fishnet is not helping me a whole lot. (This is the 30 arc-second, which is the lowest resolution, and the one you just flew was the one arc-second, which is the highest resolution. Can you tell enough of a difference or a significant difference between these two?) I can't see a whole lot of difference, at least not at this point. Yeah, the fishnet did come in to play here. It's not as noticeable right now, but just before, it was. It still didn't really help me a whole lot. I could see that there was terrain below me. (Okay, that also looked like you

used the field of view of unity I think, throughout most of your turn. Can you make a comment on how, if that was any different than trying to control it with the 30 or the 60 field of view?) I think I should have been, I don't like it that way in unity. I should have been in 30 or 60, I think. It's a little bit more awareness of what's going on. And I think things are happening too fast in unity. The field of view was probably more important for what I did there.

CCFN1: It's pretty simple. I think it is kind of nice to have the terrain underneath you, whether it be photo realistic or the other way, whichever way that other was. The fishnet helps a little bit in this terrain concept, but I don't know if I particularly care for this one. I mean it's pretty generic and pretty plain. It doesn't seem like I would believe the terrain as much. Just because I didn't care for the display, as generic as it was.

Block 2, Low Altitude:

EBGFN1: It changes a little bit at a lower altitude. A little bit more visibility here. I can see it - in all (FOVs) I can see good. I think I still like 60, though. Outside visibility is gone. Coming up on TURNL and going to make my left descending turn. (Now that you're even closer to the terrain, how is the terrain depiction on this display concept?) Excellent. (Do you find the fishnet helping you any?) Not at all. *He let his altitude drift up at the beginning to over 6600, for more than 30 seconds. Was also fast for majority of turn.* (Just out of curiosity, if you had a higher performance rating, would you have liked to rate that one a little bit higher?) No, I didn't feel that I did that well on that run, so I don't feel I would have had a higher performance rating. But if it was up to me, yes, I think the actual display was good. It was my fault that I didn't keep it where it was supposed to be.

PR1: The terrain looks good. The 60 matches up with what I'm seeing outside. (Now that you're a little closer to the terrain, what do you think of the terrain on this display?) I think it matches the other one. It's very good. (Does the photo realistic give you the elevation cues that you need to know in relationship to the terrain?) I'd say so. Rating this just for the display properties. Well I think when you're a little closer to the ground, you've got a better terrain awareness of what's going on, and possibly was more valuable to me, being a little closer to the ground. And I'm going with the display characteristics so much more than demand on the pilot.

CCFN1: It's probably showing me the river. Outside visibility is gone. Coming up on TURNL, starting my left descent. I think without the terrain below it, it makes you focus a little bit more on your flying and better attention to what's in the blue. (Just a reminder, there is actually terrain below you, but with the way it's depicted, you don't feel it's giving you much information, is that a fair assessment?) Correct. I know that there is terrain down there, and I don't feel like I'm as close to it or am I looking at that information that way.

EBGFN3: I like 60 field of view. I think it's pretty realistic looking. (Do you feel that the display is giving you adequate terrain information? Also, can you see the fishnet, and does it provide you with beneficial information?) No, I can't see the . . . I can see the fishnet a little bit, but it's not helping me all that much. I think the color is giving me great awareness. Outside references gone. Coming up on my waypoint and TURNL. Going to start my left descending turn. The terrain looks good. The fishnet is giving me a little bit of help of what's going up and down, but I think the shadowing still does as good of a job. (Okay, any other comments?) No, I keep reading them and nothing changes. It's still the same thing.

CCFN30: Sometimes I like the simpler version of it, but it just doesn't give me the terrain. (It looks like you're flying on the field of view of 30 right now. I think last time you used 60. Is there a reason for the change from this display concept?) I'm just trying to really concentrate on

just what's on the upper, which is the blue, and see if it's a little easier to turn and descend. Losing outside reference. Coming up on TURNL. Going to make my left descending turn. Well it looks like I could possibly see the mountain coming up on the big screen but I couldn't really see it on this, at least on this field of view. (Did you find that field of view, did it help you when you made your turn?) Yeah, I think it helped me make my turn a little better, a little smoother. *Went to Unity at the very end of the flight.* (I'm just curious, why a three instead of a two?) More so maybe just because I don't like the display and I don't know if it's done that much by the pilot.

PRFN1: I think 60 matches up with what's outside. The fishnet is not doing me a whole lot of good again, but I like the color. Losing outside visibility. Coming up on TURNL. Going to make my left descending turn. I think I was paying a little bit more attention to the fishnet, just looking at what was happening in the valleys, but I don't think it was helping me at all. But the display was nice. (Why a two, and not a three or a one?) Because I like the display and I don't think it was deserving of a three, but I don't think pilot compensation was number one. I thought that was better at a two, so I think two should work.

PRFN3: I like 60 or 90. (Can you tell much of a difference, since you are flying the three arc-second this time, which is the medium resolution and the one just previous to this one was the one arc-second, which was the highest resolution, can you tell much of a difference between these two?) No, I can't tell much difference. Is this a better resolution here than the previous? (No, this is actually a little bit worse. This is a medium resolution where the previous one was the highest resolution.) Then I can't tell much of a difference. Sixty degree seems pretty realistic with what's outside. If I could take this thing down in between the hills into the valley, I could get a good picture on it. Losing outside visibility. Coming up on TURNL. Start making my turn and descent. I did see the tower to the left and it seemed a little closer in the big screen than it did on the little screen. But that's all. The terrain looks pretty good.

PRFN30: I can see the fishnet, but again, it's not doing me a whole lot of good. (Can you tell a difference between this one, this is a 30 arc-second, which is your lowest resolution?) Yeah, I can tell a little bit of a difference, not much, but a little bit. Coming up on TURNL. Starting my left turn. The fishnet is not doing a whole lot of good. I could tell the resolution wasn't as good, but I don't think it bothered me very much. Yeah, just turning a little sooner. I'm actually putting the nose right on the point instead of taking it in a little further. I think before I was waiting to cycle and to take it one step in, so I'm trying to time that out.

EBGFN30: Probably not as sharp, because of the resolution. I see the fishnet down there not doing a whole lot of good. But you can still see the terrain pretty good. It really matches with what's outside with the highlights. I don't know how much good the watermark really does, how much it helps. Outside reference is gone. Coming up on TURNL. Going to make my turn. I like it. Good color variation, but the fishnet is not doing any good. (Is the resolution adequate for you?) Yeah, the resolution is good enough.

BSBG BL: Just clean and pretty simple. (Do you miss not having the terrain information?) I don't in this situation, but probably in the real world I probably would miss having it. I believe just because of not having the situational awareness underneath; the terrain. It had more to do with the SVS display more so than the pilot side of it.

EBG1: The resolution really is good and I like it at 60 field of view. It matches pretty close to what's out there. (Now that you're a little closer to the terrain, do you have any comments on the terrain concept?) The field of view, I think I'm at 90, that really shows me right on top of that ridge really nice. (It is 90. How about the terrain portrayal itself?) I like it. I think it shows me

exactly what I need to see. (Do you miss any of the information that may have been provided by the fishnet?) None what so ever. You know how I feel about that fishnet. You could take that fishnet and heave it over the side. I'm doing it for the SVS display. I thought that was an excellent display and told me everything I needed to know, so it was more for the display.

Block 3, Approach:

CCFN1: That's the coolest thing in the world. I like it. (I noticed that you stayed on field of view 60 during the turn.) You definitely can't use unity, because unity comes too fast. Ninety maybe just isn't enough. I thought it was between 30 and 60 and it seemed to be pretty good. I wasn't really concerned about the terrain. Concentrated on the boxes. I could see the terrain, but it didn't bother me too much. And I didn't use the MX20 at all. *He flew a little high in the turn, for around 16 seconds. Did shallow the turn. Stayed at FOV60 through turn.* I'm doing it because the SVS display was really excellent and I didn't see any problems with it. Really, more so that than the pilot compensation.

EBGFN1: Yeah, the terrain is definitely easier to see on this concept, but I'm really not paying a whole lot of attention to the terrain, but again, if I was in a real airplane, I sure would want to know what was down below me. Right now, I'm just trying to fly the boxes. And I like this view. Is this 60 that I'm in? (Yes.) I still don't see a whole lot of reason for the watermark. Speed's getting a little high. Here I think I like unity better, now. Yeah, you can see the runway a little easier, and it's easier to control the boxes. *Speed was a little high for about 11 seconds, and at the beginning was a little to the left of course for about 15 seconds.* Just that it was excellent. It was easy to fly. It almost makes you not want to have to fly the normal way.

PRFN3: I really can't make the terrain out. It's not really doing me a whole lot of good. I see the fishnet down there, but it's not, I don't think it's as natural. (Just curious, do you find it hard to transition when you're changing the fields of view, like going from unity to 30, or from 90 to unity?) From 90 to unity I do, because I'm lost in the box. The box seems . . . if the plane is over it, the whole box it ends up at the left of the screen. It would be nice if it was more centered. But I'm not in the center of the view. That time the terrain was pretty nice because I could see the mountains ahead of me, so I was looking at that as I was coming down. *15 seconds at the beginning out of path vertically and laterally. He really plays with the FOV control.*

EBG1: I like this display. I think the terrain matches really good, especially in 60. A little low on my air speed. Is this unity that I'm in right now? (Yes.) *Was a little slow, and a little low for about 5 seconds before turn. But other than that did really well. Seems like at the end he was playing with the interaction between the waterline, vv, and tunnel. And, not even looking at the 3deg GS line. Just using his boxes.* I really liked the display. (Okay, just out of curiosity, in using the symbology, do you find that three degree glide slope line helpful?) No, not at all, because I'm really just keeping it in the boxes. I guess I don't understand the three degree glide slope line. I mean it doesn't, I think with keeping it in the boxes and heading for the next box and then once the runway is in sight, putting that thing right on the runway, then I'm not even looking at that.

PR1: I think it matches pretty close, but I think I like the other one previous to this better. Yeah, I think the EBG, you can really count on what, by the shades, on what the terrain really is, whereas this kind of meshes together a little bit more. Right, it's almost when you have the tunnel, why have the three degree glide slope line? It's not doing you really any good at that point. At least I'm not paying a whole lot of attention to it. I think between the runway and the box, it's giving me everything I need to know. *Flew FOV30 during the turn, and did fine.* Excellent display.

EBGFN3: A little high on my altitude. I still like it better than the photo and really I don't think the three arc-second, I can't tell a whole lot of difference with my resolution. I guess you wouldn't need the vertical line if you just keep it on the runway. I'm trying to just keep it right on the glide slope and right onto the runway. I didn't pay attention to the boxes. *Flying a little less precise this time, but still PTS 90% of the time.*

PRFN30: It's pretty bland. (Do you think that's due to the 30 arc-second resolution?) Yeah, probably. The fishnet, I don't know, I guess the fishnet doesn't do me a whole lot of good. I can't really get a good depiction of the terrain, actually. I guess maybe a little bit with the fishnet, but it's still real difficult. (You mentioned earlier that you weren't using the MX20 at all and I was just curious if that's still the case.) Now I am using it. I've got the zoom up to about three miles and I think with the zoom up a little bit, I know I wasn't allowed to play with it, but with the zoom up, you get a better feel for where you're at and I think with the two of them, it's really showing you how you are on the whole path. So today I like it. And I think, too, I can't see the glide slope come alive on the dots, and it's giving me an idea of when I'm coming up on that outer marker before the outer marker goes, in case the sound doesn't come on. I like the glide slope line now. I think it's a little bit more accurate than trying to follow the boxes. I think following the boxes is a little like looking too close, like when you're driving down the road instead of looking down the road. So the glide slope gives you a little better indication.

PRFN1: (Okay, can you tell a substantial difference between this display and the one that you just flew, which was the 30 arc-second? And here you're flying the highest resolution, which is the one arc-second.) Yeah, I can see a little bit more detail to the valleys, and I think with the fishnet now, you can see that. Without the fishnet, you probably couldn't see that. So it looks okay, but I still like the EBG. I think one nice thing about the EBG is that it would actually match the way they do turns, also, if that makes sense. Here you can't tell a whole lot of difference between the one arc-second and the three arc-second. From the one arc to the three before, it's all kind of blurry down there now. Whereas I think where the EBG would show actually what, you know, you don't really want to see the buildings, but you want to see the terrain differences, I would think. The tower stands out. Excellent because of the display characteristics.

EBGFN30: Just the color variation. I think it's not as sharp, but with the color variation, it all kind of runs ahead of you. The fishnet is not doing me any good. (Do you feel that the 30 arc-second is enough information for you for the terrain cue, or would you prefer to have it at the three or the one arc-second?) It gives me what I need. Again, I'm not paying a whole lot of attention to the terrain and I think just the highlighting would give me enough of what you need. I think if it's, I don't know, sometimes if it's too realistic you pay too much attention to it. There's that updraft over the ridge again. Like in that view right there, it's showing you the mountains and I think it's giving you exactly what you need to see. I think those mountains are showing up there enough. Just in the color variation, I don't know how well the detail would help from that point. *Last 4 minutes Unity FOV.* This is fun.

CCFN30: It's pretty bland, really. I can see a little bit of the rolling, but it's almost like you don't believe what's below you, maybe. (Do you still have a good feeling for the mountain range beyond the runway?) Not really, it's not as good. I don't think it's as nice. Really just the lack of terrain base, so I would put it fair, some mildly unpleasant deficiencies, because it doesn't have great terrain.

BSBG BL: Just pretty generic, pretty plain, but I still like the boxes. (Do you feel without the terrain display that this display is lacking?) Yeah, it's really not in the simulator, but again, if I was in real life, I sure would like to know what was below me and not just a big brown screen. (Just curious if you're finding this any harder or any easier to fly than the displays with the terrain depiction on them?) Just at the... possibly without the runway, I'm not trying to focus as much now on the runway and just trying to keep it in that lower box and keep it on the glide slope. But again, it sure would be nice to know what terrain I had below me and ahead of me. I can tell that the MX20 is giving me terrain information, but it is sometimes a little difficult to figure out. *Was too high at the end, by a good 45 seconds (at least 1 dot, even got to 2 dots on the GS. Was following GS line, and didn't understand that you have to have an aiming point.* (Do you understand that you have to have an aiming point for that glide slope line?) Yes, yes I do, and that's kind of why on a number five, moderately objectionable deficiencies, and if I would have worked a little bit harder, with pilot compensation I could have made that work.

CCFN30NT: A little bit more work. To know where I'm going, I've got to use the MX20 a little bit more to know what's happening here. Trying to follow altitude a little bit better. (Okay, do you miss the tunnels?) Oh, yeah, big time. I do have the runway in sight on the display screen. I actually found that maybe this time flying to the diamonds was not too bad, even actually without the boxes. The boxes were easy on coming up and setting up the approach, but once I got on the glide slope, getting rid of the boxes and following the diamonds actually seemed to go well. *Was a little high at the start (15 seconds). Zoomed in to the MX20 for navigational info. A little more work. Definitely misses the tunnel.* I think I had to compensate a little bit more to follow things, but I think by taking the boxes away and the terrain, it had some mild unpleasant deficiencies.

Rare Event:

PRFN1: Well, I can see the fishnet. The fishnet is kind of showing me that up and down terrain pretty much matches. I like the 60 FOV. You can see the terrain elevations but I think you've got to work a little harder to see the differences between the photo realistic versus the EBG. A little cloudy outside. Outside is going. Coming up on my waypoint. Going to start my left descending turn. It looks pretty good. It's pretty close. I can see the two towers coming up and I have them in my field of view, too. And I'm a little low on my altitude. Oh, baby! Was that my fault? I felt a little lower going over the top of that ridge, because I hadn't been that close to that ridge, and normally I was high enough that the clouds would still, they wouldn't allow that ridge to show through, but this time I can see the ridge. Cool trick! *Was a little fast on descent. 3:35 said that he was low on his altitude. At 4:05 also mentioned. Then he crashed.* Just that the display was really great and especially once you got down low there. Even though I do like the EBG better than the photo realistic, it was pretty intense when I got down low.

Subject 16 (BSBG Baseline):

Block 1, High Altitude:

BSBG BL: (I typically don't talk much on the first run just to let you get acclimated to the simulator, so you can expect more conversation from here on out.) *Stopped his descent halfway through the turn, until turn was complete, then started descent again. Changed the FOV on the baseline, at the end. Actually did very well for the first run, and it being BL to boot.* I think I chose the three because of the fact that, I mean actually I don't think the display was too bad; but, I think I was kind of rating it on my performance. The fact the airplane felt pretty unstable. I kept going like, like from the jump it started rolling to the right. (Yeah, that would be the turbulence.) Oh, okay. I thought it was going to be like light, light. It was like rolling to the right, it kept on, you know what I'm saying? I didn't know if it was the rudder or trim or what? (Yeah, I know. This is the light to moderate turbulence.)

CCFN30: The view I have on right now, I can see a river and, let's see, I guess it's in the valley and stuff. I don't see a river on the big screen. I don't see much terrain. (Now that you're a little closer to the terrain, do you have any other comments on the terrain since your liftoff? Or do you have field of view preference so far?) I guess this one. (The 90-degree field of view?) Yeah. *Didn't remember to descend during the turn, or even after. Had to be reminded, but kept his numbers when he did descend. Thinks he likes the FOV90.* I think the fact that, I mean because I didn't see too much terrain elevation and stuff, and the display basically didn't show me exactly what was, beneath me.

PR1: I like this. I can see the terrain and everything; the natural terrain down below. I think this one right here made me feel like I could see both the ground and the sky and I could also line it up on the horizon line. (Okay, and that's your field of view of 60.) This right here though, the horizon bar overlaps it a lot and so I'm pretty sure there's a lot of correction that needs to be done inside there. I can tell when I go to the next one, which is this one right here. See, I was below and I couldn't really tell that on the other one. Because then I'd have to resort to the VSI over there. And so if I have a 60 it's, it might not be, 100% accurate or whatever, but it's a lot more accurate than the other one was. I don't have to take my attention off of the horizon, and I can concentrate on my heading, air speed, and horizon, as well as turbulence conditions. Because like there's terrain right now that's under me. I can't see it because I'm at the 90. (No, that's the unity.) Because I was able to see the terrain and I knew what was around me and everything.

EBGFN1: This is good also. I have like an idea of the elevation because of 3-D graphics. I'm too high to see the fishnet. I see the fishnet now, or something. I don't know if it's the terrain or not. Bottom left-hand corner, lower left-hand corner. (Yes, that's FN. Do you feel that it is providing you with any beneficial information?) No. It's a good view. I mean, to me it looks like the other one, except it's not really depicted, like the grain and the color. It's just really a general kind of a terrain. Because like the terrain and everything looked basically the same, like a good depiction of the terrain, but the other one had the green grass and everything and the other one *this one* didn't. (So you like the, I guess, the closer depiction to reality?) Yeah. *Likes the terrain in this depiction, but likes the more realistic picture better ("green grass").*

EBGFN3: I think it looks a little punched up. I really can't, like with all the dark lines and everything, I really can't depict the different crevices. I mean I can depict the ones that are closest to me, but I mean it's not as depicted as the other ones. (Okay, so you can't tell the difference, I mean this is a three arc-second, so this is a medium, whereas the one that you just flew was the one arc-second, which is the highest resolution. So you feel that there is a substantial difference between the two?) Yeah. There's a lot better depiction of the terrain. (Okay, so now that you're a little bit closer?) Yeah. (So are you sticking with your field of view of 60 as your field of view choice for this particular scenario?) Yeah. Because the terrain, the depiction came in at the lower altitude. I guess it could be a little bit more important since you don't want to hit anything. And also still the brown clay coloration.

CCFN1: It's like the other one. (Actually the second one you flew was like this except it was the lowest resolution, whereas this is the highest resolution.) I can't tell much difference. I see like one mountain peak and besides that it's, it wouldn't be desired by me. Actually the depiction is starting to come back in. I can see more. I guess the fishnet makes a difference, I can see more now. I can see two towers and I can see better terrain with the fishnet. By comparing that to the other one, the other one would be a four -- that first one I did without the fishnet. Because that, at the high altitude, I really couldn't see anything until I descended down to 8,000. At 8,000, that's

when I started seeing depiction of the elevation and the ridges and everything. *Comparing this to CCFN30, the other one would be a 4 instead of a 3.*

PRFN3: It looks good. I can see a lot of the same like precise depictions from the screen, or outside the window to looking on the ground. I think, I know, for some reason I want to say the one without the fishnet but at the same time I haven't descended yet and before, when you've been using the fishnet at the 8,000, that's when the fishnet really kicks in. I can tell a specific difference in the layout of the terrain. (It looks like you entered your descent in the field of view of unity. How did you like that?) I did that because it gives a precise picture of your attitude instead of delay. I think the other; I think the one without the fishnet might have been better. *Used Unity at the end of the descent, to give him a more precise view of his attitude. Thinks he might like the one without FN better.* All the terrain depiction was there and I just think that the other one was a little bit easier -- I don't know. But it practically looked the same. I think maybe the other one looked a lot more, a little bit more realistic because of the fact that there wasn't the fishnet. That might be just it.

EBG1: This terrain is depicted pretty well. I can see ridges; can see a lot of ridges. Compared to outside, I don't know, it looks just a little bit more developed -- outside does -- I think maybe because of the color. That elevation's depicted a lot more at the lower altitude. (You get a little better feel for it once you're a little bit closer to it?) Yeah. Because of the depiction at the lower altitude. Also it had nice terrain. It wasn't really colored in or whatever, but it still was a clear picture of the terrain.

EBGFN30: This one, to me in my opinion, is practically the same thing. It looks like I'm about to land. This one must be the 60. (Yes.) I feel a little bit more comfortable in this. And that right there is just, in my opinion, it's just a delayed reaction of attitudes and indications. The terrain -- you can't really see too much definition in the terrain. It might just be the altitude, but you can tell those mountains are there but you can't really tell like where. It's a little bit better, not really though. I can see two towers. The other one had more definition. It looks bigger than the other one. *At beginning, Unity and FOV30 makes him look like he's about ready to land. The FOV60 makes him feel more comfortable. FOV90 gives a delayed response in terms of attitudes. Can't really see too much definition in the terrain. At the end altitude, a little better, but not really. Can see towers. EBG1, the mountains look bigger.* Because I think based on the fact that the terrain elevation wasn't too depicted, whereas it wasn't as depicted as the other one was previous.

PRFN1: This is pretty much very depicted. I can see a lot of terrain; a lot of it matches what I see on the screen or out the window, I should say. And I can see the fishnet. And again, using the unity, it looks like it makes it closer so it looks like the mountain is right in front of you. You should be pretty much aware that things are further. I think with this type of display, the fishnet really doesn't do too much more because of the fact that it's already a good display; a good depiction. It's pretty evident; it's pretty there where you can actually see, so the fishnet just adds to the artificial aspect of it. The fishnet is more visible. The terrain is not more depicted than it was before; it pretty much looks the same as it did before. (Can you see the towers down there?) No. I can see the two all the way off. If there's any towers in the mountains, then I can't see them at all, but I can see the two that are off and they're zero-six-five. In fact, I couldn't even see the towers. The depiction stayed the same at both altitudes. The fishnet really didn't add anything to it other than just the artificial aspects of it.

PRFN30: It's depicted and I can see the fishnet depicted and that's about it. I can see the fishnet's more visible. Really no terrain depiction. I do see discoloration: like dark grass, dark

green, dark, light green. Yeah, there's really no terrain. Like very minimal. I can see the fishnet. That's because I couldn't really tell the terrain. But you could see like the city areas and stuff like that, so I guess in an emergency situation that would work. But besides that really, there was no real terrain indication.

Block 2, Low Altitude:

BSBG BL: Well for terrain avoidance it does not work at all. (So you find that you do miss the terrain information that you received with the other ones?) Right. Like on this one, I mean I can basically use like the unity, because it doesn't matter, and if anything it'll just give me better, more accurate, attitude awareness. So, I'm just worried about my attitude right now, and you know what I'm saying, how I'm flying. (Just out of curiosity, are you checking with the MX20 for your terrain awareness at all since you don't have the terrain awareness on your head down.) Yeah, yeah, I just realized that's my best bet, to use that. Due to the fact that I couldn't see anything terrain-wise and I had . . . When we grade these, are we using the MX20? (Yes.) The display, the SVS didn't really help me, except for to maintain, you know, my attitude and everything and positional awareness. But for terrain-wise, it didn't help at all. The MX20 was the one that did that.

CCFN1: The terrain elevation, I can tell it's there but it's not really helping. The fishnet I think, well I haven't seen it without fishnet so I couldn't tell you if it was the fishnet that was making it do anything at all, but I can tell that there is a little bit of terrain elevation. Terrain is a little bit more visible at lower altitudes. (And for this lower altitude maneuver, are you still sticking with the field of view 60?) Yep. *He thinks that the FN is helping define terrain, but since he hasn't seen it without the FN, can't really tell. Was a little high at the beginning for almost 30 seconds.* I could see some of the terrain and stuff and it wasn't that difficult.

CCFN30: The terrain looks very flat right now; I can't tell where the terrain is. I can see the river; two rivers, and besides that I can't tell any terrain right now. I can tell the, in my lower right-hand corner, I can tell the terrain kind of comes up. Outside, that's it, I really can't tell. I can look far off to the mountains, the mountains or whatever; tell there is a difference in the terrain, but besides that, that's about it. *Will exercise the throttles at the beginning, get S&L, then say "I have the airplane". Terrain looks very flat, at the beginning of the run. Can see the rivers. Definitely a difference between this and CCFN1 - CCFN1 had terrain. Still a little high at the beginning, but not for as long as the previous run. At the end altitude, can see a teeny bit of terrain right beneath him, and can see mountain on the horizon a little. But that's about it.* I wasn't able to see terrain.

EBG1: I can see the terrain. I can see different colors and stuff. The unity view still looks like I'm about to hit the mountain. That view (FOV 30) looks like it also. I like the depiction of the terrain. I can see the crevices and everything. *About 15 seconds too fast during descent.* Because I was able to see the terrain and everything.

EBGFN30: No, I can't really see anything on here. I see the little dark crevices where the ridges and everything are, or the little valleys and the mountain peaks are, but it's not that defined. There were specifically two mountain peaks that just disappeared into the fog. From here I really couldn't tell where they were; they looked close like looking out the window, real close. But from here I really couldn't tell. It doesn't give too much more information; I can see the one peak right here where the two towers are, and I can see the fishnet. It really, really doesn't make a difference. I didn't really see the terrain that much but I could tell that they were there.

PRFN3: Alright, well it looks real and I can only tell there's a fishnet when I get close, like down below to the lower left and lower right. So, basically whenever I get close to something I can tell there's a fishnet; otherwise, I don't know there's a fishnet. I can tell the mountains and everything. This view right here, the unity view? (Yes.) It's cool right now because when I come back here, I can tell if I'm high enough, my heading, and so with that in mind, using the unity view, it'd be easier to keep everything on track. Because of the quick reaction, I'm getting a lot of deviation. *At the end altitude, likes to scroll to Unity, because he feels that it gives him a good view of the terrain, lets him know he's not going to hit anything, and his controls are more sensitive.* Because it had all the realism except the fishnet.

PR1: Oh, it looks even better than the other, it looks real. Like even realer than the other one. More definition. (Is there enough of a difference where you would determine whether or not you would buy the software if you could put it in your plane?) Yeah. Like if you were to actually fly with it, like probably look at it on the back of a box or something, then you wouldn't get it, but if you actually flew with it to actually see it like this, how I'm seeing it, then one might purchase it. Yeah, the lower altitude has a pretty good depiction of the terrain. (Okay. Are you still favoring the 60-degree field of view?) Yeah. For the accuracy and everything.

PRFN1: The terrain is pretty much like I see outside and it's, this terrain is probably pretty good, the display. (How do you, do you see the fishnet?) Yeah. (Is it giving you any beneficial information?) Not really, no, I mean I don't think so. Right now, I'm coming like descending down, and the fishnet, it really looks, it makes everything look like high-tech and everything. That's really all it really does for me. Yeah. It'll sell people and they'll think, you know, like, advanced and everything but like if I was to buy something, I'd buy the regular one. The one with no fishnet; like this but with no fishnet. Alright, I go with a five. I mean it shows most of the terrain and everything. *He was high for a good part (over 6600 ft) at the start, then after he leveled off (over 5600ft), for more than 2 min., so gave him an adequate.*

PRFN30: The terrain isn't really coming up that much. It looks flat. When I look out the window I see increases in the altitude, the elevation I mean. I really can't see differences in the elevation of the terrain. I saw the towers, though, and that's about it. (Did you happen to notice them on the out the window, also?) Yeah. *Was a little high right before the turn. And a little fast during descent, but for a total of about 12 sec.* Because I really couldn't tell the difference in the elevation of the different terrain.

EBGFN3: The elevation is noticeable. It's partial, like is not too defined, but it's noticeable. I didn't really realize it before, but the MX20, I didn't put down on the paper, but it does provide altitude. When I use it, I really just used it for waypoint and a crosscheck with heading. (Fishnet do anything for you on this display? Any enhancement?) No, not really. (What do you think about the overall view there in terms of height perception, depth perception, terrain?) It's pretty good. I can tell the difference in the terrain. Not, not as good as the other ones; as the . . . (Photo-realistic?) Yeah. I prefer the realistic. *Saw towers (goal posts), on HDD and OTW. Although he likes this display, he liked the PR better than this display.* It was a two because I could tell the elevation and everything, but it wasn't as good as the realistic photo, but it was still good.

EBGFN1: Alright, it's a lot of terrain depicted on here. I want to say because of the fact that it's not colored; it's, I mean this is only in one color, or not one color but brown, it's not as defining and so it looks kind of cluttered. That's my initial perception, that it looks kind of cluttered. Yeah. This has more definition of the ground, but it's still a little bit, I think it might be, the fact that like how the crevices are all in here and everything you can't tell. Like from back here I

really can't tell which is which. Let me zoom and see if I can . . . That's really too close for in flight, like en route. For en route this really doesn't work. And back here it does. Like when you go, when you zoom it, you're up close you can kind of look and see where everything is, but at the same time you don't know where you are, you know what I'm saying, according to that, because as you see, or you saw, when I zoomed in there, I looked really close but then when I looked out, I actually looked far away, so . . . (at target end altitude) It's more clear now to where the crevices are and everything, and the mountains are easier to find. It's just like far out, looking far, being higher up, it's difficult. Yeah, the medium (3 arc-sec resolution) looked pretty much better than this. And I prefer the medium. I mean for the low altitude, like how I am now, it's perfect. So, for low altitudes it's perfect, but for high altitudes it'd be too cluttered. I mean, but obviously when you go down lower, then it's all good because it's easily defined. *For en route, Unity and 30 doesn't really work.* Because it looks pretty good. It was really good down low and it was a little bit too cluttered up high. But then again it's like the whole thing is collision avoidance of the terrain, so if you're close to the terrain; it works really good. Up high you really, you really couldn't care where the terrain is.

Block 3, Approach:

EBGFN30: I really didn't pay too much attention to the texture. I really concentrated on the boxes. So you guys want to know about the actual texture, like if I was really paying attention to all that stuff? The boxes really just, the fact that I put all my trust in the boxes and everything, I didn't really see too much of the terrain based on what I did last time, so I'm going to give that about a three.

EBGFN3: (Do you see any difference between this one and the previous one? This one is the higher resolution, but other than that, everything else is the same.) Yeah, it's a little bit more, I can tell. I can see a little bit more landscape; like a little more terrain elevation. (Are you able to see the roads on the display?) Uh, huh. (Do you find that easy to spot or does it confuse you with the fishnet?) No, it doesn't. *Saw the tower also like last one. Tachometer and manifold pressure will be nice to have. Roads and FN do not confuse with one and other.* Because I could see it, but like again, it really didn't do too much. You know what I'm saying? Like I saw everything, and it didn't really impact my approach because of the boxes. The boxes make a huge difference.

CCFN30: I don't see any terrain elevation. I suppose the mountains are all around here, right? I just don't see any mountains at all; it's like a desert. (You do not see (mountains) at all?) No, it's just flat. I see the towers and I see a river. I think I see a lake off in the distance off to my right side. I haven't seen any roads. I probably wasn't paying attention earlier. (Do you think it was because of the fishnet or some other reason?) It's because I was concentrating on the boxes. I can see the runway from here. I see the road right here. I see the airport off in the distance. That's the airport or a city. *Don't see any terrain elevation. Could see towers, lakes, and rivers. Did not see the roads at first because concentrated on the boxes.* Because of the fact that I couldn't see from the airplane, the terrain.

PRFN30: I can see a little bit of the elevation right here. Just a little bit though, but not as steep as it looks out my window. And the mountains are off in the distance to the left, I cannot see them at all here. And that's about it. I can see the towers off in the distance: one right side. I think there are one, two, three, four, five; five on the left. Now if there's any mountainous terrain out here right now or any type of elevation, or elevated terrain whatsoever, I can't tell because everything on here looks flat. (Do you feel that, that gives you enough information that if you had to do a go-around, that you'd feel comfortable where you were in relationship to the terrain and where to go to miss the terrain?) Yeah. I also wanted to reiterate how helpful a tachometer or manifold pressure gauge would be. Because I really couldn't tell too much of the terrain.

Yeah, I was thinking three, because I could see the city. (But you want to stick with four?) Yeah. Because there was a lot, there were like big mountains that I really didn't see.

BSBG BL: You guys know there's a difference in the heading indication between the SVS and the MX20? Yesterday it was, I guess, or the day before yesterday, the MX20 was indicating off to the right. And today it's indicating off to the left. (Do you miss having the terrain displayed on your head down display or are you getting enough from your MX20?) Oh, no. I mean the MX20, I really wouldn't trust that thing. I think the only thing that compensates for the loss of the terrain depiction in the head down is the squares -- the tunnel. Yeah, if anything, I can concentrate on the tunnel more so, and not even really worry about the terrain below me. You know on the MX20, it doesn't really tell me anything like where the terrain is. It just says I'm being like surrounded by especially at low altitudes where the terrain, the MX20 can't depict between different terrain areas -- elevations. (Is that pretty much why you don't trust the MX20? The description you just . . .) Yeah, because on this one on the head down, it shows me everything. For terrain purposes, I'm going to have to give it a four, because I couldn't see the terrain at all. The fact that I couldn't see the runway at all, so I was forced to really concentrate on looking out the window as well. As soon as I break out I'm looking for what I'm going to line myself up with.

PRFN1: Much better depiction of the terrain. I can see the little crevices and everything, the mountains or hills. I take it that that number that's counting down below, above the diamond, that's the count down for localizer intercept? (It's telling you how many dots away you are from the localizer.) (How do you like the fishnet in this depiction?) Pretty nice. (Do you feel it does give you some beneficial information or can you do without it?) I can do without it. *At the beginning was a little left of course for around 15 seconds.* The depiction of the terrain came in pretty well and I was able to see a lot of things that I was pretty sure I would need to see just in case I was in a situation where I wanted to avoid the terrain.

PR1: I think it's mainly depiction of the same type of terrain as before just without the fishnet. Yeah, I like the one without the fishnet. Like the fishnet doesn't give me any confusion or anything but it's just . . . I guess I just like that real realistic look. *Gives him the same terrain awareness, but without FN. Likes the PR without the FN, better.* When I'm giving the scores, they're just based off of the terrain that I'm looking at. Because I mean like the boxes are all I need really. *Thinks it might get better than this.* I would buy this product just because of the boxes, if anything.

EBG1: Yeah, I can see a lot more terrain depiction. Yeah, it's a lot more visible. A lot more defined. Matter of fact, it looks closer. Yeah, it does; it looks a lot closer than the other one, but I really can't pick up, because I flew, I think I just flew over the city, right? I like this one for terrain purposes and how it depicts the terrain a lot more visibly. On the basis of, like I say, like the city. I guess the photo, like a snapshot or something, and the city is shown in the other one and there's no city in this one. But like some situations you'd like to know what areas are populated and unpopulated for emergency reasons, and everything is grainy. Most people automatically assume, unless they're briefed otherwise, that it's unpopulated down there and they'll just do an emergency descent down there, and then come out of the clouds and all the sudden, be right over a city. Based off the terrain. But it really did, just off the initial, it showed me the mountains and I was right in front of it. That's the best one so far. So, I definitely would be able to avoid that mountaintop and all the other ones really didn't, they showed the mountain a little bit smaller if they showed it at all. Looking out the window right now, I look pretty close to mountain and the SVS showed that I was pretty close to the mountain, as well as the other terrain behind the airport that showed . . . And that was another thing, for go-around purposes, the

terrain behind the airport was a lot closer than on the other one I saw, where I thought it was good. But basically as I have gone further and I can compare them, the terrain is a lot closer so it would probably be a little bit steeper climb or something for a go-around.

CCFN30NT: I wouldn't buy that MX20. The whole experiment, I haven't used that at all. The tunnels make a tremendous difference. They take away a lot of workload. And terrain, I can't see -- I guess that's a city off the back -- I can kind of see a mountainous terrain behind the airport but very vague. It's far off. *20 seconds too high at start. Descended before GS. Went to 2200' before GS kicked in.* Basically, it's just like the ILS that'll fly your diamonds. And you have to keep your scan going and there was no depiction of terrain.

EBGFN1: The terrain is a lot more visible. (Do you find that the fishnet is providing you beneficial information?) Not really. (So you pretty much settled on your field of view 60 for the entire approach?) Yeah. Sixty, yeah. It gives me adequate perception of the terrain around me and everything, my whole flight environment. *About 23 seconds too low after turn. About 10 sec too fast on speed during turn.* Alright, that gave me good perception of everything that was around me, so I gave that a one.

PRFN3: Pretty, pretty clear depiction of the terrain. If I am flying over a mountain right now, I don't see it on here. When I do see it, it's kind of low or not that high in elevation. I can see some terrain but it wasn't as in depth as the other one.

CCFN1: I can see like a little bit of bumpy little terrain things down there. But not really. It doesn't really tell me where anything is. I can see the roads, the river, and the tower, and stuff. (Do you feel like you get the cues with the 60-degree field of view that you need, even as you approach short final?) Yeah, I think the 60. *Momentary 30 deg bank during turn to localizer.* Because I really couldn't see the terrain that much.

Rare Event:

EBGFN3: Terrain is kind of very visible, I can see that the coloration is the opposite of what it looks outside, like the green is where the brown is, and the brown is where the green is. It shows a lot of what I'm seeing outside. It looks like I wanted to hit the mountain. (Again, pretend that this is an aircraft and fly it as you would an aircraft.) Yeah, I could tell it was . . . While I was flying in, I was like man, this looks pretty low. And then I didn't know what you wanted me to do, so that's why I said something. (Well, that's good. That's exactly what we wanted you to do -- let us know and then take maneuver.) *Was a little high for ~ 20sec at the start. ~10 sec high on speed during turn. 3:45 says looks like he's going to hit the mountain. At the cue, he maneuvered to avoid.*

Subject 17 (BSBG Baseline):

Block 1, High Altitude:

CCFN1: I missed my heading way off, didn't I? I was concentrating so much on all these numbers. It was a little overwhelming there, but I think it'll get better. *Was 9630ft for a good 45 seconds at the start. Overshot the turn - turned to 340 on her turn. Also was a little fast on the descent.* I think being the first one is a little overwhelming, so I'm not sure how fair it is to this first theme, but again, it just seemed like there were a lot of different numbers to get used to. Kind of everything is moving there at once. And the terrain didn't catch my eye much at all. There just wasn't much there, so it didn't give me many clues.

EBG1: I really like this terrain under here, this is great. (Have you played with the fields of view at all?) No, actually I haven't yet. *Still a little high at the beginning, and a little fast during*

descent, but less than 10% of the time. Because I felt like it was much easier to do, and having that terrain under there was nice.

EBGFN30: I don't like this one for the straight and level. It seems like it is so much further out than where I really am. I'm sorry, closer than what I really am. That one right there. (And that was unity, by the way.) I don't like it as much as I did the last one. But this seems more realistic to what I would see out the window, if it wasn't IFR. (Okay, this is your 30 FOV.) This terrain is not bad right here. I feel like the last was better, but it's a heck of a lot better than the blue and brown. The one arc-second, the previous one just seemed to be so much more detailed. Again, this is much better than the blue and brown, but I still like that last one better. (Okay, and can you see the fishnet at all?) I could earlier. I think it was when I was making my turn I could see it. But right now I can't really see much. That vertical speed indicator, that's giving me a hard time. It seems like there is just so much clustered in there. I think with more experience on it, you get used to it, but I'm having a heck of a time holding that. *During descent in the turn, speed got above 110 more than 10 percent of the time.* Again, the detail wasn't as good on this one, and you know, it was nice, but it wasn't as good as the previous one, and again, I'm still having a little trouble with that vertical speed indicator, although that's been the same through all of them. I'm finding it's a little distracting like when I'm flipping through the field of views. You know, it goes from such a great variation between them. (Is it hard to transition from one to the other?) Yes, especially when I'm up here at least, maybe it will be different on approach. But when I'm flying up here, it seems like when I go to that unity, I felt like I was going backwards, because I was seeing ground and now all at once I see almost just all sky. It's almost like you flip back. I don't know if I'm explaining that very well, but the nice thing is that it's real easy here on the yoke to switch it real quick. I don't think I'd ever use that knob on the left, but it's real quick and easy to flip through them. It just takes a couple of seconds to get reoriented between the screens.

EBGFN3: I noticed on these ones, like on this mode right here, it almost seems like my little velocity indicator is even touching the ground. That's a little deceiving. Like especially right there. It looks like I've already flown into the mountain. I never really noticed it on the other ones. I don't know if I just didn't catch it or it's different on this one. It almost looks like it's almost just right on the ground. I think it's supposed to be that way, but a couple of times, like when I was turning and stuff, it looked like it was just going right through some of the mountains there, touching the tops of them. This one also just doesn't seem quite as realistic. I don't like all the little groves in the mountains. I know that there was one before this that we've done that the mountains looked a lot more realistic. Again, this is better than the blue and brown. Yes. I'm trying to do these field of views and kind of play around with these as I'm doing these flights. I'm trying to experiment and see which ones I like, but it does distract me more. Should I concentrate, should I just do one field of view that I like and stick with it so I can keep my heading in the altitude better or are you wanting me to try and play around with just to see as many of them as I can. (Please cycle through when you can.) I think I already kind of commented on what I thought about the flight. Yes, again, it's better than the blue and brown, but it's not my favorite yet.

EBGFN1: I think it looks real accurate. I feel like the height of the mountains they showed me on the sectional was like 4,400 or so and we're dropping down to 8,000 and it looks very realistic to me. And also trailing off, you know where they're starting to level off and go out of the mountains, you can tell that. Like right here you can tell the mountains are smaller than what they were as you came across. That's what it looks like to me. Again, the terrain just looked so much more realistic. And you could even tell where the mountains are higher and some parts are lower than the other.

PR1: Now this one I like even better than all of them. This one I can see every little dirt patch down there on my screen. It's also a nice tour. I think there was a house or a building or something down there. That's nice for situational awareness, or where I'm at. This field of view (60), this is nice on this one. I can actually almost see like what's right underneath me or behind me. This is a great screen. This was nice. Looking out the window and seeing nothing and then looking down here and seeing everything that's down there is great. Especially if it was an area you know, I mean it would feel so much more helpful, knowing exactly where you were at up there. *FOV 60 is the best setting.* Because you could tell things so easy on here. Yeah, I liked that best of all. I thought I liked the other one good, but that one, just because for situational awareness it was just great. I mean I could get little red buildings down there and I also, that field of view was great, being able to see what you just passed. I've been out flying before and passed something and I think, now what was that?

PRFN3: I don't like these criss-crosses in this fishnet much. They're distracting. (Now what about the resolution?) It looks about like the last one. Maybe it's just me, but it doesn't seem like it's quite as much detail, but maybe it's just me. I'm sure they're very close, if not probably identical. I just missed my heading yapping. But the criss-crosses, I almost want to look at them like they're roads or something. (This one actually has a slightly lower resolution than the previous one.) So it wouldn't be as much detail then, would it? It's not just my imagination. Well, it's still quite an improvement over what we've got, at least the planes I fly. I like the detail more on the one but this is more realistic, though. (You mean the EBG for detail? The blue or the elevation based generic shows more detail?) Yes. The one that was real sharp I think was more detailed than this one, with the mountain peaks. My favorite so far is the last one we just flew.

PRFN30: It's kind of blurry, not near as detailed and I still don't like the fishnet on it. (Okay, your performance was marginally desirable because you almost went past the criteria. Basically it was on the speed. If you can try to maintain a speed a little bit more constant, then it will be better.) Just that I don't feel like I can, the detail there is not real good, I mean for the height of the mountains and again, that fishnet thing for me is distracting. It takes a little more effort to really see where you're at and what you're flying over.

BSBG BL: This is real boring to fly. Any of the ones that had any terrain, I don't feel like I have near the control of the plane (on this one). There is no reference there like terrain, it is hard to hold a steady rate of descent. Yeah, just with all the numbers clustered in there I'm having a little hard time maintaining what I want to maintain. I understand it, I'm just not doing very well. It's amazing how when you go back to this blue and brown the self-confidence drops dramatically, at least it did for me, not knowing exactly what was under you. It's pretty impressive, actually.

CCFN30: When we first started on this one, it looked like there was a river running north and south of my flight path, and I was looking out and it looked like there was a river, but it looked like it was running east to west. I don't know if there was really one there and I just couldn't see it on the outside view, or what it was, but it was pretty deceptive. I mean it was in plain site, it looked like, on the monitor, but I couldn't find anything out there on the ground. And then again, that one had the fishnet, didn't it? I didn't even really notice it until towards the end, after I had leveled out again. On my monitor it was running north and south of my flight path. But when I looked outside I didn't see any river running north and south. It looked like there was one cut in, going east and west, but I didn't see anything running north and south. That would have been really, it should have been there. Yeah, it showed up so clear on my monitor that I would have been really confused up in the air wondering what that river was? (First of all, what you saw on

the display is faithful regarding the river.) It may have been there, but I sure couldn't find it. (Am I correct to say that you found the fishnet a little bit confusing or the fishnet was confused with the river or other landmarks?) Not with the river. I mean the river was confusing because it wasn't showing up, because they weren't correlating. But the fishnet I haven't liked on any of them so far just because I think they're distracting. Especially on the ones with the terrain, the ones with the fishnet, when I first glance at it, it almost looks like they're roads and it distracts me. (Okay, so I guess you're saying that the fishnet is a little bit better on this one compared to the others?) Well at least it doesn't have that terrain distraction where I mean obviously I know there is no terrain down there so there is not going to be any roads, so yes, it's not as distracting on this one. I don't find it of any benefit. I don't know if you want this input or not, but this navigational with the waypoints are nice. I have a hand held GPS but having it up there on the panel is awful nice. For the same reason basically as the last one is that there is just nothing, no terrain there so you really have to keep your attention as to where you're at and your altitude even more so.

PRFN1: Just the same old thing, the fishnet just seems to distract me. But I like being able to flip back on that field of view. It is easier once I've weighed top level and straightened and all that stuff and it's nice being able to flip between, and of course the terrain is great, it's just the confidence to still see what is underneath you is amazing. (Okay. I also want to find out if you have a preference on the field of view.) Most of the time it seemed like I liked the one where you could see the most, where I could even see behind me. The highest. (Okay, that's the 90.) But I also used the one right below that, too, and that's probably the 60. I'm kind of torn between the two of them. It almost kind of depends on where I'm at in flying. It seems like with the terrain and stuff, some places I liked 60 and some I liked the 90. I'm kind of torn between the two of them.

Block 2, Low Altitude:

PR1: It's very realistic. I mean I can see every little valley down through there. I can actually see what looks almost like an electric line cut through the woods there. (Okay, do you feel that this display is giving you a good depiction of the terrain?) Yes, this is great. Like I said, you can almost see shadows in the valleys. It's pretty detailed. It's also nice seeing when you're going to be out past the mountains, too. You can see the brown flatter area ahead of you. *Speed was a little high for more than 10 % of the time.* Again, the terrain was just great, what you can see there. It's amazing what you can see on there. You can see how close you are getting to the trees there on the mountain, it's pretty detailed.

PRFN3: I can't really see much difference right now. It looks pretty close to the one I just flew. I really can't see much difference between the two of them. I don't like that fishnet stuff. Just a note before I forget, for people who are short like me, not that the rudders matter much in this it seems like, but I'm barely touching the rudders. I don't know if that's something you might want to think about in the future. I have the same problems with the planes too, that I run, is reaching the pedals. Now that I'm closer down here, I can tell a difference at this height between this one and the last one. Things are kind of more colored in rather than more realistic like trees and leaves and that kind of thing. It's not real blurry but you can tell a difference at this height. Now up higher, I really couldn't tell much difference. (Do you feel that you've lost enough resolution that you would not feel comfortable with this terrain depiction on a display in your aircraft?) I guess that depends on what you compare it to. When you compare it to what I got now, no this is still beautiful. But I think you can still certainly tell where the terrain is and where your mountains are and where the town is at, but it's not quite as fine, but it's certainly an improvement over what I normally fly with. *Was a little fast on this one, too, for about 45 seconds or so.* I think I covered pretty much my thoughts about, up higher it looked about the

same but down lower you could tell a little bit of a difference, and again, the fishnet thing, I don't like the fishnet thing.

EBGFN1: It definitely gives you enough detail about the terrain. It's not as nice as the other one and it seems almost backwards with the mountains being brown and the valleys being green, whereas the other ones were the mountains were more green and the valleys brown. It makes you feel pretty comfortable seeing all of it right there on your screen. I like this field of view right here for this display. (That's your 90 FOV.) It's interesting. Some of them I like the 90 and some of them I like the 60. I think (I like) the 90 a little bit more but it just kind of depends. This display is nice with the mountains. They're sharper than the other ones. I like the other one I think better overall, but this is nice having all the little crevices. Yeah, you could see the ridge line and exactly where they're all at. (Is the fishnet providing you beneficial information on this one?) No, I'm just kind of blocking it out. *Was a little high at the beginning, but not for more than 10% of the time.* When I got down lower I did like the way you could tell how sharp them mountains came up. It seemed like a little more detail on the height of them and how close you were to them.

CCFN30: I'm seeing the river now, a little more of how it's running on this display. I'm actually closer to it than what it appears on the display so that's a little bit deceiving. It looks like it's closer than what my monitor here shows. At least that's what I would think. Looking at my monitor I would think I still had a ways to go to get to it (at FOV60), but it looks like it's not too far right out my window. I just switched it. That's a little better. When I was still descending but flying straight and level I could see that fishnet pattern. Its right in the front part of the display but then it would disappear further out in the display and it was actually fairly distracting. The other thing I noticed and I thought this happened on the last time I flew before lunch time, and actually it happened again this time, after doing these turns with the terrain and then going over this, as I'm turning I almost get that middle ear turning thing. I'm not actually flying but it just kind of throws you off a little bit. I don't know if it's because I don't have anything to look at, and now I'm back level again, you know like you have the mountain ridge or the trees or whatever versus, it feels like you've got to really concentrate to keep from getting dizzy, basically. Yeah, this one right here and then before lunch it was also on the blue and brown. I didn't say anything because I thought it definitely is a little hard to keep that dizziness under control after being up with the terrain where you have something to line up with and the trees and all. I was just thinking coming in IFR just 1,000 feet above for me is a little scary. When you don't have that picture of the mountain right there, all you've got is your blue and brown. Just because it took me a lot of concentration even like to keep on track. Did I make sense when I was talking about that fishnet when I was descending? When you're flying level it seems like you see the fishnet across the whole part of it, but when I was descending you could only see half of it. I thought that was distracting. Of course you guys all know that I don't like the fishnet, right? (Yes.)

EBG1: It's not as realistic looking out there as it is, but I still like the way you can see the peaks. They're pretty sharp peaks that you can kind of tell. Again, it's almost looking like two different pictures between the two of them, but the terrain is still nice. I think it looks so different because looking out the window its green mountains, brown valley is vice versa on here. The pattern is still laid out the same. Like this section right here is really nice, the way it's got the mountains and how close together they lay. You think if you lost your engine maybe you'd at least have a chance, huh? You'd end up going right into a mountain but if you could see like this, there might actually be a little valley that you could get in to. At least get low enough you might even get through the valley if you could see that you weren't going to smash into the side of the mountain.

Was a little high at the beginning. Again, I think I was kind of chatting while I was flying there, why I like it.

CCFN1: It just dawned on me, what this reminds me of, this display here. It's spider man. You know, doesn't he have a blue and tan outfit with all the little lines on it? Yeah, look at all the little lines. I think he has that all over his costume or something. Something I realized on that one that I seem to be having trouble with is that 20 degree bank, there are so many other, all them little hatches and it's not really marked, at least not the way I'm looking at it, and that seems to be throwing me a little bit. On all of them. Yeah, the roll scale. I mean it's the second big hatch over, but there's nothing there to keep, by the time I look at everything else and come back it takes me a few seconds to figure out, okay, one, two, how many hatches over I need to be, so a comment there. (Do you think it would be beneficial to maybe have that second hatch a different color than the standard rate turn or something?) Yeah, yeah, that'd be great. Bolder or a different color or something. Something to mark it a little bit. I like the 60 on this one just because it's so poorly relates to what is really out there, I need to be as close as I can yet see enough, but I like this one. It's probably the most accurate for me, anyhow. (Now that you're a little closer to this terrain, do you have any additional comments?) It's still kind of nauseating. Just that weavy, all them criss-cross lines. You know how the speed indicator on the left, it has like half a three and half a two showing? You know how I've been saying how things are kind of crunched up on the right with the altitude, that's kind of the same thing, now that I've spent more time with it, is there's just, like right now for example, you've got to numbers to glance over at, it just kind of takes a second. You know how you have the 054 degrees heading, that little digital display there. That's nice, I like that. Instead of rolling like that. I like that flash. I really like that heading indicator, that's great. You don't have all the other numbers up there rolling around and just in an instant glance, you see exactly where you're at. *Speed was too fast for too long (over 40 seconds) on descent.* There's just no reference at all there. I'd rather have just the plain blue and brown than to have all them squiggly lines going. (Do you remember, was it when the constant color fishnet 30 run, has it been too many runs in between these two runs, the constant color fishnet one, and the constant color fishnet 30, to make a comparison between those two?) I didn't notice that fading out. Is that the other one that I did that faded when I got to 30? (Yeah.) At least it stayed consistent. And they also seemed to have, the previous one kind of went up or down, but at least on this one I could see some little hooves in it. And it didn't disappear. There were a lot more curves to it, which I'm not sure if that's good or bad.

PRFN1: It still amazes me every time you guys put it up. Now why are the lines not near as pronounced here? Is that normal? They were real distinct on back, but now they look real light and faded. Is that okay? (Yes, I think it's just an artifact of the terrain falling away from you or coming toward you.) Again, just how distracting the lines are. Especially when they were real bright and bold. I mean it was even worse. Like right now it's not, at least they're faded right now. But on back they were real bright and it really took away from which peaks were higher than the other ones. I find them distracting. Number one, they look like roads to me, when you're looking at them. And two, at least on this scene that we just did here, was I noticed at this lower altitude that I can't seem to tell, but normally without them you can see, okay this peak is a little higher than that one and you know, the lines going in all different directions it just kind of seems to level them out, where you can't really tell which ones are higher than the others. (That actually takes away from your elevation awareness?) Yes. The detail is great, but the fishnet takes away from it.

BSBG BL: Watching this MX20 it's pretty scary seeing all those terrains starting to come up close to you and there's nothing here to correlate with it. (Have you been looking at the MX20 when you were flying with your other displays?) I glanced over but I've never noticed it, I hadn't

really noticed that terrain sign come up or the green come up until just now. Maybe it's because I had everything I really needed here with the other ones, but it sure caught my eye this time. I'd still take this one over the fishnet. Even though it has a little bit of terrain because for my perception and eyes, it just throws me off more than anything. I thought it took a considerable amount of pilot compensation to keep everything together.

PRFN30: Just that you really don't notice that fishnet up at this altitude. A little bit, but it's not too distracting. Yeah, there's just not much detail. Especially when I come around in my turn and coming down I noticed that from up high it looks like the detail is not bad at all, but then when you get down lower it's just more like a green blob. It's just really not anything close to the other ones with the mountains were brown and pointed up. It's even kind of, looking further out, even a little blurry. Just another thought on this one is that you couldn't tell which peaks were higher than the other, they just all kind of flooded in together. It did give you some terrain detail elevation, but it was real hard, I mean you couldn't have told which peak was higher than the other one. *Was a little fast on this one for over 40 sec.* Again, because it just seems like you have to really pay attention between the blurring of the terrain and all them lines. They're very distracting.

EBGFN30: Probably nothing really new, just that it's nice seeing the ridges in the mountains. They're pretty distinct. It's not a blur like the previous one. At least not at this elevation, this height. It may be my imagination but it almost seems like on this screen here with the darker mountains, I seem to like the further back view. That may not be right, but it just kind of seems like it. Yeah, it seems like on the photo one I like that 60, I think is what it is. On this one I seem... (You like the 90?) Yeah, that (FOV60) to me seems like it's a little blurred, but that (FOV90) just, I don't know, it's not really blurred but it just seems like I get a better feel of where I'm at. You can really get a feel for how close you are to the mountains on this display here. (So you feel that the resolution of 30, which is the lowest resolution, does give you enough information?) Yeah, it does, compared at least to the green kind of blobbed together, I mean right now I know that I just passed an area I was closer to, but it looks like the terrain has dropped down some so I do have a little more room between me and the mountain there. I noticed the MX20 on this one where it starts showing the green, and they work together nicely when you have the terrain actually there, too, and you can see how much further you've got to go before you get out of that high terrain. They just complement each other pretty nicely. Whereas back with the blue and brown, you really didn't have any idea. You couldn't really guess how much further it was going to be before you got out of the mountains it seemed like. *She was high and at the start for a while, and fast on her descent, for more than 30 seconds.*

EBGFN3: At this altitude I really don't see a whole lot of difference between this one and the last one. I've still got that fishnet that is distracting me. Now there I can actually see it almost looks like a river or a road down in that valley. I can actually pick out that detail and I didn't really, I didn't notice it on the last one. All I saw was the green, so that's kind of neat. Is that the river? Okay, I couldn't tell if it was river or road. The terrain looked pretty nice in that turn. It was pretty sharp looking. And again, it is here also. The detail is nicer. (Can you tell a difference now between this display and the previous one which was the 30 arc-second?) Yeah, I can. I can even see the shadows of the ridges. Up higher I really couldn't see much difference, but down lower you can see it a little bit nicer. Again, I would have done a one if it wasn't for that fishnet.

Block 3, Approach:

PRFN30: So far I like it, actually. The turns throw me a little bit. I seem to be trying to, I go too fast in the turns or something, and I have to always go back. Or at least both times I seem to

have, but maybe I'll get better as I do this more. But so far it's pretty easy to fly. (Have you had time at all to look at the terrain or are you concentrating on the symbology?) A little bit, it's more on the symbology than anything. I like this field of view for right here. I can see the runway great. (That's your unity field.) Yeah, that's pretty cool, because like right now I can see it on the outside of the window but coming down like that and knowing that it's right there gives you a lot of confidence. *Was to the left of path at the start for about 10 seconds, then was out of turn for about 20 seconds (out of bounds for both dogbone and diamond).* I liked it real well. I tried to look at the terrain a little bit and it was just kind of all gray, more than anything it seemed like to me, or grayish white. So I didn't really get a good feel of what was around me in the sense of mountains or valleys or anything like that but maybe that was because I was concentrating so much. Bit it did kind of look just all blurred together.

CCFN1: I still hate that spider man pattern, but . . . That does make it easier for the turns, in this field of view here. I wish the dog bone and the diamond was like in different color. It would make it a lot easier to identify it quicker. The MX20 is really nice on these approaches so that you can just double check yourself and make sure you're on the flight path. *15 seconds out of parameters on the turn, again. Switched to FOV90, and gave her more info to help negotiate turn, better. 25 seconds too low on short final.* Again, you don't have any terrain around you at all to tell you where you are. But I don't know, just with the tunnel and no terrain there at all, to me it was a little bit harder to do, I thought. (Did you experience the vertigo thing that you had on the last one?) Now that you mention it I didn't. I don't know whether I had the tunnel there, I'm guessing, to concentrate on something that was more steady instead of just the turning back and forth. But I didn't at all, but yesterday I did.

CCFN30: I didn't like that one at all. I think with the blue and the brown and then you've got that green thrown in there coming at you, it just makes it that much harder. (Can you tell a difference between the resolution from this one and the one that you flew previously to this one.) I think this one was actually sharper but to be honest with you, I'm not sure. It just kind of all goes together. Horrible! Just everything was kind of running together and my speed was up and I was off my path, and first I was low, then high. Yeah, I was kind of all over the place. The first part of the approach is, you know I like the further back, the more it boxes, but then you get closer you want to switch over and it takes me a few seconds to get reoriented when I'm flipping through there. First it takes me a few seconds to figure out which one do I really want? Do I want the unity or do I want the next one up. And then once I decide which one I'm going to go with, then it takes me a few minutes more to get reoriented into where I'm at. It (changing FOVs) just throws you off so much there. Even though when I get over where I need to be, everything seems to fall into place, but perception-wise, it just makes like you're way out when just a second ago you were right on. *Was about 10 seconds to fast and too high at around 2000msl. Was a good 35 seconds too low on short final, again.* Just because I didn't feel like, I thought I was out of where I should have been too much and too long several times.

EBG1: I really like this field of view for the turn. (Just as a reminder, that is your 90 degree field of view.) The terrain is nice, too, at least compared to what I've just had. I can tell that I'm still fairly high up above it. This part here is a little confusing when you have so many tunnels coming at you, although I don't like any other ones either, just for this section here. I've noticed it on the other runs, where there is just like a bunch of them. I think it's just so many of them. This terrain is nice here, I see I've got mountains beyond the airport. That's pretty nice. It also shows me there's a higher one to my left, so if I had to do a go around, it's pretty helpful. (You did mention that you could see the mountain range beyond the airport on this one?) Yeah, that's helpful. (Is that the first time that you've noticed that?) Yeah, I didn't notice that on any of the

other ones. It looks like we got some nice fairly flat area around the runway and I like that real well. I think it's real easy to fly.

EBGFN30: This is real confusing with these little squares coming at you and all the little squares down on the ground. (Another distraction with the fishnet?) Yeah, it's pretty distracting. At this altitude right now, it's pretty fakey looking. It's just kind of a big green, it almost looks like a cartoon drawing type of thing. You just really can't see any detail other than all those little fishnet lines. I can see some of the brown on up ahead. That's a little helpful knowing that there are some mountains up there. It doesn't seem to be near as detailed. I mean I can see, obviously there are some mountains and it's a little higher on the left and they look more smooth, not quite that jagged up peak that I saw earlier. The detail don't seem quite as good as it was on the earlier one. Oh, yeah, I mean at least I know there's mountains up there and that it is a little bit lower on the center right than it is on the left. So it does show me that. Although I don't like the detail quite as much as I did on the other one, at least it gives me the feel that there are no mountains right near the runway but there are some ahead of me, and I can tell the elevation that it is higher at one point than the other. Again, it's not quite the detail, but it certainly helps a lot.

EBGFN3: I've noticed that when that little dog bone goes up high, it triggers me to check over at my altimeter and it's kind of a nice way they work together. Sometimes you get concentrating on your route so much you forget about that altitude a little bit. So having it all right there together is pretty nice. I like how there is just this one square coming at you on the very short final. It makes it a lot easier. You know I didn't notice the towers on my left when I passed them. I seen them outside but I didn't see them on my screen. They may have been there and I missed it, but on some of the other screens I noticed that they were very easy to see. In fact, that's what triggered me to look outside, was to see if they were there, and I didn't see it on that one. Again, the detail is not as good and the fishnet I still think is distracting. But other than that it does give you some information about the terrain so that's real helpful.

PRFN1: I like this color scheme better with the mountain terrain and the valleys in brown. It looks more like what you actually see outside. And the peaks are definitely nice and sharp looking, like when you look outside, too. The only reason I don't give it a one is because of that fishnet. I still think it takes away from it. Everything else looked good. Again, the peaks I could tell which ones were higher than the others, how far apart they were spaced, with good terrain awareness.

CCFN30NT: I miss my tunnel already. Okay, that was hard. *Was too high (above 2700') for at least 35 seconds. Overshot localizer - was off path for too long. Flew high, for most of the flight.* I didn't feel like I had much control over it. I mean I was chasing the needle and the altitude just kind of going back and forth, it makes you really appreciate having that little tunnel. It's such an instant way of seeing whether you're high, low, or where you're at. It was a lot easier going on approaches with the tunnels, actually. I'm giving this one a seven, because I thought the lack of control throughout the whole approach wasn't comfortable. There was no terrain awareness. In fact, if I hadn't had the MX20, I probably would have blown the whole approach because at least I could glance over there and see am I getting back on the flight path or am I still way off. So that was a big help on this one.

EBGFN1: Again, it's just kind of reversed with the brown on the top and the green on the bottom, versus what I see outside and it's not a very realistic right now. We've got the fishnet there. I think I'm starting to get the hang of this turn. I think what I was doing was trying to, the second box back, trying to line up into it. That's why I was making my turn too short. But it's starting to come along a little bit better. I do think that having that dog bone and diamond a

different color or something would be a tremendous help, especially if you're on a long flight or doing several different approaches. It would be less tense looking at it all the time. The altitude is so much easier to hold on those. The mountains are pictured good on this. You can see which ones are higher and lower and all that in more detail. Again, the only reason I'm holding off from one is the fishnet.

PRFN3: It's okay, it's not my favorite. You know, they've got all the criss-crosses and the terrain is not real detailed, at least not at this altitude. (You've kind of settled on a strategy for that field of view, haven't you?) Yeah, I've found where I'm most comfortable at. I still have a little difficulty with the transition between this one (FOV90) and when I try to flip up to the unity or 30. It still takes me a little bit to get reoriented. It's almost like from where I am comfortable with the one field of view, and then when I go, when it starts getting where it's confusing and I go to switch, it's like there's a short few little seconds there where I need it really on that little part of the flight, and then it's just a matter of hanging in there just for a couple of seconds and then this one is coming in and doing nice. I really like this part of the flight with this field of view. It's nice. (That's your 30 degree field of view.) When I'm on, I think it's the 90, when I'm coming through the tunnel, that seems to work really nice. And then once I get back out straight and level and starting to go down a little bit it seems like they get all clustered. That's when I flip over to, when I flip over to the unity or 30, I think usually I've been going to the 30, it's just not, it seems like it's a little confusing until I get a little further down and then it starts coming in real nice. There's like this little window between the two resolutions, the 30 and the 90, where I'm not finding something that I'm real comfortable with or is real easy to use. It just takes a little bit. The fishnet thing, and it did have a fishnet thing, didn't it? Now they're all running together.

BSBG BL: The tunnel helped on this one compared to the one like this without the tunnel. But I really miss having that runway there. It sure helps you know how much further ahead you were and it helped you line up, I thought. I never realized until this one how much I use that runway as a reference point. I knew I was always looking at it but not having it there then, it seems like my eyes had to go up and back outside a lot more, trying to find it, to make sure I was on the right path. One other thing is that especially during the first part of the flight in the turn, I did experience a little bit of vertigo again. I don't know whether it was with the squares or what. I didn't earlier today but I did on that one. (So this is the first time today you had it?) Yes, yes. *About 10 seconds left of path at beginning, and about 5 seconds right of path in turn. 18 seconds high on final.* But I'd give it lower if I could, just because I miss all that other stuff, the terrain and the runway.

PR1: This is the one I want you guys to package up for me so I can take home for a souvenir. I'll plug it into my little plane that I fly back home. I've said it a hundred times, but I really like this terrain. It just matches perfect to the outside. That was a better transition. I tried waiting a little bit longer before flipping over and it didn't seem quite as distracting.

Rare Event:

PRFN3: Well it looks just like outside. Other than the distracting fishnet it looks nice. I'm supposed to go down to 5,000? I was about to say, man, no way I'm going down to 5,000. There's no way, those mountains are right there! (Good job!) *Very shallow descent rate. Noticed early on. Never descended all the way, actually stopped descent at 5300', and made course correction to avoid towers (at around 4:15). 4:19, said something to the effect of "are you sure you want me to descend to 5000'?"* Again, it would have got a one without that fishnet, but coming across them towers, I mean it was great to see it right there on your display and see where they were and how high they were and it's a nice display there.

Subject 18 (BRD Baseline):

Block 1, High Altitude:

PRFN1: I was kind of quiet myself. It was pretty turbulent, I noticed that, and I had to concentrate a lot. A lot of numbers. (Okay, were you flying the symbology too much where you didn't notice the terrain below you? Can you make a couple comments on the terrain portrayal itself?) I was actually fairly high. But I didn't feel the need to really concentrate on it that much, except for when I did turn, I did notice where the ridges were at. I could tell where the ridgeline was. *Very shallow turn and shallow descent. Otherwise, on his numbers. Didn't use FOV.* I chose the good, negligible deficiencies; pilot compensation not a factor for the desired performance. The reason why I chose that was the display gave me quite a bit of information and it was just a matter of looking . . . I was having to fight turbulence the majority of the time, and there was a lot of information to look at. And once I found the information I was looking for, I was able to compensate.

BRD BL: Tried and true, I guess. I'm used to seeing this one. I'm just passed the turn. Twenty degrees bank, five, go back to 1,700, 65, 55, 50. A lot of turbulence here. A thousand-two hundred. One thousand feet. Five-zero. A hundred knots, 8,000 feet, 0-5-0. I'm having to look around quite a bit at all the different gauges. There was a lot of eye movement between the location of the air speed and the vertical speed indicator being on opposite sides of the panel. Having to move eyes around a lot. I was having to compensate quite a bit and I was having to look from gauge to gauge to find out what my air speed was. And then my heading with the turbulence was batting me around quite a bit, so I had to constantly check my air speed with my heading and my bank angle. And I had to move my eyes around quite a bit around the cockpit there. Increased my load there; had to concentrate more on it.

EBGFN30: I think it's a pretty good representation of the ground, where everything's at. I can see the valley between the mountains. If I had to make an emergency landing without power I could probably pick a fairly decent location in the valley and be lined up pretty well with it. Good heading indicator. I'm watching the descent for the turn. Five hundred, 1,000. Throttle's back. Down the ridge. The display really helps to point out where the high points are in the terrain. Grid lines aren't as obvious with the color that the terrain is right there. It's almost the same color. Unity. I can see the airport. When I back up to 90 degrees I can see what's directly below me. I can tell that I'm coming up almost right above this ridgeline here. Once again, I can make a determination if I lose an engine or lose the engine, I can see that I'd probably fare to the left instead of to the right because of the terrain. *Was a little low at the start for about 10 seconds.* Only because I had a lot of information that was right there in front of me and all I had to do was move my eyes slightly to it, but I had a hard time at first, finding the rate of descent and reading it. And I got distracted with one of the other numbers and lost my heading instead of paying more attention to the rate of descent. And I think it's just a matter of learning it, and concentrating a little bit more on that.

CCFN30: On this one I can tell where the river's at, whereas before I couldn't quite tell compared to the view outside, it's a lot different. I can point out the river, where I can't on the screen on the outside. I can change the field of view, as well and it gives somewhat of a representation. It's very difficult to tell; it looks almost like it's flat outside. (Looks like you changed your field of view back to 60. Do you like this better than 90?) Yes, I do. It's not so much. I'm able to keep my numbers a little bit better and it's not as cluttered. I'm at TURNL. Left descending turn, 30 degrees of bank, 500 foot descent, 1,000 foot, heading is 0-7-0, 0-5-0, descending to 800 feet. Yeah, it's a lot more difficult to pick out the ridgeline here. I can tell the towers were there and I know a section of the towers are right along the ridgeline, but it looks almost like a desert only with minor peaks and high areas on the other side of the runway. Yes,

the terrain display wasn't very good but situational awareness as to where the location of where you are, like say in reference to towers or airports, obviously marks like rivers but not as far as terrain. *Changed the FOV to 90. Looks like it's flat outside. Then changed back to 60. Able to keep his numbers a little better with the 60 - not as cluttered.* I selected good, negligible deficiencies. I didn't have to compensate too much to fly the pattern, but I didn't have a lot of situational awareness as to how close I was to the terrain, other than the altitude that I was flying in.

PRFN30: It's pretty good. It gives you exact replication of what's on the outside and the field of view (90) so you can get a better look at what's below the nose, the area I'm coming up on. And the fishnet doesn't really seem to give you an improved look on things. But the shadows that are inside of the display kind of give you an idea where the hills and the valleys are. That fishnet looks like it helps a little better here along this ridgeline here. (How do you like that unity field of view?) At first I thought it was really sensitive, since you only see the 10 degrees above, like maybe six or seven degrees below; but it doesn't. I might be able to hold the numbers a little bit better with this view here. The MX20 display, it gives me a reference that I am above, well above, the terrain. I felt like I had all the information that I needed to perform the turn, and if I needed the terrain awareness or if I needed to use the terrain map on the bottom, that I had enough information there to make a good decision.

PRFN3: Yeah, I'm able to determine an elevation, the peaks on the display is a little bit better with this version. Ninety degree turn to the right, or to the left. Twenty degrees bank. Got the turn there by a few degrees. Satellite map gives me a pretty good indication of where the, a representation of where the trees are located at. You know having a flight area is one thing, but having to land in a forest that's flat, is another. (Did you find that the fishnet gave you any beneficial information once you were on that ridgeline?) Absolutely, yeah. It was a pretty good display. *Switched to 90 at the very beginning, and stayed until after turn.* As with the other satellite terrain with the fishnet on the lower resolution -- this is the higher resolution and I had a little bit more terrain information. I was able to determine a lot of the peaks and the valleys a lot better with the higher terrain.

CCFN1: It's a lot better than the three arc. Once again, it doesn't really tell me, it looks like I'm flying over a hilly desert. It doesn't really give me much information as to where some populations might be or some fields instead of some . . . or forests even. It all looks pretty much like a big beach, or a big hilly beach. But I can get a lot more terrain information, elevation information from this one than the original two-tone display. (Actually it was 30 arc-second; so you're comparing the highest versus the lowest right now, this being the highest resolution.) And it still has some, it doesn't give me a lot of information as far as if I come against a particular situation, I don't have a good idea as to which way to go. It all looks like a big beach. I'm at TURNL. Left turn, 20 degrees of bank, five-zero. Once again, with the other display we had, two two-toned display, I can see the ridgeline a lot better this time than the last time. And I can tell the, you know I'm lined up with the two towers right below my nose, where I wouldn't normally be able to see if I was in the IMC conditions. I wouldn't normally be able to see the two towers that just passed beneath the nose. This widening of the display gives me that ability to see them. Yeah, the unity display shows a lot more detail and I'm able to kind of keep the numbers in the right area; doesn't get away. While I had a lot of terrain awareness as to where the peaks and the valleys might have been, I still had to guess as to where a field would be or a forest would be. And if I had a dead stick situation, I wouldn't have a lot of information as I would have with the satellite imagery. (At the end of that run you talked about that the unity, you liked unity. I was just curious of your FOV strategy at the moment. It seems like you keep the field of view 60 and possibly 90 at the higher altitude and then through your turn; and then you scroll back you

unity. Is that correct?) Yeah, with the wider field of view, at like say 60 (FOV), I believe 90 is a little bit too much. But at 60 I like the feel of that where I can get a wide, it's almost as if I'm looking outside the aircraft and I can kind of keep the horizon in a good spot on the display. And then when I'm at a straight and level or I'm coming up on straight and level, if I switch to unity, I'm able to nail the numbers as far as like the straight and level and having the descent and having to come out of the descent at that particular altitude, I'm able to get that altitude a lot easier with unity.

PR1: This is good. It's almost like an exact replication of what I see on the outside; definitely make a good decision in a time crunch. Possibly panning out say like to 90 degrees where you can get a really good field of view. Also if I was just flying along in VFR conditions as I am right now, if I peel it back to 90 degrees I can see what's below the nose over the cowling, but I couldn't normally with outside conditions. Twenty degrees of bank. Rate of descent here is too fast; back to 1,000, pull out at 0-5-0. I had unity view on for that turn and descent and I let the rate of descent got up there above 2,000. (Other than that, how did you like the perspective that you had during your turn?) Actually it was really good. It wasn't as sensitive as I thought it was. I just passed the altitude. It wasn't as sensitive as I thought it would be. Almost like looking through a big magnifying glass and trying to drive a car. Didn't think that it was -- that's what I originally thought it would be. I thought it would be like making a turn, a precision turn, and it wasn't too bad. I like this display here. Blew the altitude there. I was able to -- it looks like there was possibly a lake on the left-hand side there? Whereas with the other display -- the two-tone display -- I wasn't able to tell that that was a lake over there. *Kept Unity during the turn. While talking to me, past his altitude. Went to 7800, then came back. Probably more the 20 seconds. Gave him the benefit of the doubt since he was talking to me during maneuver.* Pilot compensation not a factor for desired performance. I had a lot of the information that I would need to execute the descent and the turn and if there was a situation where I needed to continue to descend and execute an emergency landing, I had a lot of good information as to where would be a better spot to go to or to go towards.

EBGFN1: This display over the satellite imagery is a lot different as far as the information it's giving me. The satellite imagery isn't making the peaks look as steep as they were represented here on the display. This display also definitely helps out by determining what areas of land are of equal elevation or similar elevation. And that would also help make it a good decision if I had an engine-out situation or an emergency landing situation. Coming up on TURNL. At TURNL, making a left turn, 20 degrees of bank, headed toward 0-5-0. Thousand feet descent. That was on unity. Eighty-two hundred. I've got it on 90 degrees. It gives me a really good representation of where that ridgeline is at in relation to all the other elevations. The grid lines, the fishnet lines definitely gave an impression of where the peaks and ridges were. I can, if I had to at this point, land the aircraft. Of course, it wouldn't be in a very good situation, but I can tell where there's a trough or where the ridgeline goes up or down. It not only gave me the information I needed to perform the desired performance, the turn and descent; but if I had to continue the descent, also had more information to continue down to the surface.

EBG1: Terrain information here visually looks really good; however, if I was at a closer altitude, I would have to pretty much guess where the ridgelines are without the fishnet. Having no fishnet on this display here. The one with the fishnet had a little bit more information as far as terrain. Abeam TURNL, 20 degrees of bank, 5-0 heading. And this terrain here, the 90-degree field of view is good and it also gives a lot of good information as far as the elevation, height. And without the terrain, without the fishnet, I can still determine where the terrain is with the difference in shading and the light. However, with the fishnet, it would be a lot more information as far as . . . a lot more detailed information as I get closer. *At the end of descent, changed to*

FOV90, gives him good information. Because it gave me all the information I needed in any situation I might incur. And I don't think that it had, because it didn't have a fishnet overlay, I don't think that it had any negligible deficiencies. There was still a lot of information.

EBGFN3: This gives a pretty good layout -- the representation of the terrain even with the highlights, shadows and the highlights. At this altitude I can barely see the gridlines, the fishnet. Abeam TURNL. Twenty degrees of bank. Thousand feet for the descent, five degree bank angle. Unity field of view really helps out with the bank angle; not the bank angle, but the descent angle pitch. It looks like the mountains, the look is a little bit smoother than the one arc-second that they had in the last display. These mountains here appear a lot smoother than the other ones. A lot of the terrain between the ridge on the right -- the ridge that I'm flying over and the ridge all the way to the right and also on the left -- it seems a lot smoother than what it was on the one arc-second. Because, well it didn't hurt, it didn't affect the ability of me to maintain altitude or a descending turn to a 0-5-0 heading; however, when I got a little bit lower, then the definition of the terrain between the mountains seemed a lot less than it did originally in the higher resolution display -- the one arc-second.

Block 2, Low Altitude:

EBG1: A left turn, twenty degrees bank. Being down this low as compared with this morning's demonstration, it really gives you a lot more information as far as the texture of the terrain. And now that I'm in a lower altitude and you're looking at the display, it definitely is a lot better than it was earlier at the higher elevations. You get a lot more information, which you might need if you have an engine-out situation. You could make a pretty good decision. I felt like the display gave me enough information that I could make an educated decision on what to do. Either with the descent that I had and also if there was an emergency situation that could have arisen, I had a lot more additional information.

EBGFN1: (I notice you're using the unity for your field of view?) This time I am, yeah. I normally use the 60 degree because it gives me a similar display as if I was looking outside the cockpit. Coming upon TURNL. Abeam TURNL. Left-hand turn 0-5-0, 20 degrees of bank, 1,000 foot descent. The gridlines in this view here definitely help give you a better representation of the terrain. Shot that one. Being this low here, seeing the towers, being able to open up the field of view to 90 degrees. I'm able to see right below the nose, below the cowling, whereas if I were under VFR conditions I could still see how close I was to the tower looking straight out, of course. (I think you were in unity for the first couple minutes and then you changed to 60. Was it just before you turned?) It was just after. (What do you like best for the terrain feature?) Sixty degrees is what I like better. I can get a wider field of view whereas with 90 degrees -- I think I'm at 90 right now -- with 90 it's just too wide, it's too much information, and all my heading numbers are really small. *Flew first 2 minutes with FOV unity. Talked his way through turn and descent. Changed to FOV 60 just after turn. Prefers unity for symbology and FOV 60 for terrain.* As with the other display with the elevation representing the colors. With the fishnet it gave me even more detailed information as to what the lay of the land, the lay of the different ridges in between the mountain ranges. I knew that if I was to go off to the right-hand side and I needed to execute an emergency landing, that it would be pretty bumpy; whereas if I went to the left side of the ridge I would have a more successful chance of landing.

PRFN3: The peaks don't look as high as they did before, but the grid maps definitely help kind of interpret what the lay of the land is. It just seems a lot flatter than the previous view. Yeah, I can tell where there's forested areas a lot easier in this view, whereas the other view didn't really show representation to where that was because there might be road up here on the ridgeline. I can kind of see where a lot of the terrain features are a lot better with this display than the previous

one, whereas the previous one just gave me the elevation -- not necessarily what was on the ground. It really helps you make a better decision where you want to go because there could be, you know, a flat forest on the previous display would show up the same as a flat field because all it's doing is picking up the elevation. This allows me to determine what's on that flat area -- whether it's a forest or a field -- a lot easier with that previous display. And where you lose the information on the photo-realistic, the altitude information, on the photo-realistic display the grid lines or the fishnet definitely helps out, fills that gap. The curvature.

PRFN30: I'm coming up on TURNL. Abeam TURNL, starting my descending left turn, 0-6-0. Ah, that really flattens out the resolution on this display; really flattens out the mountain range, too. (FN) doesn't really help much. It looks like it's really flat land. It looks like I could almost land anywhere here, except for the fact that, you know, there's a forest here. That's the only thing that would prevent me from actually executing an emergency landing, would be the trees which this view definitely represents. Then it doesn't look like there's much mountainous terrain here. It was pretty hilly in the previous resolutions. A little misleading. The resolution of the terrain. Makes it appear like it's flat. It was good information as far as being able to tell where the forest was and where a road might be if I needed to execute a landing -- or a field -- but it really didn't give me the elevation information that was, that I needed. As with the previous display that had a higher terrain resolution, I could tell it was really mountainous; whereas this display here was deceiving. It looked almost like a flat terrain with a little, small hill.

PR1: Yeah, it's almost as if with the highest resolution even though the fishnet is better to give you additional information, that it can give you visually, with the increased resolution of the display, it provides way more information than the other one did without the fishnet. It is really deceiving when it is low resolution. I'm two-and-a-half miles from TURNL. Climbing, too. Now we're abeam TURNL. Seven-zero. The terrain resolution is almost like night and day here. You can see all the peaks and valleys as compared to the other display, the lower resolution. And the terrain avoidance display in the middle is also good info, too. It tells you where the towers are at in relation to the aircraft. (The MX20?) Yes. A full 90-degree field of view gives you a nice VFR representation as if there was no clouds out, but the numbers are too small; too close together, to really get a good, controlled feel for it. Looking at the center where the velocity vector's at. *High on altitude.* That display was actually my favorite. It gives me the most information but, at the beginning there I ended up being high. I was messing with the field of view trying to identify, just trying to evaluate and look at each of the different displays and I didn't pay attention to the altitude. It kind of got away from me.

CCFN30: (FOV unity for a good deal of the time.) As a far as a location, using it as like a navigation aide with, you know, references to the towers and the landing area, I suppose it's adequate but, as far as the whole situational awareness of exactly where you're at and where would be a safe place to land, doesn't give you much information. It looks like I could just drop down here below and land on a slight slope, a down slope, but I know from the previous flights that it is much more hilly than this display actually represents. It could be very misleading. *Flew most of 1st leg on FOV unity - off heading quite a bit.* Because when you get the proper flight information as far as the altimeter heading and what not, the terrain information can be misleading in case of an emergency. You'll think that you're in a safer area than you actually are. But as far as piloting, it doesn't really hinder you that much up until the point where you need to make a decision based on terrain information. (Okay, so you get your flight cues but, once again, you feel it's misleading in the sense that you don't know what's underneath you. Or would you rephrase that, please?) Yeah, you get your flight cues as with the other displays but the resolution of the ground terrain, or of the terrain below you, is very misleading. It looks as if you're . . . It's a lot smoother than what it really is.

BRD BL: Left descending turn. Thousand feet. With the MX20, I'm able to see some of the tower information: the tower locations, and the ground terrain now is coming into the screen. Alright, there's a lot of terrain information on the MX20. I still have the somewhat of a terrain idea, a map and an idea of how close I am to the terrain around me; not a, you know, a textural, graphical display but it's definitely a relationship of where my aircraft is from the ground. Because I had an idea of where I was at and my air speed; I had to work a little bit more; I had to look around. But I think that also might have enhanced, it seems like it enhanced my control of the aircraft because I was more attentive instead of looking at the terrain and where my relationship with the horizon was, or my aircraft was with the horizon. Because I was looking around at all the gauges, I was also more attentive as to the situation of the aircraft. But as far as terrain, I had to look over towards the MX20, more often in order to get that terrain information and it wasn't as precise and informative as the other terrain displays are. In a nutshell, anyway.

EBGFN30: I can see where the high spots and the low spots are; that's about it. When I pulled out to a 90 FOV, all the fishnet lines look pretty flat but the visual cues as far as the color, I can tell that they're not exactly flat. Using the MX20 and the terrain information here was able to fill in some of the gaps as to where the high areas and the low areas. I use a strategy of when I'm doing a maneuver, I'll go to unity. That gives me a lot more information; target information. And if it looks like I'm off a little bit as far as like it's getting away from me, I can back it out to say 60 degrees. That kind of gives back a reference point as to where I need to go to. So some of the larger numbers, for instance, I'm here at heading zero-five-one and I can easily see all the way out to zero-three-zero and zero-seven-zero, zero-eight-zero on the ends of the display. So it kind of gives me a better feel of where exactly I'm at, and then I can go back into a unity once I get my situational awareness back. The resolution was, with the 30, the resolution was kind of flat, so I found myself using the MX20 a little bit more often to try to correlate the two together to try to find some of the high points in the terrain. As I came up on some of the terrain, it looked as if it was even or flat on the head down display, but on the MX20 it was showing a few peaks where the towers were at and I could see the towers on the head down display but I had to figure out that, or I had to look at the MX20, to find out that that little area around the tower was the high point as everything else looked kind of even with that elevation. The top of the mountain looked flatter than it actually was. It looked more like a hill.

PRFN1: It's outstanding. It pretty much speaks for itself. It gives you a really good representation of what the land -- what's on the land as far as field or a tree, like a forest area -- and it also gives you the fishnet overlay on top of that to enhance the elevation from the land all the way around. It's really good. *Started at FOV 60. Called 2 1/2 miles from TURNL and changed FOV to unity just prior to turn - has done this for most runs.* It pretty much spoke for itself. It gave me my situational awareness, how the aircraft was flying, and it also gave me the terrain information, an enhanced terrain information, that gave me... I could have looked outside the window and probably gotten the same, exact look as what was on the screen there. It was just excellent. It gave me all the information I needed. I think the only thing it left off was the winds, the surface winds.

CCFN1: A mile out of TURNL. I'm abeam TURNL. Left-hand descending turn, 0-5-0, 5,000 feet. Thousand feet per minute. Roanoke in the distance, towers and MX20 . . . I see the terrain is coming up here. Five thousand feet. I was on unity the entire time there shortly after the beginning because the terrain information it was giving me really wasn't -- the only thing I use this display here for is horizon. For the horizon information. Yeah, I was using unity because of terrain information, it's got a pretty good resolution on it but, you know, it really doesn't give me . . . I wasn't needing to use it for descending and level flight. I wasn't able to use it much to make a decision other than having to look for flat land if I had an emergency, in which case I would probably back out to a 90 degree field of view. The terrain gives me a pretty good

representation of the lay of the land, you know, as far as the elevation -- the peaks and the valleys, but you know, it's really anybody's guess as to what's in the valley until you get down low enough. If we were actually flying in a soup, like we are right now, and I had to make a crash landing, I really couldn't make an educated decision on whether I'm going to go to the left or to the right because I don't know exactly, you know, what's there. I could actually turn away from a pretty good landing field that would have been represented on the either satellite image. *Sees airport and buildings just out of turn (on unity). Used unity more on CC because he didn't need to look at other outside areas.* Because I had good situational awareness on the aircraft, however, the terrain information had that one feature missing where you can't really tell what's on the land. You can tell the lay of the land as far as elevation information, but you couldn't really tell, you know, if there was a good landing area there just by using that display. So, in case of an emergency, I wouldn't be able to make a real good choice on which way to go.

EBGFN3: I think it gives a lot of good representation as far as the elevation and the lay of the land and the fishnet display enhances that, enhances the colors, the information the colors give you. And being in the unity field of view really helps to maintain the nose and attitude a little bit better because your horizon's focused in. (During the maneuver?) That's correct. I wanted to kind of evaluate, when I get close to there I like to pan out to evaluate the texture of the terrain. Like the other, like the other display this one here gives me a lot of elevation information with the colors, but it doesn't give me the -- which is good for number information as far as, you know, it's a thousand feet above sea level or what not, altitude information, but it doesn't really give me information as to what's on the ground there. But, in an emergency situation, if I was in the clouds -- of course, a VFR rated pilot, you shouldn't be in the clouds, period; but, the other display would give me more information that I could use during an emergency landing and this one here gives me more information on just avoiding the terrain in general; not actually landing. It gave me a lot of the information I needed in order to navigate the airplane and fly it. But it did lack that information that I needed to execute emergency landing as far as what was on the ground, whether it be a forest or a field, it didn't distinguish between the two. (Okay, so it gave you the information to navigate but not to land the aircraft with any kind of knowledge of what was under you?) That's correct.

Block 3, Approach:

BRD BL: It's a lot of work. I've got the runway in sight. I was compensating, trying to compensate for the crosswind. *Flew alt and speed ok, but had difficulty with localizer course.* Yeah, it's, it was a lot of work. Had to concentrate on three different, four different, display gauges in order to maintain, say for instance, the heading and then altitude and then air speed and I was having to just divvy up a lot of my attention in three or four different areas. Constantly scanning. It was pretty difficult and having to look at four or five other areas and trying to keep the airplane in one spot was difficult.

PRFN1: Wow! Right on the numbers! That's awesome. That turn sure was cleaner though. I'm at 60, it looks like now. Yeah, this is 90 here. (You used 60 all the way through?) Yeah. Right now I'm trying to concentrate on the tunnels. Back at the initial turn, looking at the localizer it showed me how close I was to the MX20, how close I was to the terrain, and I was able to verify that on the main display. But, definitely having the 60 degree field of view, I like that a lot better than the others. (And you used that almost all the way through this approach, right?) Yes. I switched a little bit when I first came. My turn changed to brown on the first turn. Having all this, like the three-degree line here and the boxes, the tunnel, definitely helps line up the approach. I was close enough to see the runway on the monitor, on the display. And I was able to line up, right before I got to it I went down to unity to see how the three-line would look. And it was kind of small so I went back to the 60 degree. And when I go closer I tried to back the

unity and if was large enough to where it provided a good tool for me to line it up. Kind of magnified where I was aiming at and I could see the runway better; aim towards it. So you went to unity to check the three-degree line, just inside the middle marker, switched back to 60 and then back to 3, and that close in it helped you. I used the MX20, when I was right over that ridge. And then, when I made the right-hand, when I was able to verify the MX20 with the display to see how close I was, because the display looked like I was pretty close, and I was able to verify my relation to altitude with the MX20. Because not only at the beginning I was able to see where my terrain was and how close I was in relation to that, by using either the display and the MX20 together; but all throughout the approach I could definitely see exactly where I was. I could tell if I was above or below, not just by using the dog bones or the localizer information, but by using the tunnels and my scanning wasn't as traumatic as it was with the standard instruments. (Was it as much of a workload to use your scan?) Absolutely not.

PRFN30: Yeah, the terrain on the MX20 shows a yellow area straight in front of me right over the knoll. And on the display it looks pretty quiet. But I can definitely see because of the photo-realistic. I can tell there's some sort of a city, a metropolitan area, there below me; like maybe a mall structure or something down there with a highway around it. I can tell I'm right now probably over a slightly sloping area but not much more than that. I've switched to the 90-degree field of view now. And there's a lot more boxes and if I cheat, if I keep the velocity vector -- I'm trying to aim it right there on the 3-degree line -- but if you put the velocity vector in the middle of the box all the way at the end, I'm actually able to aim it a little better than I was before with the 60. I was pretty close and instead of aiming it from one box to the other, I found if I backed out to the 90 degree, the 3-degree line wasn't so small. But if I aimed the velocity vector towards the . . . lined it up with the 3-degree line marker and kept the velocity vector in the middle of the last square, all the way at the end, I nailed every single square at that point. I went to 90 degrees this time on the very beginning and I actually kind of like it. Before I'd made a comment that the 3-degree line was kind of small, but this far out it really isn't an issue. Once again I can see on the MX20 there's terrain below me, within like 500 feet of terrain. Looking at the main, primary display I can't quite tell if there's really much of a slope. It's a slight slope, but not much. That was the 3-degree marker to line up with, for the throttle and the velocity vectors. It's an invaluable tool here for a perfect approach. This is awesome. Yes, I did. Backed it to about 90. Yeah, it's not too bad. Going to 60 to see if I could see the runway a little bit better and I couldn't. I'm not up close enough really to . . . I went to unity and it was still kind of sensitive, I was still kind of far out. I went to the 30 degrees to kind of, so the screen wasn't so sensitive to my inputs. It had all the information I needed right there to make my turn onto localizer and I was able to line up with the thousand-foot mark on the runway really well, ahead of time, and the only gripe that I did have was it didn't really require -- I didn't really need that information -- was the terrain. I could tell that there was a high point or a hill. By using the MX20 it looked like a hill because of the green everywhere else except for that one little spot where the localizer antennae was and, on a display, however, it looked flat. And I could tell that there was a metropolitan area there so it would have been a possible landing area if I needed it. But I went in shooting the approach with all the information that I needed. I could tell there was like a hill because there was a spot say was within 500 feet of me but everything else was green. I couldn't tell how high the hill was.

CCFN30: I just think the previous one that had the photo realistic with 30 arc-second and the fishnet was, the terrain elevation, is all that green? But with this one here I get, constant color, it does point out some towers that are good reference points, landmarks, some rivers like the one that's right below the nose here. Those are good reference points, if you're familiar with the area, as to where you're at in reference to the airport. *7 seconds to right of course before turn. Through turn, a little off altitude (can't remember high or low) for about 5 seconds. 10 seconds*

low on final. Because it didn't really show a lot of the land, like the satellite imagery gives you a lot more information and as far as elevation. It did have good, some good landmarks as far as rivers and the towers that were on there, but it still gave me information that I . . . all the information that I really needed to shoot an approach. Wasn't really lacking anything other than the fact that it didn't show anything other than rivers and towers.

EBGFN1: Yeah, right here where I start passing over the ridge, excellent information as to what the ground looks like below me. I could make a pretty good decision if I had to make an emergency landing right now as to where I'd go. (An emergency landing) doesn't look very good all around. (Do you find that the fishnet is giving you any beneficial information?) Actually, it does. It has a conscience rating on the tunnel; try to keep the velocity vector centered. Out of my peripheral vision I can see some of the contrasts in the color of the terrain in the fishnet. I'm able to kind of see where some of the ridges are out the side on peripheral vision and when I'm coming up on a hill, like the one up here on the left; it kind of helps me identify where some of the ridges are. (When you have a minute. You're coming up on a series of roads here. I'm just curious if it's confusing that they get kind of cluttered into the fishnet, or if you're able to pick up the roads.) That the . . . Yeah, it is kind of difficult to discern between the . . . I can tell there's a difference in color. Yeah, I can tell there's a difference in color and they're a little bit thicker. Yeah, I can sort of tell but it does get kind of confusing with those that are going maybe 20 degrees from my flight path here. Kind of get mixed up with the grid. Yeah, as I'm getting lower here they're getting a lot thicker. Easier to discern now in each field of view. At 60 degrees field of view you can tell the difference between the two. I found the 90-degree field of view really helps out a lot because I can aim the velocity vector all the way at the end -- at the smallest, at the end of the tunnel -- and pretty much nail the other ones automatically. Oh, like right now, usually when I pass the marker I'll switch it to unity. As I get closer and start lining up the -- just gauging ahead and trying to line up my three-degree mark. *Has been off numbers on and off for a total of about 10 seconds, after turn. Does confuse the roads a little with the FN, but not enough to be a problem. FOV90 really helps out a lot, because he can aim VV all the way to the end of tunnel, and it seems to work well. Then after MM, will switch to Unity to line up 3deg GS line.* I had all the information I needed in order to shoot the approach. And at first I didn't know until you pointed out the roads on the display; that would definitely help out in an engine-out situation. It would give you something to aim for because it looked, the terrain in the area was rather hilly and that would have been something I would have probably wanted to aim for to execute an emergency landing. And it gave me a lot of information I needed right there.

EBG1: It helps me, I can pick out the terrain. Got a better view than what it was with the lower resolution. If I had an engine-out situation or an emergency where I needed to land, I could definitely negotiate a landing using this information. Help line me up with the ridges a lot better. (Okay, it looked like you stayed at view 60 through that turn. And I'm just curious if you can make a comment on how you found the 60-degree field of view to work for you during the turn maybe compared to the 90?) Yeah, it didn't seem too bad. Actually the reason I didn't switch over is because I was trying to keep it lined up. Yeah, I like the 90. Gives you more boxes to shoot through. In that turn I just didn't switch over. I can see the roads now more prevalent than I did before. The grid lines; the fishnet. Like I said before, with the fishnet I could see out of my peripheral vision, where the contours were a lot easier with the fishnet. And, it's not as prevalent here but I still have the highlights of the, you know, with the highlight and the lights coming through and the shadows on the backside of the hills and the ridges, I feel like I could probably negotiate an emergency landing at this point using the information that I have here. This is much better. I can distinguish where the roads are at a lot better with this display. Something else I wanted to add: I'm at the hill to do 90 right now and, I know there's a slight turbulence in the display, and with 90 degrees, the resolution is like really crisp and the runway is pretty tiny. I

feel like if we were actually in real turbulence and bounced around the cockpit where my motion was moving around, my head was moving around a little bit, it would probably be harder to line up the runway at this resolution; probably want it at a 60 or so. (You're talking about in real time for, I guess, real life.) Actual flying, yes. And I felt like this display was better than the display with the fishnet, the elevation. EBG without the fishnet with the resolution of one, because the resolution was so high I was still able to see where the contours were. It wasn't as prevalent with the, as it was with the fishnet out of my peripheral vision, but I felt it was more important at that point to see the roads being there were similar landmarks in the area, than the fishnet on the display.

EBGFN3: The terrain looks a lot smoother than it did before, of course that's with the resolution. At this point the fishnet helps discern some of the mountains and the ridges in the terrain. Yeah, once again the roads kind of disappear, they kind of blend in with the gridlines. And actually it's kind of flat in this area here but the color on the EBG display kind of shows that it's more elevated than what the gridlines show. They're kind of telling me two different things. Gridlines say that it's flat, fairly flat; and then the color of the terrain shows that there's actually some curvature to it. (Are you talking about the shading itself?) Yes. Yeah, the gridlines didn't seem like they belonged there. At first they looked like they were alright, but then closer towards the airport they really kind of counteracted with what the shading told you. Because of the difference with the shading of the EBG display showed at the resolution, which was the three, and then with what the fishnet was telling me on top of that. The fishnet said that it was fairly flat but the terrain color difference showed that it had some elevation to it.

CCFN1: (It looks like the past couple runs you've kept the field of view at 60 through the turn. Have you found that that's okay?) Well, maybe just the fact that it comes as default at 60 and I was trying to concentrate on the crab at first. (And you haven't changed your mind? -- you still prefer the 90 through the turn?) I'm at, yeah, I'm at 90 right now. (Comments on terrain depiction?) Yeah, I don't like the constant color all that much, just because visually it gives me . . . Out of my peripheral vision if I had the photo-overlay or the EBG display, I can get a lot more information without actually having to look at the terrain just by peripheral if I've got the other types of displays, whereas with this display here, you know, it's just kind of two-tone, kind of plain. But the grid overlay definitely enhances this. It enhances what I see on this display. Almost a must. As before, the river, the rivers that are, the towers that are set up on this display here really help kind of cue in as to where I'm at on the map or in the city. And also with the MX20 pointing out where the different elevations of the terrain are and where the towers are at, it kind of helps having the two together to enhance each other. It's kind of hard to discern which way the fishnet is and which way the roads are. Where the blue creeks and the rivers, the waterways, are have enough of a contrast and color, but it really doesn't disturb. I felt that the constant color display, definitely needed a fishnet overlay for it and then when I got closer in towards the final, there I was kind of distracted having a lot of the highways in there crisscrossing. But it gave me all the information I needed. It actually showed the approach safely.

CCFN30NT: Like giving a blind man a cane and then taking it away from him. Yeah, the terrain information, having flown this area before, I can kind of tell that it's not as flat as it's appearing here with the constant color and the fishnet. I feel a lot more comfortable having a little bit more terrain information. And I sure, certainly do miss the tunnel. Started my turn a little late there. Yeah, once again with the constant color display I'm able to pick up some of the rivers here which are good reference points. That's a plus to have on this. Still doesn't show me a lot of the terrain elevation and stuff, but it does give me a few landmarks, which is good. *Did pretty well - did bump into some of the limits, but not very often or for very long.* I had to

concentrate quite a bit on keeping the diamond lined up, say, on the glide slope. Making that first turn, looked like I might of overshoot it just a little bit. I didn't have that experience when I used the tunnels.

PRFN3: This display looks a little bit flatter than the previous photo-realistic with one arc-second. Obviously enough resolution but the gridlines help with my peripheral sensation of how the contours are and it also helps to have actually found out where the metropolitan areas are. See some pockets of populated areas and some pockets of the forested areas. Yeah, the terrain looks pretty flat. The resolution is so low that it really doesn't give me a lot of terrain information. The MX is more information than this display here is. It gave me enough information where I could shoot the approach really, fairly easily. It didn't give me a lot of the terrain elevation, however, because it was the photo-realistic view it gave me a lot of information as to where the city was at. I could tell I was coming up on a metropolitan area.

EBGFN30: Yeah, this terrain, the fishnet tells me that it's fairly flat, but when I reference the MX20, it shows me that there's actually some ridges below me. Okay, 90 degrees here. And I can kind of see that ridge in the EBG display in the shades of altitude but the fishnet's kind of telling me another story other than what the EBG's telling me. Yes, how they're opposite. The shade tells one thing and the fishnet tells another thing. Yeah, this display would probably be better without the fishnet, once again. Another thing that might be beneficial in shooting an approach is to possibly have the boxes that represent the outer and the middle markers shaded: It could be a blue to correspond with the outer marker and then a yellow to correspond to the middle marker. Kind of give a visual reference while you're flying. Give you an idea of how far out you are. *He's been outside of bounds for about 20 seconds.* Because with the fishnet display over the EGB display kind of requires you to ignore the gridlines in order to pick off the elevation differences between the two, between the areas. Everything else, all the other (aircraft) information was there.

PR1: This and the EGB are very, on the high resolution -- one arc without the fishnet -- is probably my favorite because it gives me a lot of terrain information without the distracting fishnet. I'm talking about the EGB. With this one here it gives me a lot of the information as to what's down there as far as like a pasture or a forested area or a city, metropolitan area. That's good information to have and also I can discern where the ridges are at. And once again I had some, it looks like some landmarks: some roads down below. It kind of helped. Kind of let you know where you're at in the approach. Kind of pick up some towers that I can relate with that MX20. And, once again, the different colored box for an outer or middle marker would definitely enhance the distance information that I am from the airport. Because even though it didn't have the fishnets, which was an added, additional visual aide, I felt like it gave me quite a bit of information. I could discern the different kind of the 3-D look. I could discern between the highs and the lows on the display well enough to where I could have made a good decision in an emergency.

Rare Event:

EBGFN30: Yeah, I can tell what the terrain below me is like as far as like the lay of the land because of the different colors and the shading; however, the fishnet, once again, is very hard to see there, it's a little bit better to see here. But it still, it's kind of representing it that it's flat, misleading. (It looks like you're flying in a field of view of 90.) Yeah, I backed up so I could see the, the gridlines. This field of view is good because it gives me a lot of heading marks, heading markers. I can go ahead and determine if I'm coming up to zero-five-zero a lot easier. Yeah, it looks like I'm about to fly into the side of the mountain, but, uh . . . (Again, fly this as you would your aircraft.) I wouldn't stay at heading. I can't, I can't fly zero-five-zero. I can't

fly anything at zero-five-zero, at that. *Switched to FOV30 on descent. At 4:19, said that it looks like he's getting ready to fly into the mountain. Instead of climbing, he just changed heading, which wasn't enough to get him out of situation. Would have crashed.* Because it gave me the terrain information and as I was saying before, in the case of an emergency if I had like an engine-out or something, this is an instrument failure and I was able to make a determination whether I was going to turn to the left or to the right. I was a little late on adding power so I probably hit the bridge that was in front or I would have come really close to it. But I was able to make a determination even though I was in the left-hand turn, I was already banked to the left, and I would have continued with that bank and avoided the terrain.

Subject 19 (BRD Baseline):

Block 1, High Altitude:

BRD BL: Alright, you guys took the visibility away from me. Just when I was getting comfortable to look out. In terms of the simulator, put an input in; expect something to happen. Maybe it rolls or turns a little bit faster for a turn input, than you would get from a pitch input. I've got to say I think that it's easier for me to see altitude and air speed variations with the round gauges. It's the one thing I can say that's a plus. That part of it, I think it's easier to see both movement and if you don't have any other cues, where you are on your rates; but I think that's pretty customary. *Did over shoot his heading slightly, and was a little fast, but still within PTS. Can see towers straight ahead on the MX20.* I really think it's not satisfactory without improvement, for where I am right now. But I would agree with number four: Minor but annoying deficiencies, and that's only that it was hard for me to maneuver both laterally and vertically, and maintain air speed and watch both parameters. *There is some workload here. For where he is, right now, he feels that there is some improvements (because he hasn't flown in 10 years).*

EBGFN3: Well, first off, I'm back with the velocity vector and I've got my speed cue which, actually once I figured that out, it's pretty nice. The resolution on this is real good and color. I was thinking if this was more basic and I'm looking for the fishnet, but I don't see it. There goes my visibility. I'm a little high. Now, this is where my comment: the speed's pretty good, I can read speed pretty easy and, of course, the little helper here with my speed is great. I've spent a lot of time talking about that thing (acceleration caret) as not being necessary for GA and here I am using it a lot – may have to reverse my decision. What I find awkward is using the tape -- the altimeter, that may change by run 11. It's fairly busy on your altimeter and I'll pay attention more to give you better comments. Right around the pointer it looked like you're displaying the whole altitude and maybe that's what it is. I've had to look at it a couple times and I had to look at it and think about it a minute to figure out which one's my altitude. Okay, that just lost control because I was playing with the FOV (during turn). The ridge is very clear; I see the towers on the ridge. What I did was put the flight path vector on 5 degrees down. Probably should have had it under control before I did that. *Have VV and speed cue, which are nice. Resolution and color is really good on this one. Can't see the FN at the higher altitude. 10 seconds out of bounds on the turn, speed, bank, and over shot. For descent, put VV on 5deg down. Flipped FOVs during turn, and that's why went crazy. Thinks he likes FOV30. May not use the speed trend (green line) at all. "Is it satisfactory without improvement?" I'd say it is because I have all the cues there and fairly easy to follow. I just need to scan a little and not fixate on a turn, which I suspect by one or two more runs would happen. I actually like that display. I like the cues that are there; what it does for you. The resolution was really good. Cues are fairly easy to follow. Need to scan more and not fixate. Very excellent display.*

PRFN30: It's more resolution but, you know, you spend your time flying the symbology versus the terrain so other than a nice picture, I don't know how much more it does for me than the last

one. I'm looking at my turn and I'm seeing a compass and I think it's because the heading indicator's at the horizon. I guess I'd look for it to be somewhere else, if that makes any sense. Okay, and I can see the wire frame this time. I have to look real hard to notice at this altitude that there's a difference in the resolution, which kind of tells us that maybe to save memory you don't need the higher resolution on a system until you get lower. I don't know if that would help the system or not. Yeah, this time I did and what I was looking at this time for the 60-degree FOV was trying to do a better job with the heading. I thought it might help on the heading indicator. What I have to remember, though, is it gives me more pitch degrees so five degrees is, isn't so far down. (Fishnet) It was just kind of there. *Stayed at FOV60 this time, during turn. Can see the FN, through descent. Thinks that there is not much difference between high and low DEM at the target end altitude. Maybe this tells us that we don't need high resolution at high alts.* I think this one's easy, as far as the performance. Really nothing changed but the terrain. And I'm giving it about a, same as the last, about a 2.5. *Very easy to fly, really likes.*

PRFN3: Okay, I'm going to actually try to look forward a little bit more this time instead of staring at the screen, if that makes a difference, and I'm on the 60 (FOV) which actually -- to me, 60 matches pretty close with out the window. *(And 60 will make the terrain look a little bit further away.)* Okay. Maybe that's why I can see below better with 60. It looks like 60 works better for me. That's funny. Now, when I did this at CAMI, I think that they targeted 40, okay? And the difference I would say, is what I see in the terrain. I think that's what's making the difference for me going to 60; I get more feedback from the terrain. And I'm coming up on my waypoint so it's about time to start a left turn. Let's try a little less this time. Five degrees. Overshot just a little. The roll pointer's fairly sensitive. I don't know if you've had that feedback. Maybe that's good. I can tell it's a little bit lower resolution but I actually could tell when I was looking out in the distance early on. That's where I started to notice it. Other than that, I didn't notice it. I think that it, the terrain depiction in general though, is has a lot to do with the FOV, which is probably a good thing. You're getting more information from the terrain. Now, maybe once I got to where I wasn't having to watch all of the symbology to fly the parameters, I'd notice the terrain more and it might make a difference, okay? So I need to say I'm working pretty hard to do a poor job of flying the parameters. I shouldn't need to. Well, I'm still working to read the altimeter tape well. Well, and you know I just realized I'm not looking at the tape at all. I just look at the pointer and the numbers in the pointer. That's all I'm noticing. Actually, I think that's true on the air speed, also. I'm just looking at the box. Okay, whereas with heading, I can watch the tape move a little if I make my eyes move and see the digital above. Okay. *Strike the comment earlier about preferring FOV30. Roll pointer is fairly sensitive. Can tell that it's a little bit better resolution. Terrain depiction in general has a lot to do with the FOV. Maybe once he gets more acclimated to the system he will be able to look at terrain more. He's not looking at the speed or altitude tape - just instantaneous speed and altitude.* At this altitude for me it (terrain texture) doesn't really change a whole lot of things. *Feels like he is learning about the symbology.*

CCFN1: Oh this is, yeah, just flat brown. Okay, the first one had some shading and gave me some terrain features where this really doesn't give you a lot. I do see the fishnet though. It's very subtle. I really, I better not evaluate it; it's unfair. You can see motion with these, but you're so high the blocks are very close together. (At the lower altitude) it's hard to see that there is variation in the terrain. You can make out that it's trying to show me the terrain, but that's about it. I can't tell what's high and what's low. I would say it's a lot of computer processing power with very little benefit. The tower points are easy to see, so that's beneficial. I, it looks like I have a river. That would be beneficial; you know that's a landmark now. The runway's off in the distance. But I really can't, I can tell I'm very high over the towers. (FN oriented N/S/E/W) That's what you get in the Midwest. You can actually fly section lines. And so that's a concern

for us in the middle part of this country, if someone puts moving wire frame or moving fishnet on just a flat display basically trying to add more than just blue/brown and they move it, is somebody going to think that -- somebody flying in the flatlands -- will they start equating that to their terrain, go to a mountainous region and, when they don't see mountains on their display, they think that it's clear. We wonder if that, if somebody might forget that they're in the mountains and look at their display and think, "Hey, I'm in the flatlands." So, even though you get speed cues, and that's a benefit and maybe because you get speed cues it'll help you, it'll give you a little bit of an altitude cue also, like a video game. There may be the confusion factor that could be a safety issue where you think you're over flat terrain and there's really a ridge or a hill. *This terrain texture doesn't give him much info. Can see the FN - they're too hard to see. You can see the motion with these FN ok. Likes FOV60. Can see towers at lower altitude. At target alt, it's hard to see there is variation of terrain. Can make out that it's trying to show him terrain, but that's about it. Can't tell what's high or low.* "Is it satisfactory without improvement?" I'm going to give that a "no"; and I'm going to give it a four because it was almost distracting without much benefit. I told you I could see ridges, but I really didn't give any, I didn't get enough cues to know which were high and which were low, so it's, it's more a, it would probably be better to have nothing than to have that at that altitude. I guess we'll see what it's like low. *Wasted processing. Have to have the color to get the depth perception.*

PR1: I probably was targeting 30 degrees because I found that it was more precise to fly this velocity vector but, the more comfortable you get with the symbology, I think I might find I like the 60 better. Maybe I should try 30 and see if I do a better job, too. (after turn) Okay. I think this gives you all the cues to fly precisely, once you learn how to do it. Yeah, I'm finding that 60 is a little better for me. I'm a little fast. There's my altitude, okay. Now terrain-wise, it's a delightful picture. Benefit-wise, you know, I think it's harder to see the towers. I see roads, I see buildings, I see a lot of detail that's really nice but it might be better to have -- okay, there are the towers. Now I see them. I think that, given a choice, we probably want to not worry about the road and highlight the towers, especially the top. . I can tell where the ridgeline is. I can tell where the valleys are. I can dive down and go through the valley. *FOV30 may give you more precise flying. So, maybe once you get used to symbology, FOV30 wouldn't be bad. Did roll to about 120deg while flipping through FOVs for about 10 seconds. Not sure what the benefit of 30 over 60FOV is. Shadowing is very important in this concept. The PR does give him the info on the peaks and valleys that he needs.*

EBGFN1: I actually think the terrain stands out better. I remembered this from the first one. I was thinking it was pretty good. Now the resolution's very high so I see a lot of the valleys. I'm anxious to see what it looks like along the ridgeline. If you do the photo-realistic I sometimes wonder if having all of the green, the trees, doesn't give you as much of an altitude cue or a terrain cue as using generic colors like this. That aircraft waterline is there. I don't think I've used it once. I just simply fly the flight path vector. (after turn) Okay, now I can see the fishnet. And I can see the towers. Oh, I really like the, I like this terrain depiction. The last one was good but this one lets the towers stick out. (a different color band for a different elevation level) I really can't get anything out of the fishnet. I don't think it does anything because your resolution's so high already here that you could see just about everything and you have the shadows. It's pretty good. *Terrain stands out better than PR. Can see a lot of valleys. Can see the FN during descent. And towers. FN not giving any additional info. Really likes the terrain depiction. The last one was good, but the towers stick out better in this one. Really doesn't get anything out of the FN. The resolution is so high, that he can see just about everything with the shadows, etc.* And that may just be because I'm learning what the display's telling me, but I think that I like that terrain combination, plus maybe getting a little more comfortable with the symbology is making it easier.

PRFN1: I'm just following the digital read-outs, not so much the tape. In fact, I hardly see any tape movement in the altimeter. The tape motion itself is so slow and so subtle; I just read the digits. Terrain is good; a lot of detail. Now, I don't know that the wire frame does much for it -- the fishnet. Now, with the fishnet, what it looks like is a lot of roads. I can make out one little road. I'm going to be a little to the right of my towers it looks like, but that was because I let the roll go too much in my descending turn. I think what this is showing is, making a plane fly is still a large task if you're in turbulence. In smooth air it doesn't matter much at all, does it? Most things fly real well. (FOV) To me, 90 maybe compresses things too much and you miss the detail like the obstacles. It lets you see the terrain real well. Still think 60 probably gives you the best balance of symbology to fly by and resolution of the terrain. *Doesn't know that FN is helping him. Bank angle was high for about 5 seconds. A little low at the start for about 5 seconds. On descent, with FN, might easily be confused with roads.* Good, but I think the other (EBG) was better terrain-wise. I think the other made it a little bit easier as far as finding obstacles like the towers.

EBGFN30: No, I'm trying to think of some, but it looks like the other depiction at this altitude, at this point in the run. There really isn't a lot of detail at this point until we get done with the turn and we descend, to tell resolution. I think that's why it's hard to see much right here. When we get around over the ridge, now it's easier to start picking things out, determining whether the resolution helps. (after turn) Now, see how the towers stick out? I have real good terrain resolution here. Feel like I can tell where the peaks of the ridges are. This is a lot smoother so I would suspect some of the, I hate to say peaks; but there's probably some cut-off. This looks rounded or smoothed. . I think it'd be hard not to say that I'd rather have the one or three arc-second. 30 is quite a bit. It's a big jump - over having the 3 arc-second, even. You know fifteen might be a nice happy medium -- but what you really get out of this though, is seeing the towers which are going to be your obstacles. And you can make out terrain I guess with this scheme, you're going to get terrain warning also off of your moving map, right? You know I think this is the scheme the enhanced ground products use. It makes sense, especially now that I see it, to where en route you may be at 30, close to the airport, say within ten miles, it goes to 15 and then when you're on the approach, within 5 where you're fairly close to the ground you're at a higher, I don't know what arc-second they're able to get right now, but the three or a one would be really desirable, as you get close to the ground on an approach. *Was a little too fast twice, each for about 10sec. Feels like he can tell where the peaks and valleys. Feels that this is a little smoother than the IDEM. Can really see the towers. 30 is a big jump from IDEM, so maybe 15DEM is a happy medium.* Even with the lower resolution. The resolution doesn't matter that much this high.

CCFN30: Okay, the one thing, about the only thing on here I guess, that's some help, is a river. And let's assume that if I'm on a flight, I'll know what that river is so it's going to give me some type of position feedback, good or bad. Which is a positive comment, by the way. Okay, let's try 30 (FOV) for a little bit. 30 doesn't give you a lot of terrain, does it? It's so far down that you have to fly the horizon line. Yeah, and that may make things a little bit more difficult than flying 60. (after turn) Well, you can barely make the ridge out at all. But you can see the towers. We're so high that the fishnet doesn't move much at all. Now, if this were maybe a 10-inch diagonal screen to where you could see the fishnet, it might make out the terrain and that might make the difference. I don't know, but it doesn't do a lot on this size display. I can see my airport. Hey, there's maybe something positive about this particular display. You can see the runway a little easier because of the colors and the towers, but the towers stand out pretty well with the EBG. Yeah, because I'm beginning to see if I had a high enough rate of descent, I can see the altitude -- It's okay, you can stop it. I can see the altitude tape move. The air speed tape

doesn't move whenever change in air speed's enough for it to move, so my only cue on the air speed is the digital change on the pointer and that's really all I've been looking at, the altitude. But if I'm at a thousand feet per minute or higher rate of descent, I begin to see the altitude tape move. Okay. *FOV90 - about the only thing on here of some help is a river. Will give him some position feedback, which is helpful. FOV30 doesn't give much terrain info.* The rationale being, the cues were so nominal from that display that it might as well, it probably wouldn't be much different from just having blue and brown. I was sitting here thinking about whether I really looked at it or not; if I just ignored it. In fact, it probably would have been easier to have had blue and brown with the division at the horizon and the very, very low resolution, non-descript single color. It would be interesting to fly that back to back with just a blue and brown.

EBG1: And we're back to what's obviously become my favorite display, only we've got the high resolution this round. And I'm climbing. To me this (30FOV) is almost useless - there's just nothing there. The FOV's way too narrow. The problem with 30 is you don't have a lot of resolution on the heading tape, for one; and you do get better terrain resolution at the 60. I'm not sure attitude (pitch ladder) matters that much. At least it doesn't to me. I could go either way: I could go with higher resolution or lower resolution on the attitude, but leave the heading tape display. (at turn) Yeah, that ridge is very clear and I can't see the airport. Towers already stand out, the peaks are there. What I really like is the elevation. You can tell where your low terrain and high terrain is, not only by the shading and the 3-D effect, but by the color. I've yet to get anything out of the fishnet. If you're just drawing a computer graphic, it seems like that's why that used the fishnet because it's basically -- that's what they started with -- a computer game or whatever, where it's really a wire frame and so that's why it looks like a fishnet, but that was the best they could do. Then they started shading them. Well, you've actually drawn this, drawn the terrain, so I don't know that you need the wire frame any more. You can clearly see the runway and the towers (at target altitude). For me, the 90-degree FOV puts everything too far away. And it might give you a false sense; a false sense that it's farther away than it is and it'd be behind the plane. *Not sure attitude pitch ladder matters that much. Would rather have more numbers on the heading display - it's more important to him. FOV60 is still his preferred.*

Block 2, Low Altitude:

CCFN30: They (grids) look a lot like what I saw at the higher altitude. I can see a little bit further back. What you see is fishnet up front and then it sort of fades away maybe a third of the way up the bottom, or a third of the way up the terrain. I'd call it (terrain information from this display) marginal. What I see here is a river and, for the most part, it looks fairly flat and smooth. Maybe some rolling hills; that's about all I can see. I'm going to make an attempt to look out the window a little bit more, especially now that I'm lower. And maybe compare the two. Of course, now I'm starting to lose my visibility out the window. Actually the transition (from out the window to the cockpit) hasn't been a problem at all. (That's) one of the nice things with this display. (after turn) The fishnet stands out a lot more; I'll give it that. And my towers are coming up. Getting a little of the terrain display now on the MX20, which is nice. I still don't feel like I get a whole lot of terrain information from the fishnet and the constant color. It's better now that I'm down low. Okay, that's a definite. I think it's the 30 arc-second that just smoothes everything out to where the terrain is really a lot rougher than what this display depicts it as. Getting the motion information, though, from it (Fish Net), which is worth something. Now here's an interesting thought. Since this 30 arc-second tends to smooth the terrain down, I wonder if my perception of the terrain under me not being as rough as it really is might be a problem. That make sense? I think the terrain is a little bit rougher under me than what it's depicted with 30 arc-second. I'm coming at it from a safety concern that I may not be as diligent about avoiding terrain. I like the low altitude better. I get more cues from the ground; it's making it more fun. Terrain doesn't look as threatening as it is in real life. May not fly as

diligently as he should, with the information (or lack of) due to the 30DEM. I don't know if I'd call it unpleasant deficiency. It's just a deficiency. Not negligible; it's, I think the smoothing off of the terrain and the lack of the different colors takes away from all your terrain awareness. "Minimal pilot compensation required for desired performance." I think that probably with any of the terrain displays at 30 arc-second, you could argue that you're going to have to compensate by watching your altimeter closer. You couldn't just look out the window and avoid terrain.

EBGFN3: Actually interestingly enough, this doesn't look all that different than the high altitude. I see the fishnet up front so this has fishnet embedded? Okay, now I can see it in the lower third, that's about it. I'll try some different (field of) views. I guess I should, as well. I think the constant color lacks so much there's no real reason (to scroll through FOVs). One thing the 90 degree gives you is a higher horizon, I think that's helpful. Is there a reason why, I guess when you do the FOV, it just should be the natural thing is for the terrain to drop, is that right? I like this display. Looks like I'm over a river. (after turn) I'm just looking at the resolution along this ridgeline and the way it's shaded, it doesn't seem to give the terrain, it doesn't set up the terrain like a shadow, okay? Fact, I'm not sure why the stripes are where they are. I can see out, yeah, I can see out now a little bit. I'm still fast. At this height, I don't know that I like the colors as well as I did before, at the higher altitude. I do see the runway in the distance. Towers are good. No, it looked like it was striped. It didn't seem to make sense and so just looking at it real quick; it didn't make sense where the valley was. The MX20 gives you pretty good terrain awareness again; it makes you ask, "Why am I here, not somewhere else?" Maybe I shouldn't have played with the different FOV. I got behind the plane that time. Going to play with it some more, but I think I like 60 still. *High at the beginning (6600) for more than 45 seconds. A little fast during turn and descent.* I can't blame the system for being off. I was paying attention to the display; actually to the terrain and the FOVs, so to rate it lower than a 5, I'd have to invent something. I mean, it isn't a system problem, it's a me problem. It's not a deficiency in the system. (If you did have a desired performance?) I liked that display. I would give it I think a two. I don't know that I'd give anything a one yet, because of the symbology. I think the symbology could be easier to use.

PRFN1: Now it almost matches perfect to what's out the window, which is real nice. FOV30 doesn't give me enough ground detail. I think that's why I keep going back to 60. 60 also gives me a little better resolution on the heading indicator, the heading tape, alright? And I can probably work that out as far as in the 30. We'll see what the fishnet does. I think it's distracting, especially as good as the photo-realism is. I'm not sure it's needed but we'll see. It may work well here. (turning) Let's go left in a semi-controlled fashion. You know one of the things that gets me, I think, in the roll is-- I don't want to do it right now -- but the roll pointer moves at a faster rate than the horizon. I think that's what I'm seeing. See how fast -- the horizon doesn't move very fast but that roll pointer does, and I don't know if it's a misleading. I'm not sure what it is. You get over to 20 or 30 degrees but it doesn't quite look like that. Photo-realism is really good. I'm not sure if the gridlines help. Yes, I do (have a very good sense of where the peaks and the valleys are). Where the towers are, it's outstanding. Looks like you painted the towers, too. And there they are, right out the window, which is nice. I'm getting a terrain warning, that's good. Slow, little low. When I look at the fishnet, I see roads. And I think you're, if it's missing anything it might be just some slight shading but if you go to the trouble with your photo-realism, I think I'd leave it, because it's good. I can see the runway off in the distance. I don't want to lean forward, that's how we'd really fly, right? Let me try a couple FOV changes here. Okay, 90. I still think 60 is probably going to give you better terrain and obstacle clearance. Thirty, you might see the airport earlier. The terrain with this one was good; the resolution was good enough that I didn't see any compensation in terms of altitude. You're going to fly your altitude obviously, but you aren't having to compensate for false terrain

awareness. I felt like it was realistic enough that I could trust what I had, plus my flight instruments. And that may be the problem with the 90-degree FOV. Don't know that I trust it.

EBGFN30: Everything's rounded off. The colors are nice. I can see where the valleys are and they match, but you know, you get the rounding with the 30 arc-second. I would say on this (30 FOV), now if I fly it right there I don't see any numbers on the tape, and the gap's so large that it's hard to see where you are at all. Starting a slow turn to the left. What you might see, I guess what I'm expecting is to watch that turn pointer match -- if you drew a line through the center of the airplane that they would match. Okay? The rates are different; the rate of turn versus the bank. And that's something that I think would be easy to adapt to. Very smooth, the color -- there's just a little bit of shading. Again, you see the stripes but it's hard to tell -- you see the stripes but you really can't see the terrain. And the wire frames, that just looks flat. That looks like a roof; it's V-ing up to a roof. Now unlike when we were at the higher altitude, the colors don't let the towers stand out. I guess if you didn't have a fishnet on here you couldn't see much at all, so if you're at 30 arc-second with these colors and this scenario, the fishnet is a little bit of a benefit. Because as you got down low, I almost felt like I had to work a little harder to make sure I knew where I was because I didn't trust the display. You could tell it was heavily smoothed and, because it was heavily smoothed and it was shaded, but you didn't see any depth to the shading, I think it's harder to believe. I don't know; maybe I'm stretching it, too, to give you that three. But I definitely didn't like the way the colors and the shading were, considering how smoothed it was. If it was going to be smoothed, you might as well take the shading out.

PRFN3: I can see the fishnet. Actually I don't tell a big difference between this and the one. Actually the screen's almost better in terms of seeing a little, what looked like houses. I don't see those out the window. Again, at this altitude, the fishnet doesn't do much for me. I think the resolution's so good that it's not needed. Now I'm losing my visibility, so even though I wasn't looking out that much, I'll transition in and it's not a problem. (during turn) Can actually see trees, can't you? I can barely make out the towers. They look like they're red this time. It will be interesting to try this same run without the fishnet if the towers stick out a little better. I can, I guess I can go over to the MX20 and find the towers and then come back over to this. You know as I get closer to those towers, with the 60 degree they're showing up about, out of the window, about where you'd expect to see them in real life, so the 60 degree FOV really works well, at least in this sim. Looks like there's a road. What I don't see is the airport. Everything's brown down in the valley, which makes the airport hard to see. They're (1 arc-sec and 3 arc-sec) both good. When I'm flying at least what it seems like is, it's probably perception because you still have to fly the primary flight instruments, but I think that it's easier when you can see the, see what looks like the ground, specially as you come up on the ridge. Now I know what the ridge looks like. Maybe that's familiarity, but it's easier and more comfortable to fly up to the ridge knowing what it looks like.

CCFN1: Not much to say. There's just not much there. I can see the fishnet and you can tell there's more resolution to the terrain but that's about it. Still just looks like a rough area at the bottom of the screen. Now I can see out the window. It looks like the valley comes around and forms a U. Is that what it's supposed to look like? You don't see that on the (PFD) screen. I'll have to look next time with the photo-realism. Alright, (transitioned) in the cockpit. (after turn) If I look real hard and don't pay attention to the plane, I can sort of tell that there are ridges out there. Now coming up the valley. Oh. You know it just looks like there are some towers on top of some rough terrain. I don't have a sense that there's a ridge there at all. Well, I'd say if you didn't have the fishnet you wouldn't even see anything. Fishnet is about all you get in terms of the terrain here. For whatever reason, it's very hard to tell much more than the fact that it's rough terrain. You can't say, "Oh, there's a ridge there; there's valley here." At least I can't, from what

I'm seeing. Okay, so even with the higher resolution it isn't very good. In fact I would say you'd be just as well off to have that color go right up to the horizon line and have it be solid, but go ahead and put the obstacles in. I think you could do that. I look at this and it doesn't look like there're peaks and valleys. It just looks like it's uniformly rough, so I think you have just a smooth surface. Save the memory space; put the obstacles up. I'm almost to a point I think we ought to rate this between three and four, or four. Probably should have done that with the other constant color. The more I think about it, it just doesn't warrant getting as high a rating as the others, or even close. "Minor but annoying deficiencies", with the resolution you had in this, I don't know that it was a deficiency, necessarily. If it was a 30 arc-second, I'd call it a deficiency. *(Asked to change the CCFN30 to a 4, and keep this one at a 3)*

PR1: It's hard to see a whole lot of difference here other than the fishnet's gone. I bet as we get going though, it'll look better. I can make out the horseshoe shape of the valley from here and I can see where my river's going. I don't know how much that helps me in terms of flying in weather but it's that good, and on a six-inch screen, that's pretty good. There really isn't a transition as I lose visibility outside. I've played with all of these different FOVs. (after turn) I like the power cue. I really do. It's like cheating. And I've yet to look at the velocity trend vector. I just, the tape doesn't move. Your speed doesn't change enough to really make it a big deal. Sitting here trying to do a descent, if you're in a regular airplane or you're in an airplane you're used to, you want a power setting. I don't know the power setting here, so this (power cue) is nice. You adjust to the airplane almost instantly. Now I can see every valley; I have very good depth perception. If I had to go low, I would know where to go. If I had to avoid terrain, I'd know where to go. I can see my towers coming up. Definitely like this better than the fishnet. It isn't confusing like the fishnet. I can see where my highline wires are going and the roads. (The towers are) standing out pretty well right now. You know, the only way to make it better would be to have them glowing yellow or orange instead of the darker color. And that might be one way to make them stand out. But I think it's a less confusing display when you take the fishnet away and whether you've shaded it or whether you've picked it up from the photography when you overlaid it, you really have good depth perception with it - this display.

BRD BL: I don't have a lot of interest in going back to flying IFR until the display's changed. I really don't. I don't think I'd fly IFR without a moving map today, but I don't have a lot of interest in doing it until these new displays get into airplanes. We're back with round dials and I can look out the window so I've got that going for me. Now, it'll probably be real interesting when we transition so if I have trouble, I'll be sure to note that. I may spend as much time inside just trying to hold these parameters. I should be outside looking at things. Now I know you've heard this before, but I think from an altimeter standpoint, this round dial is a little easier to read. And it's just a function of the tape. I can't believe I actually did this at one time. (after turn) Well I can see I'm over the ridge on the MX20. Actually, a reasonably stable descent coming up on a hundred feet above; so we'll start leveling out. Got the towers out of the window; looks like I might clear them. You can still use the MX20 to steer, if you had to. Tell you what. I really wouldn't be able to do anything else while maneuvering the airplane. Think you basically got to get straight and level before you fiddle with GPS or radio or anything. How do you say the way you fix it is by getting rid of them; I don't know that (ranking between 1 and 4) is fair. It's a four. If I had 10,000 hours, I probably wouldn't rate it a four; but I don't. So as a low-time pilot, I'm going to give it a four, saying it needs to be fixed with better, integrated displays.

EBG1: This was my favorite high altitude; let's see if it is at low. I think it's going to switch. I like the display the way it is now. You don't have all of the features but the colors give me a lot of detail (in terms of towns). It's a little bit harder to make out the horseshoe valley. I would think with the color differential it would be easier, but it was easier with the photo-realism.

Pretty sad, just trying to fly straight and level and I'm so fixated. Oh, I see the water now. (After turn) With this level of resolution, it's clear and easy to see the ridges. The shading seems to fit with what I see, and it didn't before with the 30 arc-second. . I will say this is darker than it was before. Which makes the towers harder to see, but with the green I already see the airport. I feel like the shading on this is accurate enough that I can tell where the valleys and peaks are. Over the ground it's probably a wash. If I had my choice, I'd rather have the photo-realism as far as terrain avoidance, but this is probably just as good. Maybe it's the color and shading. For one, the towers need to stand out more than this. They seem to be brown, and so is the shading. This is kind of an overall brown versus green. Of course the towers could probably be brighter on both of them, and that's easy; you just color one yellow or something. So that's negative for the towers on this hill but you can see the airport easier because it's down in the green. I think it's a wash between that one and the photo-realism and they don't get much better in terms of making it easy to fly. How much would I spend for the photo-realistic? I don't think I'd pay a lot more. I'd pay a little bit more. You know, if it was over 10 or 20 percent, I think that what I just flew would probably be good enough.

PRFN30: The 30 arc-second flattens this whole thing quite a bit, but what works with the photo-realism it seems to artificially give you depth. So if you had to go with the 30 arc-second, that's where the photo-realism is probably going to make the most safety difference. It's got to be the color (giving depth perception). I don't know if, when the photos were taken, there was a shade but you're getting shading in it. It's not too bad. Now the fishnet almost looks flat on top of a picture that has some depth from this altitude. We'll see what it looks like when we come up on the ridge. (after turn) This is a little bit better depiction of the fishnet. I think if you took the fishnet away from this, you would have more depth. The fishnet looks like it's cloth laid over something that has more depth. Look directly under the flight path vector, there's a valley. You can see the valley. You can see the valley because of the color, if the fishnets are straight. That's a good example of what I'm talking about. I can see my towers pretty well. The fishnet -there's no reason to do that unless that's what's giving you your terrain depiction. Constant color's the only place you need it because it's your only cue that there's terrain. It works through the fishnet. Photo-realism even flattened out with the 30 arc-second, offers you a little more depth. The fishnet takes away from that. Well, you know it's just an interesting observation that the photo-realism, it's almost 30 arc-second photo-realism. I would be curious to look at how much memory that takes compared to the EBG at, say, well, 30 arc-second. If you're talking about the same memory, you get a higher safety benefit from the photo-realism because it's giving you a perceived resolution. What we've talked about with the other, where you may get a false sense of accuracy, which would lead you to get closer to the terrain than you should. But you know we've been flying over this and the one arc-second, the valleys look like they're in the same place. So it looked to me like you're perceiving more depth than you're really getting, but they're in the right places. So you don't have the accuracy problem.

EBGFN1: My initial comment here is that it's really no different than the other. It's good resolution. I like this at the higher altitudes; I like the photo-realism at the lower. Trying to fly outside now. It's pretty hard. One of the things that we've talked about that I can see, I see it with this display. The digital electronic displays can be far more accurate than the old mechanical displays and they have much, much faster response times, but I don't know that that's necessarily a good thing. Immediate response from air speed probably doesn't need to happen. This is a good experience for me to fly this display. (after turn) The resolution on this is good. But you lose something with the darkness (seems darker at the lower altitude). At the higher altitude, and the lighter shading it was easier to use. The visuals are really neat. It would be easy to get used to this shooting approaches, I'll tell you that. Once you flew this for a couple hours and watched it match what you saw and then go out and get in the clouds; it'd be very easy to go

out and shoot an approach with this and trust it. Anytime you can get your velocity vector clear of the terrain, that kind of shows you that you're able to clear the terrain, basically. There are a lot of people that will make the comment that are unsure of this technology because they're afraid pilots will scud-run. But if you use that rationale then we would have never put the VOR system in, or never allowed GPS, or air bags in cars. You know it's really hard where you draw the line. We've already seen with anti-skid brakes, that drivers push cars harder now. I would say that 80 percent or more of our pilots are going to follow the rules and use this stuff right, which means saving lives. Lightening up the color and comparing (EBG and PR textures) side-by-side, I think that's what it would take. It's so hard to do it from memory and it really made a difference sitting in there with a laptop looking side by side at the displays. "How much more would you pay if it was just a little or a lot more"? "Is it worth it?", which are good question because that's really what the technology comes down to.

Block 3, Approach:

EBGFN1: I'm just following the boxes. All the turns and everything are there. I guess I was thinking round dial where I'd have to actually make the turn and watch the needles. That's nice. Yeah, the boxes are taking all my concentration; I don't know that I would have looked at the needles. I'm just looking at them now. Off-hand I'd say that the terrain is nice, but I don't know how much I've noticed it. I've fixated on the boxes so much. And I just noticed my speed's up. And I'm trying to look for the towers; I saw that I passed them because of the marker. I can see out a little bit. But I think just watching the display is better. I can see the runway. That's nice. What it is, is a confidence builder that says, "Yes, you're where you think you should be" if I were flying a chart. That's what I expected anyway out of SVS; that's what it's doing for me right now. *Stayed at FOV60 the whole time through turn and to Outer Marker.* "Is it satisfactory without improvement?" I know this is the, this is the first run. Based on what I did, I'm going to go with a "no" and put a four. Because I think the turn's too hard. The guidance doesn't give you help through the turn. You're flying straight, it's pretty easy. But you're kind of left hanging between boxes on the turn and I think overshot the turn, I went outside. Now we'll see as this goes along, maybe I'll quickly adapt. Then I'll bump this up, okay, you get a higher score.

EBG1: Coming up on the turn we'll try 90 degrees. And the terrain, I guess what it's telling me is I have real good clearance, so I'm not concerned about it. That's nice. You throw the boxes up and they pretty well dominate the focus, at least for me. It's a little bit better: the boxes being close together (FOV90). That does help. We'll just shoot this whole thing on 90 and see what it looks like. *Changed his mind and went to FOV60.* As I switched, it looked like I was in a different location. I have to reorient every time I change FOV basically. I can see some roads (and towers) down there. There's 90. Now as the wind goes away this thing just settles right down. What I really like is seeing the runway. You just put the velocity vector's circle right there on the end of it and it's there. I'd say it is satisfactory without improvement. Probably a big benefit over the round dials. I still think there's got to be a better way to cue you through a turn. But it's a lot easier to fly than a standard ILS. The terrain is really a comfort device. You know you feel like you're not going to hit anything. I think if you're close to hitting something, you know it would draw your attention away from the boxes and that's what it's supposed to do. The other thought I had was, the fact that if this were my home base and I knew all these landmarks, that would also be, the terrain then would be a confidence builder because I'd know exactly where I was.

EBGFN3: I can see the difference in the terrain. I don't know if I'd notice it if you hadn't told me. And again, that I don't think I would have ever missed the waterline symbol. The only reason I'm noticing it now, is simply because you pointed it out, but that's how I could tell I had a crosswind. If it wasn't there, it wouldn't matter whether I had a crosswind or not. If, I'm coming

into a different airport and it's windy, all it's going to do is make it harder to fly the boxes, but it really wouldn't matter to me to know whether or not I had a crosswind or windy conditions, and that's because of the velocity vector -- the flight path vector -- concept. It's making it a lot easier to fly. If you took that away and I had to fly awhile on it, it would probably be a lot harder to stay in the boxes. I'm fixated on trying to fly this thing through the boxes and I didn't even think about it (and forgot about FOV selection). In fact, I need to look at the MFD. I was looking around to see how much extra I have as far as what do they call it: "Capacity" "Attentional Resources"? *At this point, hasn't been looking at the MX20.* I'd have the MX20 on a lower range scale so that I had the higher resolution on. I'd auto-range scale it. I can see the runway here. I don't mind the fishnet right here (short final). In fact, to some extent, it's beneficial. It tells me I'm low. Of course, I see the runway. And I'm about a hundred high. There's the runway visually. Now with the boxes are up, some of the resolution I don't know, going between three and one (arc-sec), it isn't a big deal again, because you're flying the boxes. Maybe if I was flying raw data, I'd be nice to see a little more detail in the terrain, I don't know. I think it works real well for everything but the turn.

BRD BL: If I can even do this, this'll be fun. Started that turn probably too late. Looks like the diamond's wide on the glide slope, so I'll have to get active. Now I could have looked over at the MX20, and I didn't for that turn (*Turned using diamonds only*). We'll just try to hold this, which is a workload until we get to the knoll or the diamond comes active, one of the two. Glide slope's active. Back left to get on the localizer. Ouch. Just about on the glide slope. There we go. Starting down. And, actually, I'm trying to let myself use the moving map a little more for lateral, which should be really helpful. I'm still high. A little high; a little fast. Diamond's coming back. Corrections are too big for this close. Okay, almost back on the glide slope. Going a little fast. High. Coming back. This is fun. I think everybody needs to try this. now high again. Over to the right. There's the runway and I'm 20 off minimums. There it is. (end of flight) It's (standard gages) just extremely difficult. You have no terrain awareness. Now the MX20 at least lets you have some confidence you're where you think you are, but to three-dimensionally locate yourself in space using the round dials has always been hard for me. That's probably a factor or a function of the fact that I don't have a lot of hours. Very easy to miss one parameter because you fixate on something else, too. (*17 seconds off localizer (needed to fly left) after the turn. Another 7 seconds was high and right. Another 5 seconds too high.*) If it would be in my own plane, I probably would have had the topographical moving map on the MX20 coming in, so that I could see landmarks. That's what I would use. Very hard to use round dials.

PRFN3: My first impression, coming back to this display, is just how nice it is to see the ground and the horizon. I don't know that the resolution of the ground right at this point makes that big a difference, but we're low enough that the ground now is up to the horizon. That makes a big difference; I have a huge horizon now. What you don't get is a good cue for your bank angle and I'm not sure why. It doesn't look like 10 or 20 degrees to me on the flight path vector. Same as the complaint as yesterday. I'm not sure why I have trouble with that. Don't have a lot of crosswind. Don't have a good excuse. Should be doing better. (Are you talking about the roll pointer itself?) Yes. So if I were coming into my home base seeing that ridge to my left, it's a nice thing, passing the towers, knowing that I'm not too far to the left where I could hit the ridge. Of course, I have that on the MX20, too. And again even with this display, I think that I'd want terrain warning but I'd want the topographical map page instead of this page on the MX20. That would give me a good reference to where things are from a Gods eye view. Alright, starting down. Put the velocity vector on the runway. Love this power indicator arrow. I can see the buildings. I see a road with the buildings beside it. I think here the photo-realism stands alone and the fishnet doesn't do anything for it. With the other, that's your only relationship to the ground, but here you have some really good pictures, so I think I'd do away with the fishnet on

this. In fact, now I know I'm going over the highway that circles just north of the airport. I stayed with the 90FOV. I don't know that once you get through the turn, it matters. I felt that I could see the runway at 90. Obviously I could see it at 60. I'll try to shoot one at 30 and give you some feedback. Really nice. I gave it a two because the photo-realism really comes into play as you get within what looked like about 800 feet of the ground. And in an airport environment like this one I'm flying over now, that was nice to see; it's comforting. It really was a VFR picture. I didn't think the photo-realism would matter that much or that I would think that it made as much difference as I do, now that I fly it. I like it. And the fishnet didn't add anything. It may not have taken anything away either, but it certainly didn't add anything.

CCFN1: My first impression is I just have two colors. It's basically a brown and blue. I drop my gaze, I can see that there's terrain there but I really can't make out where the high terrain is; where the lower terrain is. It just looks like it's there. Let's go to 90 for the turn. You couldn't see the terrain without the fishnet. It looks to me like it's a poor computer game. Now I can see terrain out the window, so obviously I'm flying close to something. Alright. Let's get through these boxes clean. There we go on down. Now if this was shaded, it might make a difference -- you know, constant color with some shadowing, like the early video games. (Do you think if the actual box tilt angle cued you as to what bank angle you needed to go through that turn, that would be better?) That would help. You know one of the things that came out of AGATE is using the first one or two boxes as a flight director, so you can't fly out of the box. It steers you to the rest of the course. And so you just fly whatever the box tells you to fly. That's something that's worth trying. It isn't quite as tight as flying a standard flight director, because you have a little latitude to move in the box, but most importantly, it now becomes a predictive flight director, which is really what these boxes are doing for us. It's just telling me I'm getting ready for a descent, or it tells me I have a turn coming up, and a flight director is just instantaneous; when it moves, you have to move with it. And the other thought I had was a pathway where you're just flying a road, which that may be easier for a turn. So you could use boxes and as you come into a turn, you just put a road at the bottom of the box and you just fly on the road or drive on the road. Towers, okay, you know what I haven't really noticed at all, the terrain. It just doesn't stand out, fishnet or no fishnet. Runway is standing out a little better with the 30 FOV. And it looks to me like I can put the power right on that 3-degree line and then just fly the plane to it. It almost works if I'm a little fast or a little slow. Should be a little more steady. I see more motion in this because I'm in a 30-degree FOV. (At the lower FOV, you will get more sensitivity in your symbology.) So even though the display may be better, the workload's higher. I'm working harder trying to stay in the box only because of the sensitivity. It's like on 90FOV, I just let it go right on down. I did very little work at this point. Yeah, a lot lower workload at 90. Visual cues are better, too. Now what if you did 30-degrees FOV with more boxes? And the primary reason it doesn't get a two is the terrain cues, the terrain awareness; it really didn't have any. In fact, other than the comments I gave you up front, I think I just, I didn't look at the terrain after that.

CCFN30NT: Okay, so what I have basically is blue/brown now. Let that (localizer) center first. This is pretty close to what you would have if you had just a flat bottom with obstacles. Because I can see my towers, so that's a benefit. None (no terrain relief) that's going to draw my eye to it. Glide slope's active and it's there, so it's down. A little bit above. Now, I'm going to try something and that is just simply to come over here with the flight path vector on the runway. Again, the MX20 would be a lot of help in this scenario, I think, if it had the topographical terrain and it was on an auto mileage. Five miles gave me better resolution. The resolution's too low now. And this is what's great about this flight path marker. I'm not looking at my raw data; I'm not looking at the needles at all. I'm just putting this on the end of the runway, which pretty much sets me up on the 3-degree glide slope. Now, we were pretty close to being on glide slope

and localizer at the beginning of this, which is kind of what we were talking about earlier. I'm to the left of the course slightly, but I can see that in the display and it's going to line up as I get closer to the runway. I'll just move it over to the left a little and then come back around. There. That lines them up. Too easy. Thirty-degree FOV is needed for this to do that: to make the runway large enough. Sixty-degree runway was too small. I didn't have any of the cues on the ground or the boxes. No, it's a three-and-a-half. Okay, this is, it's almost as difficult -- raw data is raw data -- it's basically flying the same information as on the round dials. The only thing that made it better was having a velocity vector and the throttle cue made it easier to hold altitude and air speed, but steering was just as hard as flying round dials. What brings it from a four to a three-and-a-half is the fact that once you get the runway in sight, you can just fly the runway cue. Well, then it's a three because the cues make it easier to fly (than round dials). The display is a lot easier than a round dial for a good chunk of that approach, so it probably deserves a three. The tunnel helps. It makes it a little easier to fly. Like I say, I'm not so sure that it wasn't about -- it was probably about the same, tunnel or no tunnel on the approach -- just being able to put the velocity vector on the end of the runway. If you're on 60- or 90-degree FOV, that's probably what I've been doing from the knoll inbound. If I can put this velocity vector on the last box, the smallest box, that's what I've been trying to do, and that's equivalent to putting it at the end of the runway.

PRFN1: Beats the heck out of the CCFN. Alright, this is what's misleading, flying straight through boxes that are curved or crooked. I think matching the box angle closer to what you're banking would be probably a helpful improvement. I'll try to look at these dog bones. I really haven't on any of the other runs. I would say that you just don't need those, in all honesty. If you were really going to implement this, where you are in the box is pretty much a visual, I mean, it's visual. What you care about is where the diamonds are. Let's try 30FOV, not (Unity). Coming up to knoll and we're coming up on a descent. Okay, that's 30, 60FOV. See how the boxes really just give me a place to put the circle? I can just put the circle inside the boxes and I'm there, but that's a straightaway that let's me do that. Put the engine cue right on the 3-degree glide slope. I like some of these symbology features. The concept of this for me is pretty straightforward. I don't know how it is for folks that come in from GA. I think it's the greatest since sliced bread. This (short final) is where the terrain depiction is really nice, and again the fishnet just looks like roads, and it interferes with the highway that I just flew over. The fishnet's a real negative but the terrain display is nice. And I'm 200 feet above missed. What the boxes do is hide the runway but it doesn't matter because they're encapsulating the runway, and again I just put the circle inside of the smallest box and I'm there. But, sorry, I'm in a hurry to get to the end of the runway. This is really good with the exception of the steering cues through the turn. Again, it doesn't get a 1 because of the turn cues. Yesterday I wouldn't give it a one because I thought there were better cues to fly -- I can't think of them now. There's got to be a better way for the turn.

EBGFN30: Well, the shading gives me a little bit of a feel of the terrain; that it's far enough below me that I don't have to worry about it. That beats the constant color. Alright, now I'm at the 90FOV for the turn. I think that that definitely helps the turn. You can't turn too early. I'll try 10 degrees. (*Switched to Unity on about 6 mile final.*) We'll just see what happens. I'll just get a data point here for the workload since it's part of the study. Now the horizon's down towards the bottom. I guess that's the way it should be, though. Starting down. I can see the runway. The boxes are spaced pretty wide, which doesn't help here. Once I get over the hump there, put the circle on the runway. But also I'm moving slower obviously because of the size, I guess, and the number and spacing. *20 seconds low (1 dot high) on approach* Now, the depiction with the terrain, when I look at the MX20 and all the terrain around me and I come back over here and I look at this depiction, they match. I would worry quite a bit if I were looking at that

MX20 and I didn't have a terrain depiction on this display. The display lets me know I'm okay. And it says, "Okay, there are the mountains." Even though it's 30 arc-second, so it's fairly smooth, at least with the colors, I can say, "Okay, there's the mountains. I'm okay." It's better than nothing. Workload's a lot higher. Way too high. Oh, I just wonder if I've been off-course quite a bit with this. I'm looking up. Looks like I'm going right there, and yet I've got a diamond that says I'm low, and the dog bone says I'm low. Yeah, these boxes are spaced way too far apart to fly (with Unity FOV). At least that's what it looks like. And everything's red on there. The terrain display wasn't bad; wasn't that bad at all as far as terrain cues. It's definitely not a 2 and it's not as good as the photo-realistic. I think that the, on short final, it's not a good turn for an approach, but as you get down close to the ground, the photo-realism makes a difference. You don't have that with this display. I tried not to put too much of the unity FOV in. I'd probably rate (Unity) "unsat", causing higher workloads, when you can go to 60 or 90 FOV and your workload's cut in half. There's enough terrain information with the shading, even at 30, to correspond to the MX20. If you just had the MX20 alone, it looked pretty scary where you were. But with, even as poor as 30 arc-second is, it was good.

CCFN30: Going to 90FOV. You can tell you're over a ridge a little bit, but it doesn't look like there's much terrain to it. Guess off in a distance I can see a hill, might be a mountain. I'm trying to watch the dog bones and it's screwing me up. So, I'll just go back to the dad gum boxes. (At 60FOV) I thought I'd just see how they looked relative to what the picture was in the window. Now I see my river. I've never noticed that river before. Coming up on my descent. Your fishnet in this display really just tells you, gives you a sense of motion and that's about it. The obstacles I think are a benefit though. I've got two towers coming up on my left. Circle on the last box should get me there. The towers are out the window. Hard to see the runway at 60FOV; it's there but it's small. I just assume it's at the end of the box. Yeah, I guess I'm crossing over that highway since it's diagonally across the boxes. You know 90 I think probably makes it a little easier, because you have the boxes closer to each other. More targets to shoot for.

PR1: There's not much to say this high up and starting, but the view from here is really nice. The photo-realism is just amazing at the one arc-second. Everything's right there. We're trying the boxes at 60FOV. Going through here (turn) I should be able to go about 15 degrees and come right through that next box. Yeah, I'm flying through a lot of stuff though. Lot of empty air space, which is what you said. You get more boxes on the 90. I don't even notice I'm in the clouds; I just realized that. (Flying heads-down) most of the time. So I don't notice when I transitioned. The boxes are high enough workload you won't look out the window. Pathway might induce a little more relaxed response, I don't know, as far as just staying on top of the highway. But again, I could look out the window. As we get lower, I caught towers. I see those. Somewhere we crossed a ridge and I didn't think I was that far below my altitude. One of the flights: I think it was the constant color flight. Maybe I was way off my altitude. Didn't see it out of the window, though. And, I'm coming up on knoll, it's time to go down. That was the ridge I think I saw, because it was right at the beginning of the flight. Probably should have looked down, but you catch it out of the corner of your eye. It's there. So the turn wasn't very good at 60. Sixty seems to work real well here (on Glide Slope). Lot of resolution on the downtown, now I know if I lose my engine, I've got a highway right here. I don't know if you've heard that comment yet. That's a comforting thing. I'm better without the fishnet over subdivisions. (60FOV on short final) I would say that as you get this close, these boxes are just right for precision. The level of precision in flying in the center of the box is just about right as you get closer to the runway. Display isn't going to get much better, only the symbology and steering.

PRFN30: I can tell I'm flying over a ridge. Everything's flattened with 30 arc-second, but you still get shading, which gives you a lot more information than you can get with just the colors. I think it's the same comment I had yesterday. We were interested yesterday if this would really show up as beneficial even at 30DEM, as we get close to the ground, so we'll look for that. I'm back on 90FOV for flying through the turn. The distance from box to box shouldn't be any greater than what we're getting here on 90 for turns, if you really want the precision of being in the center of this box. I wouldn't want any more boxes here, but through a turn it might help the turn, or it could be just getting the right bank angle would help the turn. This should, that's what you'd want to look at, the boxes, bank angle, both. Now I'm over the flatlands. I have pretty good awareness of where things are. A good chunk of this country doesn't have a lot of terrain variation. The photo-realism would make a big difference there. And you wouldn't have to have the high memory issue with one or three arc-second. You could get by with this 30DEM. (What about areas of the country that have more drastic terrain changes, like out in Colorado or up in Alaska?) No, I think 30 is not enough. I don't know that 15 is. Three gets you there, though. I felt like 3 was enough; 1's great. You know, if you can have everything, ask for everything; but 3 was probably adequate. Wonder if they could do a scheme if memory's an issue where, as the terrain flattens out, they go to the higher arc-seconds and as you get around rural areas that have terrain issues, you bump that to a higher resolution. Just like they do around airports now. (Fish Net) interferes with the picture. I flew the 30 and the 60. At least I noticed on the 60 last time, the diamonds weren't centered and they're centered now. So I wonder if the FOV at 90 and the box size is making it easier to fly these diamonds centered. Just the one that I think is kind of prime. It doesn't look any different than the one arc-second as you get into the flats and over the town (*specifically for the photo-realistic because the four-meter imagery data was consistent between the one-, three-, and the thirty-arc-second*).

Rare Event:

PRFN30: It's just real low with what I'm looking at outside. We're on 60FOV. I can't believe it, because it matches so well with what I'm looking at outside. Think I'm pretty solid on FOV for this display without the boxes. The color and the shading are probably doing more for it (than DEM resolution). (after turn) I just have the impression I'm getting too low to the ground. I didn't have that yesterday. I'll fly the numbers for you. Probably the 30 arc-second. You know I'm a lot lower; and I'm at 5,300. Am I missing something here? It's definitely satisfactory without improvements. But, I'm going to put, I'm going to put a three, because there's some pilot compensation required. And that's not so much the terrain or the 30 arc-second, as it is the symbology, alright? Make sure that I get that point across. Actually the PR 30 arc-second isn't bad. *A little high at the start, but not for more than 10 seconds. Very shallow turn - 10 deg bank angle. 3:36 has impression that he is much closer to ground than was yesterday. Started climbing 4:10. At 4:20 again mentioned that something was wrong, and asked if he was missing something.*

Subject 20 (BRD Baseline):

Block 1, High Altitude:

PR1: (Didn't have waypoint programmed into the MX20 at first) I was going to the FOV and looking there, but I guess I didn't really have a sense of how high I was, really, above the terrain there. I was more just trying to get the feel for controlling the aircraft. *He didn't descend during turn. Was a little disorientated because he didn't have waypoint. Didn't get to target altitude.* The waypoint there . . . and then when I just, I got a little brain locked when I noticed my rate of descent was going down there, descending down below the altitude I was supposed to be, but yeah, the higher rate of descent there. But I was primarily locked on the main display instead of kind of looking over toward the navigation, so even if that waypoint were there, I might not have even caught it right off the bat.

PRFN30: I like the photo realistic. I mean looking down there and stuff is very realistic. It's kind of dark. (I have it at) full power and it (simulator) wasn't doing that before. I like the wide one right here (FOV90). With that kind of FOV like that, you see the wide angle, but you don't really have a feeling for the elevation. I can see the fishnet and a little bit of the contours. (after turn) It's still kind of hard to sense how high I am above the terrain. I'm not sure if I'm heading toward the city there, the airport there, but it's still kind of hard to sense my true altitude above the terrain there. I can see definition of the ground, but the photo realistic, it's just hard to tell height wise. *Did overshoot turn, but not by much. Was a very shallow turn.* I'm just still trying to get a feel for the simulator input commands and stuff. I mean the terrain stuff when I scan down there is phenomenal. It's just a matter, for me, of getting familiar with the simulator and I guess if I was in a terrain area I was more familiar with, off the bat I think I would be more comfortable with that. But I look down and it's still kind of hard for me. I look down and I can see the thing there, but to actually kind of picture it in my mind, I guess, and to control the aircraft, I'm still trying to control the aircraft more than I am looking at the ground there.

CCFN1: It looks like an industry display. It's very difficult to differentiate the obstacles, the hills and stuff like that. I can see them slightly, but with the photo realistic it's much more detailed here. I can see the river, I can see hills, but a lacking of definition. I mean the definition, I understand, is there, but it's hard to differentiate. Actually to me (FOV) is not making really a big difference. I mean I don't want it up real close and stuff, but yes, (there is) quite a bit of difference between this and the photo realistic. It's hard to differentiate. Like there's a valley I can see. There's a river there. There's probably a valley that goes around. I can look off in the window there, but it's still kind of hard to see ahead and see what's going on with that. I guess it's a lacking of different shades. It just got real nose heavy there. Yeah, just all the sudden it started to take a dive. I'm having to keep the pressure back quite a bit on it. If I let go, it's going to drop just right down. I have to trim up there a little bit. Yes, (trim is responding). It all the sudden just went right down. See, I'm well below the 95. (after turn) I see the towers there. Is that the runway environment off to the left there? I think that (FOV Unity) looks fair for looking toward the runway there. It really lacks the three dimensional, the depth, compared to the photo realistic there. I mean, I can see the city and all that stuff, but it was harder. And I could see the further out ridges, but it was harder to differentiate, I guess, the closer ridges. You just don't get that depth of the multicolored type display. I don't know what the deal is, but all the sudden I had a heavy nose down pitch thing. The terrain situational awareness, especially starting out, wasn't there for me at all. I could see faint outlines, but you don't have the multicolor display differentiating the different elevations to the ridges and stuff. Until I got actually toward the city there, for like if I was coming in on, I guess on an instrument approach, that would help me out. I was able to see the towers, I was able to see the runway environment, etc. But further out there it was kind of hard for me to definitely be able to tell the hills.

EBGFN3: I definitely like this type of mapping here. I can see the contours, I can easily see the valleys without having to try to stare at the screen a long time. It looks like it helps the scan out a little bit; quite a bit more than at least the previous display there. It might have been part of the problem there. I was trying to scan the terrain, where here I can look down and it's very quick to see what the terrain profile is like. Having the multicolor and stuff, the different shades, makes it much easier to differentiate. The terrain now, it looks like something you'd see on a sectional or something. It's easy to interpret. (90) FOV is what I like right there, for now. Definitely less time looking at the terrain. I can just take a quick glance real quick and go to the flight gauges there. Okay, the airport's in sight there. (At Unity FOV) kind of a little more touchy. Looking at the gauges there, I tend to see myself slightly move around a little bit more. It's more sensitive, I guess. Compared to all the other runs, I'd probably put it between a 2 and a 3, but I'm going to

put a 2 there. Having that map there, I was able to release my scan back to the instruments where they should be more, whereas before, like I said on the others, especially on the one before this, I spent a lot more time trying to figure out the map and stuff. This made it much more easier, having different shades and then the shapes representing the different elevations. That was probably one of the easier ones, at this time, to use.

EBG1: I guess right now at this time, the fishnet is not making too much of a difference to me whether it's on there or not. These displays are incredible. I can see having a display like this where we operate would be incredible. Most of your flying down there is through waterways, the hills and mountains all over the sides there, but even with something like this, with this type of resolution, the workload, the stress load would be far less. I was staring at the terrain so much. *Was so into looking at the terrain that he lost 200 feet in altitude before turn.* (after turn) I can see the airport environment very clearly. Again, with something like this, boy I feel like you could, when you get down low and you'd be able to tell the valleys very easily and be able to fly the airplane. I can see as you get in closer to go for the unity coming in to a terminal area there, it would be much more useful. Further out, I prefer 90FOV. I mean with this visual right here, besides just the stress of controlling the aircraft here on this, it's phenomenal. I feel very comfortable flying this screen here. I mean if you had to come down and make it to an airport there, your situational awareness is phenomenal. On that one, the altitude drop and stuff like that was my fault. I was kind of awed by the details and stuff. I was sitting there staring at the map quite a bit there, so my performance was down a little bit there, but the situational awareness and presentation, that was really good. Boy you guys are easier than I am on my pilots if they're off for more than a few seconds. The mapping is, like I said, phenomenal. I feel if I had to, I could get down and easily follow those valleys there if they were representative of the actual. I don't think I'd have a problem at all flying down through those, or if I had to get down, if I was trying to get to an airport and didn't even have the instrument, like a VOR or anything like that, with that I think I could make it back down to the runway there, where the lower resolution, I'd be more hesitant to rely on those things. It's incredible. I was just going to say this is really, really neat because it displays what you have when you're looking downwards. This is the forward view. I mean you could put me, if this was displayed like in the Juneau area, there at the higher resolution there, you could probably put me in pretty much any place and keep from hitting the hills there. It's just amazing, what I've seen.

EBGFN1: I guess I'm not really staring at the fishnet because I'm thinking it might take me more off looking at the instruments, the flight displays. So I guess the idea behind fishnet, if I was trying to judge distance, if I was flying over a known area or something like that, and I saw something up ahead like I was coming up to a point at that 90 FOV, I mean I think that would help me judging distance. But right now, it doesn't really pertain to me, I guess, judging that distance to the next ridge line like that, because I'm not really putting myself down in that situation where I'd be flying. Like if I was down low and I needed to know how far away am I from that object, or if I am looking left to right, how many feet is that, if I was going to make a turn. So right now, I guess it's not the primary thing, but I can see where it would be of great help in other situations. *(FN is hard to see).* I can see the soup ahead of me, can I make a 180? Are we back to VFR? Just joking. I can see how unity like this really isn't very useful until you get in to a terminal area. (After turn) I can see the airport antennas up on the hill there. (On scrolling through FOVs) Well I guess as I get to know the area there, I don't need to quite see so far out. I can start to come in. So basically going from flying along there and getting the big picture, and then as I get in closer I want to get a little closer angle, or closer, you know, bring the objects in closer to me. I'm not quite sure what I would use it like if I was following along a shore line there, and saw things approaching, or whatever. I'm adjusting to figure out, like if I was flying along and I was flying in marginal conditions, I think I might have it out further and

then as the weather started decreasing, probably bring it forward, and then as I made a 180 degree turn, I might probably bring it back out a little bit until the turn was finished and then zoom it back in. I'm getting to feel more comfortable with it. I definitely liked the display there, I'm getting to feel more comfortable as I go along here, with the handling characteristics of the aircraft. On like the velocity vector, I still find myself kind of, I'm like a little bit back behind it. It's kind of jumping ahead and then I'm putting input after it, but I felt like I was in a lot more control and a little more relaxed on that flight there. Situational awareness-wise, though, I seen the terrain there, that didn't cause me any stress there, by wondering exactly where I was, or trying to decide where to go or anything like that. It's very high detail and just a little bit on the pilot skills was the only thing. But, I guess working with that velocity vector thing is still kind of throwing me off a little bit.

BRD BL: Let's just say if you were in this condition where all the sudden things started dropping down like they would on the video, and I'm going to this waypoint, from there on, I think I would be terrified, basically having no navigation or anything like that, just the waypoints there and going in to conditions like that would not be a good feeling. Flying the instruments is not too big of a deal or anything right now, but again, just having no situational awareness now besides knowing that I'll be coming up on a left turn here shortly. I guess on that there, I was trying to create the stress that one would feel if flying on the standard gauges and inadvertent IMC and dealing with passengers and dealing with the ramifications of possibly killing people, and then also having to deal with the FAA and stuff. So from that aspect of it, flying the airplane wasn't difficult, but the stress of not knowing where I was and possibly killing people and stuff would have brought the stress level incredibly high. I don't really feel it because I'm not in that situation, but if that would have been a real situation there, the stress on someone that didn't really know the area, especially a brand new pilot or something like that, could have been a major factor to losing control of the aircraft, I think.

EBGFN30: I guess the thing for me too, on the pilot performance type thing, is to be able to see my RPMs and stuff, where I understand you've got this velocity vector and I can see on the left where the air speed goes up and down, but that kind of throws me off there, because I'm used to kind of a power performance thing. So I'm still a little bit lacking on that, I guess. But on the analog, I can see exactly where the power is, and then I know the performance I'll get, where this is still a little new. I can see the contours at the peaks aren't quite as great, but again, until I got down to a lower situation, I see the resolution is less, but actually, unless it was an area I was familiar with to really be able to give deep input of how accurate or anything like that, it is. Again, I have the sense that I'm a few thousand feet above the terrain there, but I can see that it's not quite as detailed. (After turn) When I look down on the map, I can see the difference in the resolution, but again, it's still pretty darn detailed to me, right now. I'm just flying, trying to hold the airplane level here and stuff. I can see what you mean, where you don't see quite the detail, and the hills there are more like straight lines. I can still see the lake out there. I can see the towers. (Even at 30DEM) it does enhance situational awareness, it definitely does. (And you would still use it, for instance, up in the Alaska area, where the terrain is much more drastic?) Yes, I mean I would have that and then again, it's an experience thing. You fly the same routes thousands and thousands of times over the years, but even someone who didn't know the area, if they get themselves in trouble, especially up there, it's very easy. If you go inadvertent IMC there, especially if you're over waterways, if you're in passes or you're in narrow areas, that could be a different situation. But primarily almost all of your flying is done over the water and I would say it would be no problem at all to either do a 180 degree turn back into VFR conditions, or if you need to do an alternate destination, I wouldn't feel that it would be a problem at all, period. Over land and stuff, again, if I was in some mountainous terrain where it was all hills and mountains right there, without any waterways or really knowing the area, then it might be a little

bit more stressful or something. But this here, I could easily with that resolution, get to anywhere and I wouldn't even, especially if it was an area that I knew, and having this to be able to avoid the terrain, it would be no problem. Now the brown bottom and stuff like some industry concepts will have, that there would make me a little more uneasy. Not actually displaying the water like that. It would just be showing the contour intervals and the contours of the terrain there, that would be less useful. Well, I guess I just feel like I'm just flying the parameters you guys are giving me. It would be a lot more useful if it was an area I could go through and really be able to fly the airplane. I mean right here, I feel like I'm using more motor skills and just looking and flying the airplane as required to do the different maneuvers and everything like that. *Being unfamiliar with territory, doesn't really know what "accurate" is, so feels like he is spending a lot of time become familiar with the flying area, and not being able to concentrate on giving us the feedback we want.*

PRFN1: It's phenomenal. It's pretty amazing. I mean you feel like you're in VFR conditions, even though I'm looking at the screen there and I can see the stuff coming up. Of course I'm looking at the display a little too much there. I guess the fishnet, too. When you're looking at it here, it helps differentiate, it gives a little more detail. I mean you can see the mountains and hills and all that, but it gives a little more definition with the fishnet. But it's not helping me judging distance or anything right now. When we use our GPS's, (there are) actually lines of latitude and longitude, and I use that to help judge distance, because I know what the scale is. But this here really isn't helping me for that, but it does help kind of see the hills a little more clearly. I definitely see high resolution looking toward the city there in the hills. One thing I do like about the other, though, too, is it shows you the elevations in the different colors. I kind of like that too. It seems like it's easier to differentiate, I guess like the valleys. I can see them (with the PRFN1), but it's a little bit easier with the other one. I guess it's where the fishnet kind of helps with that, lacking the different colors for the elevation. I see the airport. It's kind of hard to tell the towers, though. Maybe because there are so many different colors on there. I mean it's pretty, but it might be because there are so many other different shades in there. I guess descending there and not catching it. But again, I'm trying to look at the displays and trying to look at the terrain and stuff like that, and trying to tell the difference. See right now, if you want input on the terrain and stuff like that, it takes away I guess some of my time and attention on what the airplane is doing and some of my control of it. So I'm just kind of going back and forth there. I was spending a little more time initially when I think you were asking me on the terrain, and I was kind of staring down into it.

CCFN30: It would make me very uneasy trying to use this in a VFR and inadvertent IMC, and trying to get out. I think that with this, again, doing these things isn't that big of a deal, but, in real life, it would be a more stressful thing. Having this compared to nothing, I still think it would be a life saving thing. But it's just not quite as, near as good and it doesn't have the detail and quite the situational awareness. Again, looking outside and then looking back at this, I can see the river but other than that, I don't think it would do me a whole lot of good really right now, until I got into the terminal area where I can see the airport and maybe the antennas or anything like that. But then that hill is just, outside of there, I mean I'd be following the river line and I know that's probably lower elevation through there, but how low, I don't know. (One current industry concept currently does not have waterways displayed.) That was something I talked to the designer, or maybe the owner of the company and a couple of the FAA people that came in there, but I don't know what they're going to do with that. They have the ability to do it, but again, the FAA thinks the pilot shouldn't have that much display because then there's a fear that they'll be flying around in the clouds all the time with that type of stuff. Again, they're going away from their thing which is to prevent collision or I mean control flying into terrain, so I'm not sure. It seems like they're going kind of backward again, from what they wanted to do

originally. But here, looking again, all I see is that river there. It's very limited. I would not feel comfortable descending if it was a lifesaving thing and I'm trying to get to the airport or whatever, and I looked out and having some type of other navigational VOR header or anything like that and then having approach laid in there. Or be very familiar with the terrain and know exactly at a certain distance, what I could be down to. So I would rely more on conventional type navigation. I would use this as the primary flight display, but for navigating again to a point, I would rely on some of the other stuff. This is less than what we have capable with the GPS stuff that we have for the pilots right now. I can see the antennas there. I would use this as primary for controlling the aircraft and then whether it be GPS or backup navigational aids for the localizer here, or whatever, but I would definitely have something else as a backup to assure terrain. (After turn) I can see the water. It's a little easier to see right there, that little lake off the nose there at about 12 o'clock. It's a little easier to see, just because of differentiating between the brown and the blue there. But I know there's a hill over there and I can't tell that with this. And I can't really tell the base, except I can see a river off my nose there and I'm assuming it's going to be lower terrain in that area. Again, I don't know. There's just not really a sense of depth or height. I can see a little bit, but it's very limited. So here on the mental demand it would be greater, because I would be relying on having to use other equipment. Physical demand would be more. I would have to be moving around, tuning things in, dialing things in. Effort would be greater. Frustration probably would just be intermediate unless things started to go bad. It's kind of hard to use this (scale of 1 to 4) because the flying was okay, but in a real life situation, things would have gone way up, if I actually had to try to save my passengers. The quality of flying may have gone way down, dealing with the lack of information on the screen there, and having to utilize other things to maintain control of the aircraft. I'll put it down as a two there, but that's just the quality of flying, with what you have listed here on the right hand side. Again, if it was a real situation, or if I had to go through the whole scenario there and try to get it down to the ground, the flying quality would have dropped down. (Thinking about it in real-life terms) I would have dropped down to 5 or 6. Controlling the aircraft wouldn't be a problem. It's avoiding the obstacles that would be the problem. And if you're trying to put your mind on obstruction clearance, then that can affect your quality of flying, possibly.

PRFN3: You get a sense of more of the terrain at a further FOV(60). You know what else might be a good thing, too, is to list somehow on the display there, maybe even in the bottom left there, because I see a blank spot there, the FOV. I don't know if that's something that's going to be changeable in the end product. I guess in the lower altitude when we go into that, I'll be able to give a little more input, I guess, to see objects and actual terrain. Also having a closer FOV might give a pilot a sense that he's turning, give him a false sense and he might feel like he's turning faster than he really is. When you zoom it in, it looks like you're really zooming. Just for the display there, it's very good situational awareness and it's just still a little bit working with that velocity vector. I catch myself, if I started to stare at it too much or anything like that. It almost feels like it's a lead/lag type of thing for me on it. When I see it do something, I put inputs there. It's probably right now taking a little bit of my, I guess my resources mentally, is trying to get that thing figured out totally. But situational awareness is real good, being able to see that stuff. Again, I still kind of like the one with the different colors for elevations. It's a little easier to tell, like the terrain, the heights. Once I got used to what the different color codings meant, elevation-wise. It would be easy to use. But it's still very easy to maintain control of the aircraft.

Block 2, Low Altitude:

BRD BL: I can faintly see the ground down below me and I can't see ahead of me (OTW). Now I'm losing the ground underneath me. *Interested in MX20 and what the colors mean.* (After Turn) I never saw any of the terrain or the ground (OTW). If I was just simulating the real thing, or how I'm feeling now, my mental demand would be low, but in a real situation it would be kind

of high. Again on this, the standards I think are okay there, but when I actually go through this chart here, adequate performance attainable with a tolerable workload, I mean if you're going to a real situation there, there would be major deficiencies, because you're going to need backup to be able to fly the airplane and it would be a matter of time possibly, until it hits something. But I guess with the way you guys are working it, it would be around a three. It says here, pilot's decisions, is it controllable. Well, it depends. There I don't know if I would have made it to the runway with just what was there, so that's what's throwing me off I guess, this back sheet here. If you're going for the flying quality, I was able to keep the airplane upright and within the standards I think, so I mean that would put that around two or three. I'll go with a two. Again, actually this time I did (use the MX20 more than in the other runs). All the other times, I was just looking at the waypoint. I wasn't even actually looking at the colors but this time I was, because it was just I'm more comfortable feeling in the simulator and knowing how it flies and stuff. Again, this flight display (integrated PFD) and stuff like that is the way to go. But it's a little bit harder for me to control the airplane. I'm just used to those analogs, but this is something that would easily be able to adapt to this. It's just a matter of getting a little experience with it. Just like when they bring that new industry system there, they say it's going to be a minimum of training new pilots, two days for eight hours a day and stuff like that, to train them on how to use this stuff and get used to it. But this is definitely the right step.

EBGFN1: I'm looking on the MX20 off to the left there at about a 10 o'clock position. I'm taking it that that's some of the antennas over there? And I can see the one that would be on the hill and then the two to the left of the ridge there down over by toward the airport way, I guess. (60FOV) seems to work pretty good. I like (the terrain depiction). It's easy. The other is prettier, but this is easier to recognize things. It's a little more useable. I think (the FN) would play more of a thing for me if I was down lower and I had set distances in my head and I knew over time experiencing what each square would mean to me right now. The fishnet isn't quite as crucial on this model as it is if you have it on the photo realistic. It kind of helps out in the photo realistic, but this here has enough color graduation that it's not really necessary. It's about the same spot when I go to unity isn't it? It looks like. Then I make that turn and I see the antennas there. Well I wasn't before, using the flight display here and then the MX20, but I can see using a combination of those to verify I'm using the primary flight and then looking at the ground is that, and then I'm verifying it across, looking at the MX20 to verify yes, I am above the obstacles, so I can see where I would utilize both as I got more comfortable with the system. Right now (1000ft AGL) FN still not quite doing much right there. It's not hurting anything, but it's not really providing much of anything right now. Never perfect. I mean right there, I didn't feel any stress. I felt comfortable using both the displays there and I don't know, I feel I could make it to the runway there and not hit anything, and there wasn't much of a stress level. I just felt comfortable.

PRFN30: I like the high detail myself (as opposed to the lower resolution). I don't find it too cluttering for me at all. I like to see everything. Three looks pretty good right now, 60 FOV. (During turn) A little bit too much right there, unless I was flying a long ways en route or something like that, but, it looks nice. It's just a little harder to tell the elevation contours there. It's still usable but it's a little more difficult than the other (EBG). It's still totally usable, I just prefer the other before, the more graduated. If I was flying flight sim on a computer, I'd probably want the photo realistic, but in the real thing, I'd probably want the other. A little bit lower than the generic before that. A little bit more of a mental workload I guess on this one, but just a little bit more.

CCFN1: Having it way out there at FOV90 almost makes it kind of unusable, just because it's so hard to differentiate. I can see the river, but again, with the contrast, I don't know if it's the

contrast with the screen, but it's extremely hard to tell the terrain. If I look outside and then I look at the chart (MX20) there, it kind of throws you off. Basically, the only thing I can really recognize is a little bit of the river and slightly a bit of the valleys, but it's pretty limited. Even with the high one arc-second there, it's still hard to differentiate and not enough contrast to be able to tell between the elevation. I can just see kind of light bumps, but it's difficult. I would rely more with the MX20 serving more as a backup, to give me elevation clues, where I'm losing elevation clues with this look here. And I think if you went lower (resolution), if you went three arc-seconds or the other, it probably wouldn't be too useful, except for coming down to the runway, for maintaining collision avoidance with the terrain. You can see the antennas, you can see the runway, you can see the lake over there to the left, but it's hard to really tell the ridge, just kind of knowing what it was before. I'm spending more time looking back to the MX20 on the scan, so I feel like I'm jumping around just a little bit more on the heading and stuff. I don't really have a clue looking at the primary flight display of altitude as well. I just have to keep looking back at the MX20 to see if I'm in the green. I can see the terrain better with the fishnet. Without it, it would be extremely hard, especially with the limited colors on there. The fishnet does help out in breaking up the terrain where you can differentiate it. But it's not something I'd want to get down and dirty with, at all. *Reminded him that we wanted him to stay at 1000ft AGL at the end for about a minute.* Okay I see . . . now that would be kind of spooky there. Looking at that, and then all the sudden, I can see where that could initiate a loss of control there. That's where we've had that in the past, where a pilot was flying and even had a GPS, and he had flown with us for a while, and he got into some marginal conditions and his eyes were telling him one thing, and the GPS was telling him another, and it ended up being that he was following a fog bank along the shore and he was 90 degrees off from the shoreline when actually, he was parallel in the fog, but 90 degrees off his course where the GPS was saying hey, you're heading out deep over the water. And that kind of would give you that clue right there, looking outside there. Well, if I'm, like if it would be a lower resolution, it would be even lower. I can't go any lower than four, is that correct, for the desirable? So I better put it at that. I figure if was a lower resolution like that, it would have been lower. Again, on a lot of these flights, I mean basically just flying what you guys are giving me there and I mean I'm looking outside and I'm looking at the display screen there, but it's still, I don't know. I guess that's going to come later some time, with the experiment, is actually flying with just using that and taking the airplane to a certain point or something like that, and the lower altitude and maneuvering around the terrain there. Again, the terrain I'm seeing and all that, but it's still just basically basic attitude flying the airplane.

PRFN1: The thing with it, you can see the valley easy. I still like the generic, but this is totally usable. I'm just kind of looking outside and then trying to take a look and see the differences there. I still don't see any ground yet. Again, I like the higher resolution. The more you get on there, the better. I can see a little bit of a hill down below me. I can see using, going to a Unity FOV because if you go close up, the stuff is probably already underneath me or whatever. I'm not sure, but with a wider angle here, it looks more to what I would be seeing, I guess, than zooming it in where I think the stuff is already underneath me . . . well underneath me. That's where it could throw you off. You could be looking outside and that's where I noticed on that first one when it popped out there, right before it ended on the previous one to this, I was looking down and it was like man, that doesn't even look like it, but that's why I kind of switched to that wider (FOV). I don't know if that high rate of descent goes against me, but I was actually meaning to do that to try to get down to see if I could try to see the ground there. I don't know, as I'm getting more and more time on this, I'm getting a little used to using the different functions, I guess. Again, I felt like I was in control and I was able to see the terrain and then I don't know, I did, I don't know, am I supposed to be giving ones and stuff? I guess nothing is perfect.

CCFN30: Very limited detail. You can't even see the river. You can definitely give a low time pilot or a pilot unfamiliar with the area a false sense of security. They'll think that here it is pretty level terrain and a little bit of hills in there, not too bad. But you would be highly dependent on the MX20 for elevation warnings. With more detail, you don't rely quite as much on the MX20 as when you're lacking the detail and you're going to need to be relying on it a little more. Again, it's always good to have two things. When you're using the other, you're still looking on the MX20 as a backup. But you can spend more attention flying the aircraft on the primary instead of just looking at the navigational display. No (I do not like the way the terrain texture depicts the ridge). It's very limited. Looking at the MX20 to make sure I'm to the left of the antennas there. It would give you a false sense if you didn't, you know, that you could drop down. With the MX20 I can see that I'm safe, without the definition there on the primary. Due to the fact of resolution, having to cross check more with the MX20, I was chasing things a little bit more.

PR1: Again, the fishnet is not really effecting me. It just helps differentiate the terrain a little better. But I can still tell the terrain. I'm busy looking at the terrain there and stopped looking at the heading. Trying the different (FOV) angles here, the wider views as I come down. (After turn) It looks good. I mean I can tell the hills and stuff. I still like the generic one the best, but this is usable itself. I like the real high detail. I can see being at like a 90, it's easier to over-control the aircraft, or I mean using it back and forth with the smaller lettering and all that. I mean I know that normally when you zoom in, it's easier to over-control there, too, but I was trying to look out further and it just seemed like I was jumping around more. Was I within the parameters there or did I jump out? I saw myself jump out, but I don't know if it was in the timeframe. I want to give it a three, just because I was yanking around with it, going back and forth with the real wide zoom and then I had a tendency to, I kept my heading going to the left there on that there, but again, the terrain on that was real good.

EBG1: This one looks like the real detailed here. And I need to get down low and see what the terrain looks like up close and personal. This is easier to look at for me, at least (than the PR). Photo realistic is prettier, but I kind of like this. It's giving you a little elevation with the colors, I would think that would be more useful. On the other ones, I don't know, I keep seeing the green and I'm like oh, look at all the pretty evergreen trees, where this here is giving me elevation information and it would be more useful, I would think. I guess it's not necessarily that it's easier to over-control with the (FOV)90 or anything like that, it's just that the numbers are further out, so you're not paying quite as much attention I guess on the first time and stuff, but I was looking at the top number there. But just seeing the small . . . it looks like the increments are further. This is the best so far. Again, the fishnet I think would only do me any good if I had kind of known distances as I was flying, where I don't think it's really necessary on this to differentiate the elevation because I can see that pretty clearly. If it had a fishnet, it would be a one, but I'll give it a two. Again, I don't know really right now unless it was a different situation using that fishnet somewhere, that I would feel that I could use it, like I talked about and stuff.

PRFN3: The last one was easier for me to use. This takes a little more attention. It's excellent, but it takes a little more attention, trying to figure out exactly what everything is on the map there. You see different colors and you're not sure actually what they represent. Like I said, I see the green down there and to me it looks like an evergreen forest down there, and then I see some blotches of brown. I'm not sure what that is. I don't really have anything that tells me elevation wise, besides just looking at it, where you know, if I got the symbology down of knowing the different shades on the other, it would be much more useful. But still, it's totally flyable in a situation if you needed it. I would say that most of them are usable except when you get down to the 30 (arc-sec), if you need to get down and dirty, and then the lower resolution is extremely

hard to utilize. I mean without staring at the MX20 with the two. (After turn) That tower looks pretty close. One thing that I noticed is that as I'm flying more, the mental demands are going to stay down there, probably compared to initially, because it's a rerun of the situation over and over. You're looking at the display more and trying to differentiate things. You don't get the elevation data like in the generic. But still, it's still usable, but it just doesn't have that little extra information that the other gives you. Again, it's hard, you know, until you go down to like the 30 arc-second, which you can tell right off the bat, I can tell the one arc-sec too, but staying up high like that, I mean it's nice to have the one arc-sec, but unless you got down and dirty, you'd definitely want the one arc-sec, but it's not being a big thing effecting me, unless it's the 30 and it's like the CC, and it's like ugh.

EBGFN30: You can definitely see the resolution lacking compared the one and the three (arc-sec), but I still find it's easiest to read display-wise. The main thing that's going to give you elevation data, the more, I mean I'm seeing the mountains and also the colors, which is good. It's an easy to represent way of looking at it on there. The only thing a pilot would have to get used to is knowing what the colors meant. That would take some experience. Even with the 30 arc-sec, looking outside the window there, even the 30 arc-sec looks better than the other two (PR and CCFN), and definitely better than a current industry concept. I think it's just easier to differentiate for me, compared to the photo realistic where you've got just all that green on it. I can see where you don't quite see the contour intervals as well on the 30 arc-sec. It looks like a tiger effect there on the hills there. And I see the fishnet go straight, but I get different kind of shades. I'm not quite sure what that is. The fishnet's going flat on a certain spot there just to the right of the antennas and stuff, and then it drops down to the left there, but the color of the terrain there is kind of, I don't know, it's a little tiger effect there. So I guess the fishnet kind of helps on that, on the contours on the lower resolution. Just from lack of resolution there and then getting down there, getting that kind of tiger effect, it helped portray the elevation contours how it was brown and black, but then the fishnet was kind of showing straight across on that, so it was kind of hard to tell what was giving elevation-wise on that, without actually seeing the bumps and curvatures on the lay of the land.

EBGFN3: With the wider angles like the 90FOV here, the fishnet doesn't play so much of a predominant, like it did when you zoom in to 30FOV. Like as you get lower, I can see where it plays more of an effect, like I was talking about where I thought it would play a little more effect as you get lower there, but at a higher altitude, at this wide angle here, at 90, it's not quite as useful. You can see a little more of the detail when you zoom in like that. I definitely see a difference at this angle here like I was at before with the fishnet, and then actually seeing a little more of a bonus, but the fishnet kind of jives now with what the terrain is. Again, for avoiding the terrain and stuff, using the MX20 and then actually zooming out works better for avoiding the terrain. But I can see when you go into the terminal area, when you come in where before, in the beginning, I was having to zoom way in there just to see that I'm avoiding the terrain there. It's better at 60 to 90FOV. I'm not even looking outside and I can see the terrain there a little bit, but the thing is just amazing. You forget that actually you're looking at a computer display and you pretend you're actually flying an airplane looking outside. *At 5 minutes, turned data recorders off, and let him fly around a little.* Well at the higher resolution there, it was easier to differentiate the terrain there with the fishnet. I like that, when you zoom in and you've got that when you're coming down lower. So I like the high resolution.

Block 3, Approach:

EBGFN30: *No comments during run.* It was pretty neat. I'm just trying to get a feel for flying the velocity vector there, but yeah, it's pretty impressive. (Were you concentrating on the symbology so much that you didn't really notice the terrain, or you don't have any comments on

the terrain?) Not really. I could see it wasn't quite as high a resolution there, but I was just kind of concentrating and trying to keep the velocity vector there in the box and trying to keep it centered and concentrating on that I guess, initially. Flying-wise and stuff, I didn't feel like I had any problems or anything like that, really. I'm getting used to using the velocity vector. At this time I didn't even look at the MX20, period, not even one time, so I was concentrating more on the other, primarily. I was looking at the terrain but I wasn't, I mean I didn't even look outside the window there, until I came inside the middle marker there and then when I could see the runway there, I started kind of looking out a little bit.

PRFN30: Primarily I'm just still kind of looking through the boxes and kind of zooming in and out there. It looks good. It's still kind of hard to tell. I mean you look down and you see all that stuff down there, and you're not sure what it is . . . if it's actually a city or what it is down there. I'm assuming it's city down below, but I still like the generic, I think. It looks like I can see roads and other things. When you get in close, you definitely want (FOV) zoomed in. It seems like it's more of a workload, just because like when you were saying when you go further out, 60, right around there, seems to work the best for my en route, holding it in there. But when you like really zoom in, I think that's what I was doing, it seemed like it was harder en route to do it, until you came in on the approach or was coming in to glide slope range. I think (90FOV) kind of clutters it a little bit. This time I was a little more aware of the terrain, looking down. *Went outside bank angle for a few seconds. After turn was over one dot high for 27 seconds. Mentioned that his trim didn't seem to be working, so maybe that's why he was fighting being too high.* Just because of my performance. I felt like I was having to fight it more to keep it in the box there. That's the trick, though, isn't it? You do put the velocity vector inside and just use it to fly it in the box?

PRFN3: Well the terrain is pretty flat. I mean I can see the contours and stuff like that, but as I come in here, I can see that it's pretty flat. Up ahead I can see a hill off to the left there. I can see the antenna on it just to the left of the course. I don't think (the FN is providing useful information) right now. Again, for me I think the fishnet kind of helps break up the ground, I guess. I think for me it would be like just if I was en route, down low or something like that, to give me an idea of distance. (after more thinking) (The FN) does break up the terrain, I guess, and makes it a little bit easier to define and look at things. I can see the smoke stacks down below there. And looking at the MX20 and looking down, I can see the hill past the runway there, and I can see the red on the MX20. *Feels the hill behind the runway is defined enough to that if something were to go wrong on the approach that he could go around.* Oh yeah, with this thing, it would be easy, you could do an easy 180 and track back outbound, do a procedure turn, and come back in. And what I'd use is like the MX20 along with that, I mean if I didn't have any other navigational aids. Just the way it is right now, I could easily get back to the marker out there. If you notice, in the beginning when I was kind of jumping around, the (FOV) angles are what throw me off. I end up chasing, kind of, at first. Especially if you go from way out to all the way in, and then you've got a box right in front of you and it looks like you're off a little bit. It kind of throws you off. I think initially the mental demand for me is greater and stuff, just when I'm switching those FOVs and dealing with that moderate turbulence or whatever, and can zoom around there, but then once I get stabilized, it kind of goes down from there, the workload, and the mental demand. *Flies a little slow, but not slower than PTS. Low for 23 seconds on short final.* Mainly because the initial part there was kind of jumping around with the air speed and I saw a little bit over one dot deviation there a little bit at first, but I caught that. But I was kind of just jumping around. But I was more aware of the terrain this time, and then looking around. You can see like right here where I'm at, you can see where the hills are pretty well defined and stuff, and then I was more aware of my surroundings, I guess.

PR1: I like the high detail. I can definitely see the ridges off there down below me and to the left. I can look down into the valley off to the right. The fishnet seems to break up a little bit of the terrain better. I mean it's kind of hard to tell, really, because of the darkness of the foliage and stuff, the breakup of the terrain elevations, so the fishnet kind of helps that. I've just got to not to over-control, and not to put too much up or down there. As I get more and more flying with this, I can see that I'm looking more at the different things, like the three degree glide and doing a little more crosschecking as I get more comfortable with this. (Do you feel that the different pieces of symbology work together well?) Yes. The only thing is they might do a different color for like the CDI versus like the flying through the box or the dog bone, have different colors. I see the buildings off to the right of the airport there. I don't see a problem with the high resolution. I like it. The higher the better. My flying was, I think, pretty good there and then just again, every time I fly, more and more I'm just getting more used to looking at all the different things and utilizing more things on the displays there. I'm looking at the terrain and looking at crosschecking everything and looking over by the MX20 and seeing when I'm coming up on the outer marker there, and then just getting more aware.

BRD BL: *No comments during flight.* I could feel the sweat a little more, the heat build up when I'm out there, but I mean it's flyable, but I had to rely on the MX20 to see when the next waypoints were coming up, and that's disheartening after you've seen the others with the graphics display and stuff. But I could definitely feel myself, especially once I got inside the outer marker there, I got a little closer and less tolerance there, I could feel myself warming up there pretty good. Just because I feel like my mental workload was quite a bit greater and then the stress of not seeing the terrain there after seeing the different terrain there before, and relying more on the MX20. The only thing I was really using the MX20 for was just to see how far I was from the waypoint. I wasn't really watching the colors for terrain warning or anything like that. I was more trying to just quick overlook and then zoom back over to the analog instruments to make sure I hadn't deviated too far. And when I came in on the inside, the middle marker there, I could see where I was kind of chasing a little bit on the glide slope there. It's easier kind of in the box (tunnel). It's just a matter of getting a feel of how the airplane simulator operates and stuff. It's a lot easier when you have a visual representation of the boxes, let alone the velocity vector and then that three degree glide there, and when you can see the runway on this display.

CCFN1: I can see the ridge that's right in front of me and below me, and I can see a lower elevation down below, but again, compared to the photo realistic, I much prefer the photo realistic over this. I can see the curves and stuff, but looking out at distance, I can see the smokestacks out to the right there, but much past about the first third looking out just a little bit inside the velocity vector there when you look out there, you'd lose the detail of the terrain there, even though I can see the smokestacks and stuff out there, you just lose that. When you change your FOV, you can still fly but you saw how I was jumping around earlier, but it seems like when you're on a straight path, on a course or whatever, it makes it a little easier to adjust it. *Stays on FOV60 until right before OM, then changes to Unity for the rest of run.* Because I like to take the velocity vector with the three degree glide and put it down closer to the touchdown zone markers there at 1,000 feet. And it's just a matter of adjusting your power for your rate of descent you want there, I guess. As long as you can hold your pitch, your air speed will pretty much stay stabilized. It's a lot less stress, I'll tell you that, when you get to your decision height there, and you can see the runway on this. Whereas when you're flying the analog, you're just hoping those CDI's are accurate and that you're thing is done right there. It makes it quite a bit less stressful and relaxed. And the only thing that (this) has kind of got is, you can see the runway quite a bit easier at a distance just because you don't have all the multicolors and stuff, compared to the runway there.

EBGFN3: I like this. Again, it's my favorite. I like the color differential without too many colors on there. It's easy, definitely, to see the portrayal of the terrain there. All the hills at 12 o'clock over to 2 o'clock and the valleys without a bunch of unnecessary stuff, meaning like I don't need to see all the streets and all the other little things there. This is easy to see. Photo real is real nice, but I still like this the best because it seems like you have to process less by trying to figure out what's what on the ground, when some of that stuff you don't really need to even know. It's very easy to tell the hills way out there by 12 o'clock past the runway and the airport environment. It's very easy to see them. It just got heavy, hold on a second there. Every once in a while I get to a glitch like that where all the sudden it wants to go nose down and then I have to use full trim, but then it seems like it resets itself or something. Yeah, I like the fishnet. I guess it gives better depth. It gives it more of a 3-D effect. It's easy to see the terrain relief, though, out past the runway environment there. The only thing is when you're in this close of a zoom there (Unity), like I can see the towers out the main window there, but I don't see them on the thing there, so some of those cues that you also get to look out and see that you don't see here, but I guess that's the tradeoff when you go to unity like that. I was pretty aware of the environment there, of what's out there and I felt comfortable.

PRFN1: Again, I like the FN. Because you've got so much stuff down below me, looking down there it helps kind of break it up a little bit, or it's easier to scan it. This is really nice too, but the one before (EBG), I still like the best. When you're looking at this, you've got to catch yourself – you know, don't stare down too long and trying to figure out what's what down below you, with stuff you really don't need. I guess if I was down at a lower altitude, it might come more into play. But it does look nice, though. I can see all the towers. I can see Dominos pizza down there. There you go. It will be interesting to see the photo realistic versus the other, like in the Juneau area, when you guys do that. Because it might be different. I can see the arrows off my 12 o'clock there very easy, but you just don't see the breakup in the contours as well as compared to the (EBG). There wasn't much compensation on my part, just flying the airplane and I get the desired performance, using the displays there, just without much effort, I guess.

EBG1: I like the fishnet with it, too. The more I think about it, it just gives it a little bit more three dimensionality. I mean it's 3-D as it is, but it just adds a little bit more depth perception to it, giving you the idea of distance with the fishnet there. But like I said, I like this. It's giving me what I need to know, where the hills are and all that stuff, without a bunch of unnecessary clutter down on the ground level. Will that glide indication there for the slope be user changeable if you have different approaches that require other than 3-0? (We think so.) *SW crash at 5:26 (1780'). Only 400' above where we normally stop, so we kept the data.* I don't know, I just use that velocity vector and keep it right in the box there, and once you get your power set, there's not a whole lot you've got to do. I mean once you've got it straight and level, you leave the power on set, and when you come in on the outer marker there, power reduction, and other than that, it's just trying to keep the velocity vector where it needs to be.

EBGFN1: What I like about the fishnet is, even little differences in elevation can be easily distinguished by looking at the curvature of the fishnet. Instead of being a straight line it will bend down, and that makes it easier that way, and I can look down and see the valleys, but it's easier to define the contours. I guess in a real airplane, you'd still have your tachometer there and stuff, because pretty much everything is power performance for cruising and stuff like that. You know exactly what tachometer to go to, so I'm still always kind of battling with that just a little bit here, because it's information I don't have there. That's the only advantage I saw on the analog one there, is I could hold the air speed I think pretty good on that, just by knowing the power settings for cruise, and then of course the descent, to hold the 90 knots. I'm not even having to look at the MX20. Well, I kind of glanced over just for the colors, and then looking for

like the middle marker, I relied on that. What I did is, she said wait until you hit the box, and then do your turn. (For analog) just hold that intercept 30 degrees and when it starts to come in, you just watch the transition and how fast it moves and it controls your rate of turn. The big thing is to just watch in the transition how fast the needle is moving and you can tell your rate of turn. There isn't much of an intercept, 30 or 40 degrees. It's actually pretty good there, because we just had our Navajo back recertified IFR, so maybe this will make it a lot easier on the training to get back into it. Again, I like the fishnet because like even the little bumps down below me at 12 o'clock and the little bump off to the right there, it's easy to distinguish that. Sometimes the color, like that tiger effect or so, you can't quite tell if it's actually a change in contours or heights, where I can with the fishnet. I can verify that, yeah, okay, the color is a little different, but is it really a change in height, and yeah, I can see that. It's amazing all the information on one little screen there, compared to the analog stuff. Your scan is a lot easier, definitely. *High on g/s for 20 seconds until end of approach.* It's just got everything you need there on the display. It's easy to see all the terrain relief. You have minimal taking away from looking at what you need to look at on the gauges there. I like that one there. It's basically, just again, controlling the aircraft and putting the aircraft where it needs to go by just using the symbols there. It's easy. (Discussion about the velocity vector) I think it's real good. I think it helps keep better control of the aircraft because it's pointing to where the aircraft is going to go, or the flight path, and all you've got to do is put it right there, and the airplane is going to go there. I mean, I like it. (Regarding Capstone) I just wonder if they've tested all this themselves. Who's flown this stuff? Because it's none of us, and that's what kind of gets you. They haven't, they just bring it in and show it to you, and this is what you're going to get. They haven't had us do anything.

CCFN30: I like the velocity vector, definitely, because I can see with the other little bar there, the horizon bar there, the guy might be trying to chase that, where this is kind of giving you an idea of the wind, where it's coming from. It might be a little, you might end up chasing around whatever course he's following. And the resolution is totally bogus. See with that lack of terrain, I just saw myself kind of pulling and yanking a little bit there. You just don't have any feeling of the height there if you're looking at it. Heck, it looks like someone's tile floor. I'd be kind of curious to see what the FAA (thinks). The FAA seems to be concerned with procedures, how would you implement them, how are you going to train them. I know there's a hill out past the runway there, but it's hard to tell. It doesn't look like a hill. The fishnet is good with it. I mean it helps break it up a little. According to the display there, the dog bone is pretty well on, but the glide slope is showing it's above me. Is that right? But then when I look down at the box there, it looks like the box is down below me. *Still a little low on GS.* I think it required a little bit more input mentally and physically and stuff, because I was kind of looking at the lack of terrain that I had before and stuff, so I was transitioning back and forth a little bit more, so I wasn't quite getting I guess the desired performance I would have wanted.

CCFN30NT: I can see where the scan mentally is kind of increasing. I can see where mentally I'm having to do a little bit more scanning. Just a little low. I guess in this case, I'm not quite using the velocity vector near as much as I did on the other. I'm just kind of flying the headings and watching the transition on the deviation. I'm using more the VSI for controlling rate of descent here, and trying to get about 600 or so. As I get closer, I can see where the velocity vector becomes more of a factor for me. Definitely the velocity vector helps you maintain better, I guess glide slope and localizer. I might be chasing a little bit more. It's amazing when you take just a little thing away, you know just like those boxes, how much more it makes you work a little bit. *One dot off rolling out on Loc (for about 10 sec).* Reason being initially it definitely took a lot more mental power. You know I was sitting there used to the velocity vector first, but now it wasn't really giving me, it wasn't really doing me any good because I didn't have a point for it to lock onto, I guess. So I was more relying on heading and using the heading there until I got

inbound on the localizer and could see the runway, and then fixate, put the velocity vector on there. Then (VV) came in a factor there, but it took quite a bit more pilot performance, I guess, to get the job done initially.

Rare Event:

CCFN1: Well, I can see the higher detail compared to the others, but still, it's hard to tell much past some of the terrain there. It's harder to see further out there, what's really out there. Like if I wanted to descend down, you can't really tell what's ahead of you as easy as the other displays. You can get down and find yourself in trouble. Maybe you don't want to be quite down that way because you just can't tell. It's providing some detail, it's just I don't like it as much. I can look outside and those hills look a lot closer. Are you trying to put me into a hill here? If I go down to 5,000? I'm going to make a little bit of a climb here and head to the airport. I guess on that display there, if I hadn't seen outside there unless I had it, I don't know what magnification level I would have wanted it on there, but with that type of stuff there, it might have been a little bit harder to detect that I was getting that close to the terrain, especially if the altimeter had failed on that. To tell you the truth, I wasn't even really looking at the MX20 there. I would have got that though. I don't know what you would have said though, if I would have started climbing up and trying to go back, head toward the airport there, but that's what I was about to do there. *Shallow descent rate starting at 3:45. At 4:10, said that terrain looks really close (at between 5200' and 5250'). Really caught it OTW first.*

Subject 21 (BRD Baseline):

Block 1, High Altitude:

EBGFN3: *Was a little late on his turn, so had to prompt him.* It mostly had to do with I was having a big problem holding the heading. It seemed like, to me it felt like the plane wouldn't hold the heading and also there was this like jerk to the side, which I don't know if there was a wind set or anything, or if it was the controls, or maybe I just need to get used to the controls, but that was what was annoying me most, was the heading issue. Otherwise, I thought I was able to hold the altitude pretty well and I think the descent maybe got away from me. At the end it started to speed up and it crept up towards 2,000, I think. Yeah, I was kind of paying attention to other things, but I did notice that I changed the view once, which made it better (changed to FOV30). It was easier to fly that way for me.

EBGFN1: It doesn't appear much different than the other one. I guess the altitude is so high. I realized I went way past the heading there. I think that was part of the problem. I was staring at the terrain, which is why I kept turning. I was looking at the lines, the fishnet across it, which was pretty useful, but too useful, I guess. Yeah. It does, especially on things that are jagged and so forth. I mean I can't really notice if it's on the flatter, less mountainous terrain, but like the ones that are right in front of me, right there, it's definitely useful there, I think. *Overshot heading, for 25 seconds. Otherwise, within PTS.* I mostly was looking at . . . well I looked at number two, but it says compensation not a factor for desired performance, and I don't see a situation, right now I don't see a situation where pilot performance could not be a factor. I thought that one was easier to fly. It should have been easier to fly on the other one, had I not gotten distracted. It's just a learning thing.

CCFN1: It's not as entertaining or as informative as the other ones, that's for sure. You really can't tell, you can see the horizon, but you can't see anything in between, as in what's going on. You're flying and trying to look for, you know, just keeping your eye out like you should for a potential landing area, should you need it and this really doesn't tell you that much. I'm having difficulty descending without an RPM gauge. (Do you hear any engine noise at all?) Yeah, and I can hear the wind noise and everything as your speed increases and so forth, but . . . It's a little

easier to make out now, the fishnets anyway. I think without the fishnets, this one would be unreadable. I mean you really can't tell which way it's going, other than with the lines on there. *Was over 2600 for more than a minute at the start. Was a little late on turn, and very shallow turn. Is having a very hard time doing this without RPM gage.* Because I thought six and seven were a little harsh. I don't think it requires extensive pilot compensation or anything like that. I'll just mentioned probably the only thing I didn't like about it was, should you be in a situation where you did really need to know what's down there, I don't think that gave a very good indication of it.

CCFN30: It really doesn't look much worse than the last one, I don't think. Maybe I had a different view on before, but I don't recall seeing, noticing the river as much before. I don't think this one is much better than the, or not even as good as the last one down lower. The lines, the fishnetting helps, definitely, though. I mean like before, I don't think it would be useful at all without those unless you were probably right on the ground, almost. *Flew within PTS, on this one.* I thought that was probably the best one I've flown, but I think this is, the way I'm flying is probably also dependent on if I fly more and more of these, it will probably get better and easier, so I don't know if that was a factor or if it's that it was easier to pay attention to the display. I think the simplified ones are much easier to pay attention to, because you don't get too distracted. But they're not necessarily providing you with better information just because they're simplified, the way I feel.

BRD BL: This one is a lot more familiar and I think it was easier having the RPM gauge there. I guess the descent went okay. I was just having trouble leveling back out at 8,000. It was kind of porpoising around it. I guess because it's in my head that I'm so far above the terrain, it's not entering into . . . Okay. *In and out of numbers the whole time, but not for more than 30 sec. These gages more familiar to him.* Because I think that any time you have this, you've got several gauges you've got to concentrate on at once, and make them all match up. Sometimes they don't really seem to be in sync with each other, so it requires a little more thoughtfulness.

EBGFN30: With the views, if I zoom out, I guess I think it's a little easier to maintain altitude, because it doesn't jerk as much. It's a little smoother. (Okay, and that's your 60 degree field of view.) I can actually tell that it hasn't been as good as at least one of the other ones that I've seen. The fishnetting on the terrain is pretty useful, again, as you're pointing more at the ground, like I just was. I was just looking out at it. But for some reason, it seems to help. I wouldn't think it was when I first saw the pictures, but it does when you're actually using it. It's definitely not as good as the highest one. *Was a little slow on his turn.* It was definitely easier, I think it was easier than the one that's just the standard gauges to fly. But also I think I'm getting a little more used to flying this thing, so it could just be getting easier because of experience and not because of the display.

PRFN3: It's pretty realistic, I guess, as far as it's supposed to be. I think it's easiest flying with this view right here. (That's your 90 degree field of view.) For some reason, I really don't like the tape display for the vertical speed indicator. It's really hard to get a feeling for how fast it's moving and when it starts to jump and so forth, so it seems like your descent rate could just get away from you just like that and you wouldn't even see it coming. It's pretty nice. I think that the wider field of view, I used the wider field of view in this one I think, because you can actually see what's down there, versus the other ones it was just kind of like you were wasting your time because it all basically looked the same anyway. *Doesn't like VSI - your descent rate can get away from you.* I felt it just seemed easier to fly and especially at that, I don't know if I had not been using that view before, but that view seemed a little easier, I think. It was simpler to control, to keep the velocity vector and the acceleration vector in check.

PR1: This ground even without the fishnet looks better than the last one. (And right now you're at a field of view of 60.) I definitely don't like the unity view. It would be nice, too, if you had some type of cue that came up on the display screen telling you when you're approaching the waypoint, so if you look away for 10 seconds or say you get blurred by the waypoint. (Are you talking about a cue on your head down display? Your primary flight display?) Yeah. It seems like as you get lower I'm more willing to use a narrower field of view. I don't really have much use for like that right there, which I guess is the 90. But the 60 one looks . . . or 30 or whatever it is. (The one you're on right now is 60.) Okay. Yeah, I mean this one is pretty useful for this altitude, it feels like. But this one, the 90 one right here just seems, I don't know. It doesn't feel as right as the 60 one. Yeah, I can pick up the airport better in the first two. In the 60 one, I probably would not be able to pick that out unless I knew it was there. The 90, no way. I guess it's useful to cycle through them to be able to pick something out and then you can zoom out and you know where it is on the screen. So you can still keep your eye on it, but still see what's around you. Because I felt like I was able to utilize the views a lot better in that one than I ever had before. Changing them out and also using them to find the airport and then zooming out, and knowing where the airport was. I just felt more comfortable scrolling through them and being able to see different parts of the terrain that I needed to see at different points. I think it was a little more user friendly that time.

PRFN1: The fishnet makes it even easier to see than it was before. I think it was still acceptable, the last one, but this does make it a bit easier. . I'm switching between the 60 and the 90 at this altitude. I don't know if one really provides that much more benefit over the other. I'm finding I'm most comfortable flying in the 60 one for these situations here. I mean I like the fishnet thing, it's definitely helpful. You can really pick up the peaks and so forth. *At first he was overwhelmed with terrain, and became focused on it.* I gave that one a two, which I think I gave the last one, also. Probably for the same reasons. I was more comfortable using it. At first I was overwhelmed with seeing so much of the terrain, you kind of got focused on it, but I think I've gotten used to it where I've been able to see it as being more useful rather than just kind of blinding me to being able to fly the plane otherwise. And I've also been able to switch the views more to use, for whatever I wanted to see. I'm more comfortable switching between those and not worrying about it throwing me off as far as, you know you kind of get set looking at the numbers on the screen versus the background, and then all the sudden the background changes and at first, I was like having to readjust my eyesight to the numbers and everything, but now I'm more comfortable just changing the background views.

EBG1: This one is easy to tell what's going on, on the ground, but I guess you don't want to be deceived into thinking the terrain is I guess more simplified than what it really is. It's easy to see the little peaks and valleys and so forth but the photo realistic is kind of a higher comfort level. It's hard to believe that the terrain is truly this simple. I don't know, the photo realistic one, you could kind of tell maybe different types of ground or you know, if you had to land somewhere what would be more suitable. Whereas with this, everything just kind of looks the same. It's just kind of up and down. The same texture and color. It's still pretty useful. I don't feel like it's . . . I guess I feel a little better about it than I did when I first saw it, but I still like the photo one better. *Overshot altitude, at the end, for a few seconds. But, still within PTS.* Because I just, any time where something is depicted, it's a computer generated depiction and you don't always have 100 percent faith in exactly what that is and I guess in a way, it would kind of worry me to be looking at something like that, especially when I was closer to the ground.

PRFN30: Okay, this one here you can't really see enough to be useful. That one, either. The 90 feels like you're so far away, like everything is in slow motion. I'll stick with the 60 one. I guess

the higher up I am I would tend to go more towards the 90. (Okay, now that you're a little closer to the terrain, what do you think about this terrain depiction?) Again, the fishnet helps it. I think without that it might be hurting a little. I got the airport pretty well in the first two views. The third one, I would probably not be able to pick it out, but I knew where it was. *Can see the FN at the higher alt. At lower alt, feels FN helps, without FN, it would not show much of anything.* Just the more I think about it, the fishnetting gives you a little more confidence or a little more idea as to what the ground's actually doing. The way I see it, you can tell, it's easier to pick out flat spots or sharply increasing terrain with that on there. Even if the terrain is not super realistic, it's more easy to pick out places where it drastically changes.

Block 2, Low Altitude:

EBGFN3: I like it better than the, just like the plain untextured one, definitely. (Blue brown?) Yeah. With this one, I'm just kind of worry that it's giving you a false sense of what the ground really looks like. Like maybe it's oversimplifying it. As far as the views go, I usually, I think I flew most of the last ones with the 60, which is the one I felt most comfortable with at really any of the altitudes that I was at before. (At this lower altitude, what do you think of the fishnet on this EBG display?) I really can't pick it out too well at this altitude. I mean there I can, I guess that's the 90, but otherwise, I really don't notice it at all. I can only see really in the foreground, which I guess is the only place it's projected. Or the only one where it's visible, really. The ground doesn't look that close, but it looks much closer as I zoom out to the 90 here. I guess when you look at this unity view, you really miss a sense of that there's something directly below you like that, which you can really get with the wide angle view. And I think something else that I'm noticing here is that the tighter angle of views, it's more difficult to control when it's turbulent and you're bouncing around. Yeah, I mean I definitely noticed the difference between the 6,500 and the 5,000. It was I think much more clear at the 5,000, especially with the fishnet. I thought that one was pretty easy to fly. That ground was, I mean it definitely felt a lot closer than it used to be and I think that made it much easier to determine where you are with reference to it. I think the first ones are so high up that even when you descended, it didn't make as much of an impact as it did this time. I think it made a much more, it was much more clear when you descended and the ground got closer, and I think that depiction of the ground made it pretty easy to avoid things there.

PR1: It's much better. It's not much I guess for en route, but if you needed to find a place to land, I would much rather have this. But as far as simply something to avoid running into the ground, I don't think either one is really that much better than the other one. That one felt like the easiest one to fly so far, especially when right at the end of that turn, or the end of that descent anyway, I changed it to the unity view, or maybe the 30 view – I'm not sure, one of the two – and it seemed much easier to hold the descent angle instead of having it fly all over the place. Yeah, also with the unity the terrain was much easier to read as I zoomed into it more and I wasn't, I guess I wasn't as concerned about the things that were further away from me outside of me, just more what was in front of me as I was descending. I mean I completed the turn before I completed the descent, and that's when I changed the view (to Unity), after the turn.

EBG1: This one does a pretty decent job on the screen of depicting what I see outside on the big screen in front of me. It still is pretty detailed. I can still tell what's going on. It's pretty good. It doesn't seem as good as the last one. I was just thinking that the last one seemed more detailed than this one, definitely. Yeah, and even the first one of this that we did I think was better than this one. This was the one? It still doesn't . . . something in my head is telling me that it still didn't seem as good, though. *Was 15 seconds too fast during turn and descent... turn rate also got away from him.* It seemed pretty easy to fly. It was just looking at that ground though, it just

didn't look . . . maybe I was still thinking of the last one, but the ground just didn't look that realistic, for some reason. A little more comforting, I think.

PRFN3: The ground on the two screens match up very well, but I guess they're supposed to. I see the fishnetting just like in the foreground, which is pretty up over, I mean the first mountain in the foreground there looks pretty steeply banked and the fishnetting helps show that better. The fishnetting definitely helps you get a perspective as to how fast you're turning if you stop looking at the heading indicator and just look at the ground more. It gives a better perspective of that. I think I've realized that I like the 30 view better for the descents. It seems much easier. But I like the fishnetting on this. It makes that ground much easier to read, though, in front of me. And that little bowl that I'm flying over right now that I see, is much more evident. That one seemed very easy to fly. Like I said, I zoomed in to a closer view, I think for that descent and for that turn into the 30, and it was pretty easy to look through the velocity vector and through the text on the screen and see the ground and actually fly by that ground, as opposed to just staring at the gauges and so on and so forth. I thought that ground made that easy to fly with, and the fishnetting on it was a good part of that. It gave a good sense of motion to how the ground was moving.

EBGFN30: I can't really pick out the fishnetting too well. I can barely see it at the bottom of the screen in this view. It's a little more evident there but even so, it's not really contributing anything in any of the views. I can see the fishnetting there, but it doesn't look very believable. It seemed to be smoothing everything out a little too much. And also when I was descending and turning, it didn't really give a good sense of motion, like the last one did. I couldn't pick it out as well. Even though I thought it was easy to fly, I still didn't think it was as beneficial as the ones that were either photo realistic or at a higher . . . a better elevation model to them. I still thought it was simple enough to fly using that stuff, but I don't think it is as beneficial as the other one, so . . . And the fishnetting I don't think was as effective as on higher, the more highly accurate elevation model ones.

CCFN30: Knowing what the ground looks like down there and looking at the picture in front of me, this one doesn't give any indication that it's anything other than flat terrain here. Zooming doesn't appear to do anything here either. The fishnetting helps a lot on this, because otherwise you can't see the ground contours at all. Changing the view doesn't do much other than help pick out the airport. Mostly because the desired performance requires moderate compensation. I thought that you really had to do a lot of thinking to figure out what the ground was doing, so if you really wanted to fly the ground, or you know, fly low to that ground, you really had to put a lot of thought into it. Looking at trying to decipher the fishnetting on the ground and changing the views so that you could look at all the different areas, because they seem to show up differently in different views and comparing that to the Apollo instrument to see where the ground was. I think basically what it came down to was that the fishnetting helped a little, but it was still not a very accurate indication of what the ground was doing.

PRFN1: I think this fishnetting does a good job in all the views. Some of the other ones, particularly the lower resolution ones, the fishnetting doesn't show up as well, I don't think. (And it looks like now you're kind of leaning towards the 30. Is that correct?) Yeah, especially the 30 on the descents, as I'm pointing more toward the ground, that's definitely the case. Before I start the descent, I think the 60 is still pretty acceptable, though. I liked it. It was realistic and I was comfortable that it was pretty accurate with what the ground was doing. *25 seconds too low on target altitude.* I think with that ground it was you're so close to it and it's very easy to tell just dealing with the fishnet and the accuracy of it, that it doesn't take much to just be able to fly the plane around, looking at the ground. I think just looking at it, you can tell what it's doing so easy that it's very natural to be able to move the plane around the peaks or whatever.

CCFN1: This one is better than the last constant color with the fishnet, which was the 30 one, or the three, whatever it was. But still, it isn't as good as even the digital one at the lowest, at the 30. Not the photo one, but the other digital one. I don't think it was as good as that. (The one like this with the lower resolution?) Well, it's definitely better than those. This one doesn't do much other than tell you that there's ground down there. The fishnetting helps a lot. Without that, I don't think it would be very useful. *His turns are always pretty shallow.* I thought it was easy to fly because there wasn't too much going on, and it wasn't distracting really, in any way. But along with that, it wasn't providing too much information, either. I guess other than just being able to tell that there was ground down there, it wasn't telling you what that ground was doing, too much, and the fishnetting definitely helped it, but it still wasn't that effective.

PRFN30: This one is definitely better than even the constant color one, the highest resolution with the fishnet. This is still better than that. (So the imagery makes up for the lack of resolution?) Yeah. The lower altitude on this one is definitely better than higher up. Yeah, as you get closer to the ground, it was more useful. And it was easier to pick out what the fishnetting was doing. Probably because of usefulness. I mean it was pretty acceptable down low, but up high it didn't really tell you much, so if you had to make a decision about anything up high, I don't know how useful it would be. And changing the view really didn't help all that much as far as making it more clear as to what the ground was doing.

EBGFN1: This screen does a pretty good job, I think, of depicting what's projected on the screen in front of me – the big screen. They match up pretty well. The fishnetting definitely helps. (It also looks like you scrolled through the fields of view and you settled back on 60?) Yeah, I was checking them out and I think the 60 one is mostly replicating what's on the screen in front of me. I was just trying to see which one was comparing with the field of view in front of me, and this one seemed to be it. Maybe the 30 one. This ground looks pretty decent right here in this view (FOV 60), I think. I can really see that ridge running off to the top left or so, to the left side of the screen, I can really pick it out. I think the 60 and 90 both look really good in this one. Yeah, I guess the other one is just because I can't see what's directly in front of me or below me and that's a little disconcerting. I think the terrain depiction is really good. (Okay, and you still feel that the fishnet is giving you the additional information?) I do, yeah. I thought it was real easy to understand, much more than I remembered it from the last one. Maybe because it was closer to the ground, the shading seemed a lot better this time. It was a lot more evident what the ground was doing.

BRD BL: It's what I'm used to seeing. (I'm just curious if you do miss the terrain depiction from the other displays.) Yeah, it would be nice because I happened to glance up and I caught like this mountain looming in front of me there on the screen. I glanced up earlier and I saw one just in the left part of the picture that I would have had no idea that it was there. (It might have been your descent rate was a little slower than it has been on the other ones.) It was probably slower because it was more controlled. I was trying to do 1,000 with the others, but like I said, I had trouble descending in the other ones because of that vertical speed tape and not having a tachometer and so forth. This one, I was able to finally stabilize it around 1,000, which was what I was trying to go for. (Okay, I just wanted to make sure that it wasn't due to the fact that you were a little uncomfortable because you didn't have the terrain.) It probably would have been true. That's a good point that I didn't even think about on the other ones, about the terrain, but that does kind of seem right, though. *Did miss the terrain info - thinks that may be why his descent rate was more controlled.* Well, I think the descent was easier, like I said, because it's got the traditional VSI and tachometer, but then it was a little less unsure. I mean I'm just staring at the gauges and I had no idea what was going on outside, so it was kind of unnerving in a way.

Block 3, Approach:

EBG1: It seems like the farther out zooming is a little easier to fly. (Okay, currently you're in the 60 degree field of view. How about the terrain depiction itself?) It looks pretty decent. I'm not really focusing on that as much as I am the boxes. It's a little crowded with that dog bone and the diamond on the bottom of the localizer. It's kind of hard to make them easy to look at. Yeah, you can definitely tell it's there and everything. I definitely like the wider views better, so far, anyway. I'm on the 90 now, I think, aren't I? (Yes.) This one is better than the 60. Even though it seems more cluttered, it's easier to aim for the center of them. Again, I definitely don't like the dog bone overlapping the diamond. It is really difficult to see, especially on the glide slope. Again, about trying to differentiate between the dog bone and the guidance antennas. At times, one would be centered and the other one wouldn't and it was kind of confusing as to which one you're supposed to go by. And then as far as being good, I mean outside, the terrain looked good. Every once in a while when I focused off the instruments and onto the terrain, it was pretty evident where I was and what I was doing.

PRFN30: The brown isn't as detailed as the last one. It's definitely a resolution issue. The ground below me looks just completely flat. I can't tell if there's anything on it at all. It could be flat, I guess, but I don't think it is. Right, and that ridge in the distance isn't nearly as defined as the last one. If I didn't know it was there, I probably wouldn't be able to tell that it was there. And I've taken off of this runway in real life, so I know it's there. As you get closer to the runway it's easier to use the closer in view. The runway shows up a lot better and it's easier to put the line up the aim point marking. (Okay, and the field of view that you're in right now is the unity.) Yeah, but farther out it was helpful to see all the boxes lined up. There were boxes lined up and you could really see the runway and it worked better. But in closer, I like this better. Better than the last time. I didn't like the terrain modeling. I don't think it was very clear as far as the seriousness of the mountains around there. I actually glanced at the MX20 a couple of times that time, and I don't think that what I was seeing on the Apollo instrument plan view was . . . it didn't really sync up with what I was seeing on the other screen in front of me here. I basically don't think this view screen portrayed the mountains well enough.

PR1: This is definitely better. I can tell that I just flew over that little ridge right there and the terrain is dropping away now. It's much more clear than the last one. No, I didn't really notice that ridge the first time. The first time I was more concerned about going through the boxes rather than sightseeing as much. I don't think switching the boxes in mid-turn is a good idea. It's very confusing, like I just did. They seem to just jump all over the screen because the magnification changes so much. I barely made it through that turn. Yeah, I definitely like a longer view when I'm farther out like this. I guess I'm in the 90 right now. Now as I get in closer, I'm not really watching the dog bones or localizer or anything. I'm more just focusing on trying to keep the velocity vector and the three degree lined up with the aiming points. I'm not really watching anything else too much. *Feels he barely made it through the turn. He did make it, but it was sloppy.* I thought the terrain awareness was a lot better, being that low to the ground and being able to really see the different little peaks and the mountains helps a lot, and the towers and everything.

BRD BL: It doesn't get much worse than that. (Well, you found the runway.) Yeah. I gave up on the gauges once I could see the runway. *A little high at the beginning, but only for a couple of seconds. Missed turn, by a lot. Was also fast and low for about 20 seconds prior to turn. Was too high and almost overshoot the RWY. Could have almost been a 'below adequate', but not quite sure.* From the three descriptions of five, six and seven, it easily seemed the most appropriate: Requires extensive compensation. I didn't think number seven applied, because I thought it was

attainable, I just wasn't doing a very good job of it, I didn't think. It was difficult just to keep the aircraft descending at the same rate and on speed was a big thing that kept distracting me and then I would lose track of the turns. That's what was really driving it, was the vertical speed, I think. (Okay, and I'm just curious if you miss having the knowledge of the terrain beneath you?) I was looking at the Apollo instrument and it was useful in telling me if you're heading toward something that's bad. But yeah, I definitely missed it visually, looking at it. It would have been nice, because I caught a glimpse of that one tower you pass right on the screen ahead of me, and it seemed like I was flying right over top of it. It just kind of jumped out at me.

CCFN1: I think the ground really doesn't look too believable or realistic. I can't tell where the drop offs are or anything like that. The ground just looks like a big flat desert, kind of. This ground isn't telling me anything. The photo realistic one is nice because this approach is flying right over top of this city and it's nice to know if you're going to, if you land short, if you're going to land in the buildings or not. I think one thing that might be nice is having the boxes spaced closer on the turns, but switching the views is really disorienting. If it's possible to put the boxes closer together on the turn segments, you wouldn't have to switch the view. So as you go around the turn there are spaces, maybe twice as close or something to that effect. The boxes appear to come faster at you when you zoom out more which I think makes it easier to stay within them, it seems. There's less time to let your course wander. And then again, this ground really doesn't tell me anything. (You're boxes are closer together on the 90FOV.) Right, but I didn't like the way they looked on the straight away through that turn. And when I switched it, I mean it's very disorienting when you change them while you're looking at them. *Was more than 1 dot high (flying too low) for 24 seconds. Gave him an adequate.* Well I didn't like the terrain modeling very much, although it was better than what I had seen earlier, where the mountain past the runway is a little more evident than that one, more so than in . . . I can't remember which one it was before, but the one I complained about before. Yeah, I think that was it. I'm pretty sure it was the photo realistic one. *Mountain pass was a little clearer here than the PRFN30.* I guess I wasn't paying enough attention to the vertical dog bone but it seems like the more I use it, the more confusing it gets with different things moving around right there. It seems like it's getting harder to follow and harder to make them work.

CCFN30NT: I can't really tell what the ground is doing too much. It's kind of wavy. Now I'm missing the tunnel information. I'm just trying to make that turn. *Stayed in FOV60. 12 seconds too high on final, too. Not enough to be outside of PTS, so gave him desired.* I thought of those four choices, it required probably the maximum amount of concentration and technique that it would allow to keep the two diamonds lined up, at least until I was able to zoom in far enough to see the runway to line up the three degree line. Then it became a lot easier. The terrain wasn't all that helpful, but it was useful in that I knew it and was able to tell if I was going to run into it or not. Otherwise, it wasn't too descriptive of what it actually was.

EBGFN30: (It looks to me like you're leaving it on 60. What do you think of this lower resolution with the generic and the fishnet overlay?) It's not that great. Everything looks pretty flat, still. There might be something (antennas) off to the left there but it's behind the air speed bar. Just to the left of it, it looks like there's something. Occasionally that one (antenna) creeps up at the bottom left of the screen out the window. There, I can see that one. It looks much farther away on the screen. It looks farther away on the display than it does on the out the window view. Now I'm just trying to focus on really focusing on the runway. I'm getting closer in. The mountains in the background look pretty decent. You can tell there's something there. Yeah, I know that there's a mountain there that I would want to get over top of. They're not as good as one or two photo realistic ones that I saw. Well, for my part, I gave it a lower score because I kind of didn't steepen up that turn there to get through it. The box snuck up on me, or what

exactly went wrong there, as far as the simulator, I really couldn't . . . that mountain in the background, I could see it pretty well once I was closer to the runway, but farther from the runway, I couldn't pick it out and I couldn't tell that it was significantly higher than the runway or whatever. It was just kind of a small bump. So I had to wait until it was really close in to really be able to really see it.

PRFN3: I can really tell that the terrain is falling away in front of me. It's pretty accurately matching the picture out the window and the picture on the screen. I think they match up pretty well. The picture here does a pretty good job of showing there's development or so forth, coming up below me here. It's just showing a single road or something. And also that mound with the sharp drop off down in my bottom left is showing up very well. There is a mall right there and tons of restaurants and a movie theater and things like that. *Stayed on the numbers pretty well.* I thought I did pretty well staying on the numbers. The second time I did spin up a little bit at one point, but I think I caught that right away. I thought that was giving a pretty accurate depiction of the ground, that photo, even though that wasn't the most realistic one, but it still did a pretty good job of conveying the fact that there was population before the runway development and so forth. But it still showed the breaks in the terrain.

EBGFN1: This terrain is pretty well defined. It's easy to pick out the ridges here. (Do you feel that the fishnet is giving you additional information?) Yes, definitely. I'm not really using it to navigate or aviate or anything. It's just knowing what's below me, it just tells me more. But I'm not using it really to fly at all. Yeah, I think the 90, if the boxes are closer spaced, or seem like they're closer spaced anyway, it's kind of easier to fly the turns. I find it easier to fly, the more boxes coming at me. I find it's easier to get through them. (The ridge beyond the runway) is kind of blocked by some things. Oh, there it is. Yeah, you can definitely tell with that view. (That's your unity, just for your information.) Yeah, but I really don't like flying it at all. This one, which I would probably switch to in a second anyway, once I started the descent, I would probably be onto this. You can really tell it's there and really tell that it's rugged looking, much more so than you're able to tell beforehand. The terrain beyond the runway is definitely more well-defined here. As opposed to other ones I've seen and also, yeah, as opposed to using it far away, it's really difficult to tell. Especially that, I mean you can't see it at all there. The boxes are easier to fly this way, but the terrain is more difficult to see. And I think as you get a constant glide path, I think it's easier for me to fly the boxes. Or I can fly them when they're farther apart just as well as closer together. It's worth having the terrain in view. Well, I thought I would have given it a one except that the photo realistic is much better in terms of the presentation just because it shows the population density and everything around the airport. But otherwise, I think the terrain with that was very easy to . . . it was very accurately depicted. It was very easy to pick out what it was doing. The fishnet definitely did help on that. And I thought my performance was probably one of my better ones, too.

PRFN1: I mean the terrain looks really good. The fishnetting really helps with all the little bumpy hills and stuff in the background. There's not too much in the background here, but down below me, it definitely helps be able to see it. I think I definitely like this display for this phase of it. (As in the 90 degree field of view?) Yeah. The fishnetting gets lost in that, so you really can't tell what's going on with it. The mountains behind me are pretty well defined. They might have been more defined in the generic one. That maybe exaggerates things a little bit more, to give you a better idea of just how rugged it is, and how steep it is. *Was a little fast for around 15 sec.* It wasn't really superior to the generic one, like I thought it would be, because I think the generic one does a better job down low, showing the different elevation changes in the hills and mountains and so forth. So I think it was, it didn't do as good a job there, but it did do a better job, obviously, showing populated areas and things like that. I think one was better on one, and

the other was better in the other way, so it was kind of a tradeoff, but I don't think either one was superior to the other one.

CCFN30: I can't tell at all what's going on, on the ground. The boxes are easier to follow because there's no clutter or anything behind them, but otherwise I have no idea what's going on outside. I think this one dangerously oversimplifies the ground outside. I know there's something behind the airport, but it's hard to tell that it's a mountain. (So how comfortable would you feel if you had to go around on this one, or if you couldn't land for some reason?) Probably not very, because I suspect that that thing would creep up on me a lot faster than it looked like it would. I think it rises faster than these graphics make it appear it does. You might find yourself running into it. First, I gave it the lowest one I could, just because the terrain, I didn't think, was very accurate or very well depicted. The flying was very simple, I thought, because there was really nothing outside to distract you, because everything just kind of looked the same. That's not necessarily good, I guess.

EBGFN3: The topography looks pretty well done. The fishnet definitely helps it. It's definitely better than the 30. If I recall, that was not that well done. For some reason, I think the 1 was a lot better than this. Not as "more" better as this is, than the 30 one though. There is a bigger discrepancy between this one and the worst one, versus this one and the best one, best meaning best resolution. The ground below me now looks pretty flat and somewhat featureless, but . . . When I really can't see what I'm aiming for, I like the 90 one with the more boxes. But then when I can see the runway, I think for me it's a lot easier to zoom in. The background ground looks pretty good. The mountains behind the airport I think are still acceptable. They look flatter than they did with the one arc-second. They're not as jagged. They're definitely better than the last one I viewed, which was terrible, and then the 30 arc of this type. I thought it was well done and acceptable, but still I didn't think it was as good as the one arc-second DEM. Some of the terrain looked a little flatter than it probably really was.

Rare Event:

CCFN30: It's like a big desert before me. It just looks flat. Yeah, I can see the river and the fork in it. (And do you feel that the fishnet is giving you any information?) Not really. I really can't tell what the ground is doing at all. I can see the ridge on the screen in front of me, but I can't pick that out at all on the . . . I wouldn't really be able to tell that. Yeah, I don't really see a relationship between the two of them at all. I was going to . . . The ground in front of me on the screen looked incredibly close to me. I mean it looks like I'm about to run into the hill in front of me but it says 5,000 and he said the highest terrain was 4,000. There's no way I'm 1,000 feet above that. *3:50, saw the mountain OTW first "looks pretty close out the window", and commented that the HD did not show him what the OTW showed him Couldn't tell what the terrain was doing on the PFD at all. I didn't think it was, on my screen I didn't think it was. But out the window I was looking and it looked like I was about to run into something, but on the screen, I really couldn't tell.*

Subject 22 (BRD Baseline):

Block 1, High Altitude:

EBGFN3: I have a tendency to go left on this. I'd like to blame the simulator, but I'm sure I'm affecting the result. Just out of practice. I was so pre-occupied, I had so much trouble with the heading, that at first I just completely forgot I was supposed to be descending. I guess with the altitude, that tape on the side there, there's a lot of information right in the center with the altitude and then the arrow showing me my descent rate, so I think it's just a matter of getting used to it. I was tending to concentrate on that and then of course, I'd lose my heading again. Yes, but at the beginning I was just really trying to get situated with the controls and to get my heading. Well it

was very helpful of course, in the IFR condition. I think it relieves stress because it does give a good picture of your bearings. It shows you how close to the ground you might be getting and I think it helps situational awareness. You can see your bank angle much more easily instead of relying on just the instruments to see which way you're banking. (What about the texture of the terrain you have seen?) In that particular scenario, I don't know if it was just because it was the first one and it was just an anxiety level, but I really wasn't that mindful of it in this case.

CCFN1: I think I misinterpreted the instrument to the right. I can't remember what you call that. Well, again, my heading is off. I'm not supposed to turn yet. I need to get my airspeed back up. The arrow on the tape is helpful in letting me know what my descent rate is. On the display, I'm not so much concerned about whether there is that fishnet pattern or not. It's not real critical to me. I'm just interested in the ground. And my heading is off. As a pilot, it's a great comfort to me to be able to see my horizon line between the blue and the brown. I think it takes some panic level out. And I really don't have to work as hard with this display as I do with the traditional instruments. (Well, actually, we have that you were like 8,300 feet. So because of that, I'm going to give you another considerable improvement. Okay, so that will limit your rating to eight and ten.) Well, of course you can't get as good an awareness of how far above the terrain you are, or where any mountain ridges are. You have to rely more on the instruments for that – the altimeter and so forth. As I said, during the scenario, it was extremely helpful once the visibility is lost in VFR, I still can see because of this window, so having that information, even though it wasn't as detailed as the first scenario or the first session, was very useful.

PRFN30: Yeah, and another thing is, I'm never quite sure of my power setting. And that's a little disconcerting to me. I'm never sure if I need to reduce it a little more, or if I reduced it too much. It's a little hard for me to tell with this display. I'm glad I'm not in a real airplane. I liked the detail in that. I think it gave me just a more realistic picture of where I was, and I think in any case, the more information you have in front of you, and like I said, the more realistic a picture, I think it reduces the panic level of a pilot with my low time. It helps me also to see . . . I'll tell you, it's scary looking out a window and seeing fog. So to be able to tell more accurately what you're bank is, relieves stress considerably and then to layer in more detailed information and a more realistic picture, I think helps take the stress off of, am I going to crash. Now I can concentrate more on my air speed and actual heading without that sense of panic. I did, and in fact, I think it relieves some of my workload, because I've got that information. I know better where I am. So I'm not, I guess I'm not . . . I don't know how to put this so it will help you. I think just psychologically, it relieves a sense of workload and I think you can focus more accurately on the other settings.

EBG1: This display is so good that even in VFR conditions, I'm tempted just to look at it. I'm not sure that's a real positive thing. I'm starting my descending turn. I think this display is critical for this kind of terrain. If I didn't have this kind of visibility, I think I would have to get a psychological for higher anxiety, wondering where exactly I was in relation to this terrain. (Okay, your performance was adequate. The main thing I saw was that you had a little problem maintaining the air speed at the end.) Well, I think in this case it was a great comfort having the detail. I'm trying to mentally compare it to just the brown and the blue. I think the more information the better, and it was very accurate, especially seeing the mountain tops, to help reassure me as to where I was in relation to them. This past one seemed like it was the highest resolution. (It was.) And I appreciate that. I think that's why I said the comment at the beginning about it seemed even better than the picture I'm looking at as a VFR pilot, is almost clearer than that. I was paying more attention to the terrain in this one. I think it helped me position myself better – where was I over these mountain tops. The other one, I just knew I had enough altitude. The photo real one was fine. The enhanced. I'm just drawn to the more

accurate depiction and the one that I just flew gave that, as far as the instruments and all. The one prior to that was fine. I just want more information, I think because I'm a low time pilot, inexperienced with this. (Let me see if I can get it correctly. I seem to get it from you that the mountain depiction seems to be better with this one?) Yes.

PR1: I just had a problem with overcorrecting. I was going to say one reason I really couldn't do that, because that would just increase my workload. (Your descent was a little too fast.) Well, I think I might take back what I said before. I like the photo real one. The other one, I think it gave maybe more terrain detail somehow, just because of the shading. And also, the photo real one, it's always nice to have a realistic picture of where you are. You know, it's really hard to tell which one is more effective. They're both very good.

CCFN30: You know the previous displays really allow me to fly, I would say, VFR in an IFR environment. This one is more IFR to me, just because of the flat terrain; flat meaning you really can't tell where the elevations are. I think I like this view (FOV60) the best. *Did not know where she was on altitude – thought she was a little under 8000', but was actually 8400'. Missed greater level of awareness for the display. Still better than conventional.* The terrain . . . well I didn't know exactly where I was on the terrain, because of the lack of detail. But at least I could tell when I was above the terrain and what my attitude was, whether I was banking or so forth. I missed, I think, the greater level of awareness that I had with the other displays. But again, I'm grateful for any information I can get.

EBGFN1: (This time it was on the air speed.) The view, I was able to play a little bit with that, and I liked the longer angle view the best. (FOV90) And as far as the terrain, it's just very helpful. For reasons I stated before. I just think it improves my awareness of where I am. I think where I am on the map. Just being able to recognize certain ridges. I mean if I flew in this area regularly, it would be even more helpful. When you don't have that detail, whether it's the photo real one or this one, you have to rely more on the heading indicator to know where exactly you are. But like I said earlier, it's almost like VFR, in a way, when you have these more realistic depictions. I don't think that it's more VFR in that it would make me careless with my headings and so forth. I think it just gives me more useful information to have the detail.

EBGFN3: I just have a good sense of where I am. (Is the fishnet adding anything to your sense of awareness?) I would like to see a direct comparison without it to be able to really answer. I think it probably gives it a little more depth. (Do you feel any sense of difference between this display and the one you just did before lunch, which was the fishnet with one arc-second?) I'm sorry, I think it was too long ago for me to . . . they're all kind of blending. It seems like that fishnet does give more definition to the ridges of the terrain. (Do you get a good sense of those towers down below?) I've lost the towers. I'm preoccupied with my numbers right now, and the details of the terrain, which is not a good thing. Well, I think your question about the towers and my lack of being immediately aware of where they were on the terrain shows that I was putting a lot of effort into keeping myself where I was. What I did know was that I wasn't in jeopardy so I wasn't as concerned. I didn't see anything approaching me that I was going to hit so with all the emergency kind of thoughts aside, I was just concentrating on keeping my air speed and altitude and direction in that case. But I did like having the detail of the terrain. It caused me to worry less. I probably would have been looking at the terrain more if it was a little less sharp in the depiction. And again, do I understand correctly in that the fishnetting brings that resolution up?

PRFN3: It's as though I'm actually looking through the window of the plane, so it's not like I'm losing visibility, because as I look out the window as it were, I'm seeing the haze approaching. But there's no need to panic, because I've got my clear display right in front of me and it's

showing me landmarks. I'm going to play with this field of view. I think it's giving me a good view of the elevations. They're not just blending from one slope into another. I think it's aiding in the shading and so forth, giving me a better sense of altitude. (Compared to the last run, do you get any sense of depth perception on those mountains versus the EBG?) Yes, and I think the fishnetting accentuates that. I just think that the detail in the terrain is very beneficial for me for a couple of reasons: It gives me a good sense of awareness of where I am, and that leads to I think having a lower stress level. I can concentrate better on the instruments.

BRD BL: Where's my fishnet? The previous displays really keep my eyes focused. I can ascertain much more information, much more quickly because my eyes don't have to wander to find it. I already feel a greater sense of insecurity because I don't know actually what it looks like outside. (Is the MX20 providing you any additional information?) It is. Well, I just sort of jumped the gun on my turn a little bit. It's almost like having a GPS to look over. The numbers on the tape on the previous displays were a little difficult for me to read. It may just be me. This altimeter, though, is giving me my information more quickly. I think it's because I'm accustomed to this particular dial. But it did seem like the numbers were kind of small. There's a lot of information crowded into the altimeter reading area on the previous display. I just don't know what's going on outside. It sure does force you to trust your instruments. (Once again, what about the plan view information from the MX20? Does that give you any comfort level on the path and terrain?) No, not particularly. I mean I see some information, but I think at my level, that almost increases my workload. Well, with the previous displays, I knew just where I was. Or at least I believed I knew where I was. I couldn't actually see the actual terrain. But with this, I really had to just try to keep to the numbers as best as possible, and trust that I was where I was supposed to be.

PRFN1: I just like this better. The other is really like flying blind. Well, as far as all of them, I think this is the truest to life I could hope for, from what I've seen. This lets me know right now where I'm supposed to be. I could tell on the traditional instruments that I just used by my heading, or altimeter, that I'm in pretty good shape or not. But with this, I can still see landmarks and that makes a very big difference instead of feeling a sense of loss of control. (Do you feel any depth as you're going over this next ridge?) I do. In fact, I was just thinking, this is giving me such a better sense of landmarks and following those ridges. I can bring pilotage into IFR while I'm flying. I lost my altitude. (We're going to go ahead with an adequate performance on that one, because of the altitude problem that you had.) I know. That was too much workload to answer a question and keep my altitude. I think that what I said during this exercise, I had a greater sense of pilotage and I liked that.

Block 2, Low Altitude:

BRD BL: I miss the SVS. You know when the SVS was there, out of my peripheral vision it gave me a better sense of the stability. I would reiterate what I said earlier. I noticed that in my peripheral vision with the SVS display . . . Yes, and it also gave me a sense of a level wing on whatever bank I was using.

EBG1: Well I think it provided enough detail that, as I was trying to get my numbers straight, again I was aware that at least my configuration was decent. I knew I wasn't going to crash into anything.

PRFN30: The fishnet seems to give, I think a sense of how quickly everything moves across the terrain. I'm tending to like the fishnet over the photo real, for the reason I just stated. I think it gives a pilot a better sense of where he or she is over the terrain and how quickly you're moving across the terrain.

CCFN30: Can you tell me, was I in the unity view? I toggled through it a couple of times. I think I like the closest one, which is the unity. If I were farther back in the view on that particular display, I didn't have as much detail as I thought I needed, so I started cycling through to try to find a view that gave me a better view and better performance and that unity view with that particular display gave me more detail. And I felt like I had more control, even though I was having some trouble chasing numbers, I still felt like I had improved control in that situation.

PR1: I was playing too much with the field of view. Yeah, I was trying to see if it would be as effective at this display as it was in the previous, and actually I think I prefer to be a little farther back with this one, not in the unity mode. Because it was photo realistic, I wanted a broader picture of where I was. You know at the end, I was having so much trouble with my altitude, I just stayed put with the field of view, and that happened to be in unity. But I probably would have gone back to about 60. (Were you curious about the adequate rating on the last one?) I think it probably had something to do with my altitude. (Right, and at the beginning, on the first leg, I call it the first leg before the turn, you were high probably for watching other variables.)

EBGFN30: I think this is a classic case of chasing instruments. (Linda, have you noticed any objects at all on the terrain?) No, I haven't. I don't like the unity view in this. What's the one back from that, 30? (Yes.) I can see the runway. Well, it didn't have as much clarity as I've been spoiled with. You know, I guessed on the fact that that was the runway I was looking at, but I wouldn't complain about it at all. And I also like the option, the field of view to change that. Because I think under different situations, it is helpful. I didn't want to be so close up in the unity. When I was closer to the airport at the end, I wanted to have a little bit of a better idea of what was to my left and right.

PRFN3: I'm seeing something. Maybe they're towers. I see the runway to the, about 12 o'clock right now. (Does the fishnet looks like roads to you?) Yes. Just with the field of view, I noticed that I really threw myself off in changing that view. I'll deviate somewhere, either in the altitude or the heading, just because it looks different. It's taken me a moment to adjust to it. But once I adjust to it and get there, and get my sequence back, I'm fine.

PRFN1: I've seen good detail in the towers and in the grid pattern. I know that's a grid, and then there are some other features in the landscape. What I'm able to handle is pretty limited. I had just gotten to the point where I was starting to feel comfortable with the field of view. (So you have seen the photo real, the three arc-second and the one arc-second. Do you see any difference between the two?) There is a difference. There is considerable difference, I thought, in the detail that I was able to get. For the view, I think I like the 30. That works well. That gives me some good detail but it also gives me a little bit of a wider view, so I guess better situational awareness there. And I think because of the higher detail with that fishnet, it does give a clear distinction of the grid versus you know, like you say, I could see where it would be easy to either not see a road or confuse the grid with a road with a lower resolution. Yes, and that was still pretty good, and then there's one more with the lowest resolution. That's the one where I think there might be some problem distinguishing between the grid and other landmarks.

CCFN1: (Do you see the river?) Yes. (Okay, good. But that doesn't confuse you with the fishnet?) No, I know what that is. I think I can make out the runway. I'll just repeat what I said in previous scenarios, that either unity or 30 is good, and you don't have the detail in the terrain with this particular screen, but it still gives more than adequate information I think, to fly safely.

EBGFN1: Except for losing too much altitude at the end, that was the best yet. I would like to know for sure, but I think it was the field of view, adjusting that. I think I got carried away with the terrain. And you know what, I saw also for looking out the window, some of the towers. I hadn't noticed them before. But that was interesting. It was matching nicely with what I was seeing on the screen.

EBGFN3: I think what I've been doing in the last few runs is really trying to figure out where the optimal point of view is, and the terrain actually was fine. I would have liked a little more detail, just because I've had it and I missed it. (More detail such as the photo real?) Yes, or even a higher resolution, just to give me a little more landmarks, maybe, just to clear up I guess, some of what I'm looking at. But again, I sure wouldn't complain. I'd love to have this.

Block 3, Approach:

PRFN3: You know in order to get just to the box, it's way off the heading, so maybe I'm missing something here. I'll tell you one problem I'm having is just with the yoke. I have to put so much muscle into pulling it back, it's actually fatiguing. *Received some coaching on symbology and how to fly the simulator.* Well the terrain was nice, especially at this earlier run, I had so much detail to work with. Other than that, I was overloaded.

CCFN30NT: (Did you notice your path on the MX20 earlier?) I tried to, but there was so much going on, I really couldn't pick it up. (Okay, well you may be able to use it as a cross reference for this approach.) *It is better to have a tunnel than without. Run took longer than expected. Was off course. Took extensive coaching to get to the runway.* I think that particular display was certainly adequate awareness of what was on the terrain. And I was really glad to have it. I don't know where I would have been without it. (Were there objects, such as rivers and buildings, to help you to locate the airport?) Yes, they did. (Were you able to play with the field of view much?) Not at all. (How do you like this with no tunnel?) I would rather have it.

CCFN30: *It was a little too fast. You need to try to keep your heading a little better, so you can stay within the tunnel.* I think the terrain with all the detail that it had, I don't know, the fishnetting and all was very useful. Yes, I think that grid just gives a better sense of terrain coverage. (Were you able to play with the field of view again?) I think I did on this one. I was just looking for something to help me get through the boxes. And to tell you the truth, I'm not sure which field of view I tend to be going with. It might be the 30 or the 60.

PR1: I am mindful about the air speed. (All you need to do is improve on the air speed.) Air speed. I don't know how to keep up the altitude and lower the air speed and stay in the middle of the box. (Unfortunately, I'm not a pilot or I could give you an answer.) Neither am I. *FOV 30 worked well. Able to pick up the current location using the landmarks.* I was really grateful for the amount of awareness I could get from that particular terrain depiction, and I did play with the field of view. I think I was at the 30, and that seemed to work really well for me. You know, I think because I was so preoccupied with other things going on, there could have been one of the lower generation images, but what I did pick up very clearly was basically the terrain and where I was, on it, or over it.

EBG1: Ninety knots, look at that. I'm real grateful for the terrain. As I looked out the window, it doesn't give me a whole lot of hope, but seeing the detail in the terrain, the runway and all, I sure hope nobody would take that for granted. I think the combination on this particular one, could you tell, was I at the field of view setting of 30? (I think you spent a lot of time on 60, if I recall correctly.) That's working out pretty well.

CCFN1: Oh, no. It's coming back. Oh, I lost it at the end. It was very good and I stayed with the field of view, I believe that was 60. And that's where I stayed. I thought about moving it, but it was working really well -- the size of the boxes and all -- so I kept it there. No, but it's just enough, especially to let me know where I am at the end there with the runway.

PRFN30: It looked like it was pretty true to what I was seeing out the window, especially there at the end. It makes a tremendous difference, having a picture to see. I think it helps me as a pilot, concentrate more on just my other numbers. I just have sort of a peripheral sense of comfort there that I can see my horizon line and the strip and all of that. Yes, and especially getting this low down to the ground, that's critical. It takes certainly a level of stress away. I don't think it would, it certainly wouldn't make me any less attentive, but I think it takes, it relieves the stress of wondering where exactly I am and it enables me to concentrate more on the numbers that I need to be looking at.

EBGFN30: *Moderate bank angle PIO (30 to 30) persisted through the turn. Speed got out of range a little bit, too.* And I think my comments would be pretty much what they were with the last run. I think it was similar. Well, I missed the better resolution, but like I said, I'm real grateful for what I do have. Well, I think I tend to go with the photo realistic, just because it does give you a little more, a little better sense of realistically where you are, but this one, depending on the generation loss, I would prefer a higher resolution EBG to a lower resolution of photo real. So I think what's more important to me is the better resolution.

EBGFN3: I would say, too, that the increased resolution really does help distinguish landmarks much more readily. *Somewhat less bank angle PIOs (Observed).*

PRFN1: It would be a whole lot easier . . . My biggest problem, I think, with all of this, is not knowing really about my power settings. That's what's really throwing me. I haven't gotten the gist of that. *PIO continues from about +/-20 degrees. Power control is still difficult.* Yes, you know I hate to say this, but I was almost distracted because there was so much good detail. I was surprised by that, after what I said previously, but it's just a more realistic IFR, or rather VFR setting in the IFR conditions, and I don't know that you can fault that. And the grid pattern, again, I think that's useful. I was tempted to play with the field of view, but I really didn't want to ruin a good thing, so I stayed put.

EBGFN1: No comments. *Really tough start, went beyond L2 for about 20 seconds. Expended most of the desired L1 budget (Observed). Pilot performance was close to being L2.* The terrain was good. Yesterday, I think it was Doug that asked me about the roads versus the grid, and if I was having any problems confusing the two, and I wasn't then. I was noticing that today, and I don't think there's a problem with that distinction. I think the terrain is easy to make out, I mean the important landmarks. Plus being able to identify roads would help me as a pilot, kind of that pilotage. That's fine. There was enough information on that screen.

BRD BL: I wish I could have (landed) on the last one, but I don't think this one is going to be a pretty picture. I'm not sure I have the runway. *Flew through localizer without turning onto course. Started turn on loc at 2min, about 45 seconds late. 7+ dots of loc off for most of the approach. Was able to do GS reasonably well.* Well, I was relying a whole lot more on the MX20. And as far as the gauges, I was glad to see my power setting, just because I'm accustomed to that. Other than that, I felt pretty clueless. I was looking out the window a lot more, trying to see when the terrain was going to come back. I sure missed those other . . . I want my SVS.

Rare Event:

EBG1: I'm working on the altitude. It was really funky at the end there. It was fine. I didn't have a whole lot of need for intense detail there in the terrain. I just needed to know about where I was in relation to the terrain and it helped, of course, with the horizon. I'm trying to use the MX20 more, although I really didn't except for where I was supposed to turn. I think just because of my workload in other areas. I don't know what else to tell you about the terrain. *60 deg FOV to start, not FOV activity, good control of alt/as/heading. FOV to 90 Split ridges on approach to terrain. FOV to unity at 4:10. Passed over first hill, then down into next hill. FOV cycling. CFIT.*

Subject 23 (BSBG Baseline):**Block 1, High Altitude:**

PRFN3: My attention, I know I'm supposed to, but my attention on the terrain was minimal. I was more worried about just keeping my air speed. I found myself being more worried about keeping my air speed and altitude correct. So, I need to pay attention a little more to the terrain. (I know that you said it was minimal, but in that little bit that you had, did you have an awareness of the situation? A situational awareness or anything like that?) Yes, I thought I did, based on the MX20 and what I was seeing here, I wasn't concerned about my position or what was happening around me.

PR1: It's very crystal clear. It looks nice. It's better than outside. These inadvertent rolls, I'm assuming, are my turbulence? (Yes. Does the terrain down below give you a sense of depth or altitude?) It does, yes, it does. Unity is too close. It's too much. I don't know, I can't get a good feel of perception or what I'm . . . things are moving too fast. (Do you feel a little more comfortable with the 30?) Yeah, 30 and 60 I think. I mean it's almost like looking out the window, so it was just very crystal clear and easy to interpret. It wasn't complicated, I didn't think.

EBGFN3: It also seems fine. It doesn't seem like there's a material difference in terms of information that I need. (Do you still get a sense of the altitude on the mountain range?) Yes. You know, I can't see the fishnet. I don't even see it. I can see it, but it's not very helpful. (With the different coloring on the elevation based generic, does that help you more or less than with the photo realistic?) Neither. I don't think there's a . . . I don't have a sense that it's helping me or not helping me. It's kind of like neutral. I can clearly tell what's higher and what's lower, though. Just that I didn't notice a material difference between the photo realistic to this one. It seems the same in terms of the information that I need.

CCFN30: I really don't see any fishnet. Oh, I sort of do. It's very simple. It's very simple and clean, not a lot going on, which is nice. (In this particular display, do you have any sense of terrain like you had before?) No, not at all. This just appears flat and I have absolutely no idea except for a little bit on the horizon, but you know . . . (Do you see those towers down below?) I wouldn't have noticed them if you hadn't pointed them out. It looks like just random information. I get kind of stuck on this field of view. I like the 60. The visual display is very simple and so it seems like you don't have to pay a lot of attention to it in terms of interpreting it, but you have absolutely no terrain awareness.

PRFN30: It seems very detailed. Is that, is it supposed to be more detailed or is it more blurry? No, actually I think it's more blurry, less detail. (How does the mountain range below seem to you?) Flat. Just a little bit of curves, but flat. I mean I have a sense of terrain awareness, but it's flat. (Does the fishnet below help you any?) Not really. I don't feel like it's necessary in terms of getting some perspective. (Do you get any sense of the runway in the distance?) Yeah, right

there? Okay. I saw it but I wasn't . . . I didn't know it was there until you brought it out. The fishnet I don't think was helping, but the different colors you used there for the ground gives me some sense of terrain.

BSBG BL: Well, it's familiar. This is what I'm used to. I think in comparison with the other displays, there's not as much information and it seems less cluttered. It's not as much, just nice information. (Do you have any concerns about the terrain below you?) Yes, since I don't see anything and I'm just relying on and trusting my instruments here. It is somewhat of a concern. (Is the MX20 providing you any useful information?) Absolutely, since I know where I'm at, I'm not too horribly . . . How's that for descent? Less information that you have to use, so I think it requires some more attention to both this MX20 thing as well as the primary flight display here.

PRFN1: (Do you have a better sense of the terrain?) Absolutely. There is a lot of information here, almost as if you were looking out the window. (Is the fishnet helping any?) Not really. It doesn't really seem to be giving me any information that I would find valuable. When I go to the closer, to unity, like 30 degrees, unity, I feel like it would cause me to over-control the aircraft. Everything is so fast. I'd be chasing everything here. I can see the runway. I'm not sure why, but it really just seemed really easy to fly. I'm not sure if it was the level of information or something . . . I don't know. But it was just easy.

EBG1: No, it seems, obviously it seems computer generated or fake, but it's got all the information that I feel like I need in the sense of the terrain. I would have a sense of what my position is, and it's actually, I think it's a little easier to interpret than the other one, the photo realistic one. There's less information there. And there would be less clutter than the photo realistic. I don't have any sense of disorientation at all, on any of these so far. I'm taking the opportunity to cycle through the fields of view. I see the airport. I see the runway. (Do you think that you've got a better sense on that view, of the runway from this particular one?) This particular one, yes. I think because of the less clutter. I over-control the airplane I think, when it gets too close. I like the less clutter. I had enough information for terrain awareness, but no clutter to mess things up.

EBGFN30: I don't really have a sense of the fishnet. I can't really see it. (Alright, now that you've gone to the lowest resolution, 30 arc-second, do you see any difference with the mountain range?) Yes, less defined. But I don't know that it's such that it makes a material difference in the flying. It seems okay. It just seemed a little less crisp than the previous one.

EBGFN1: Yeah, much more crisp. Well I think I like the less cluttered thing better than the photo realistic one. (Are you just experimenting with this field of view right now?) Yeah, it seems okay. You know, I don't feel like I'm having a sense of over-controlling, so it seems okay.

CCFN1: You have some sense of terrain going up and down. Not a lot. (Is the fishnet helping to give you that sense of terrain?) Actually, you know in this one, it is. In this one it is very evident. It sort of helps discern the angles of the mountains. (Do you think the fishnet in this particular example is more useful or unnecessary?) No, more useful. More useful than without it, in this particular display. It helps with orientation a little bit as well, now that you're without a horizon. I see some towers. Yeah, actually, because again, less clutter. So I think you can really pull it out. I think that particular one requires a little more work than the generic one.

Block 2, Low Altitude:

CCFN1: (Did the fishnet give you any terrain perspective?) You know, a little bit, but not a lot. I'm not really finding a whole lot of value in the fishnet thing. The mental demand for

questionnaires is very high. It was pretty much right there, some mild unpleasant deficiencies. It just seemed okay.

PRFN30: Yeah, you know, again, I can barely see the fishnet. Although since the resolution isn't as strong, I guess it's a little bit helpful, but just a little. I have to get really close to the instrument to really see it. (At this low altitude, do you find any difference in the fields of view that you keep switching to?) No, I still seem to be favoring the 60. I see a tower. I see the runway again.

CCFN30: You know this has much less terrain features, obviously, but less clutter, as well. So I'm kind of liking the less clutter. I don't have any sense of height of terrain, or where I am, where I'm flying over the terrain. There is a waiting connection from data source on my window here. (Is the fishnet helping out with any of this?) It's giving me some terrain features, which is nice, but not necessarily necessary.

BSBG BL: (Anything to comment about using the fields of view at this particular display?) No, it's the same. (You're just enjoying the flying, aren't you?) Yup. It's a lot of fun. (With this particular display, can you say that it's really giving you any sense of comfort?) No, it's giving me nothing. Just which way is up and which way is down, but I have no terrain awareness, whatsoever. I gave it a four. Just absolutely no terrain, I had no situational awareness in terms of terrain.

PR1: Well, it's more comforting when you can see the terrain and everything. (More comforting in regards to what?) Knowing where I am. My situational awareness. (Do you get a good sense in case of an emergency landing or anything like that, that you could find a place to put down?) I don't know until I get closer, but it appears that I could find something. I liked that the best. It's like flying VFR.

EBG1: It gives me all the terrain information that I like and I need, with great detail. (In this display with this mountain range that you're flying across, do you have a sense of awareness there?) Absolutely. I get the sense I'm going to hit it. I can definitely see how close I am to it. (Do you like this view?) I just want to see what it's like, to see if I can control it in here. That gave me all the information that I would want as a GA pilot in that situation.

EBGFN30: It's more blurry. It's less accurate. (Is the fishnet helping you out any?) Not at all, I can't even see it. Now I have a better visual of the fishnet right now. I don't know if it's helping me, but . . . I don't think it's helping me. (Do you have as much awareness of the terrain like you did in the previous display?) Not as much. Not at all. But I mean I'm still aware of it and I still have a sense of where it is and how to avoid it. But not nearly as . . . (I see you're taking advantage of that unity.) That's right, before he cuts it off. It seems okay. The plane's not getting away from me this time. Just experimenting right now. I just want to see what the approaches are going to be like with the unity. Well, you know, the plane got away from me a little bit there. But I think it's me, not what I was looking at. Yeah, when I was getting ready to initiate the turn. A little bit behind the airplane. I don't think it was a display, I think I just got fixated on something and I wasn't paying attention.

EBGFN1: I'm just looking for the fishnet. I can see it when I get up close. I'm at 90 and the fishnet is very clear. And seemingly nice. (Does it help any?) Not really. The picture does it good enough. What am I at, 30? That was pretty good. Yeah, you know it seems the fishnet is more valuable when you're using a closer to 30 or unity, or something like that.

PRFN1: I'm using the 30 degree, which the previous one, the fishnet seemed to help, but this one here, it doesn't really seem to do much. There's more color and more . . . there's a lot of stuff happening now, so . . . Now I'm just going to have to question the turn. It was so awesome. It was turbulence. That's my story and I'm sticking with it. (Now the last display, where you kind of switched over to the 30 and you kind of saw the fishnet a little bit more helpful, do you have the same finding here with the photo realistic?) Actually, yeah, I can see really good here. And the picture is so good I don't know that it's actually being very helpful or not. My flying was so poor, I think it's clouding my judgment. (You think that wasn't a factor of the display though, it was just . . . maybe too much workload while I'm talking to you.) I fixate on one thing and the next thing I know, everything else is gone.

PRFN3: (Do you notice any major differences?) None at all. Except that the fishnet is coming in clear. That could be because I'm . . . Yeah, the fishnet seems to be clearer here. (Do you sense any loss of terrain awareness?) None at all. (Do you feel more comfortable in this field of view for the turn?) Which one am I on, 90? I don't know. I don't think so, I think I like the 60 better.

EBGFN3: No, it seems, it's good. I have a good sense of terrain awareness and situational awareness. I couldn't see the fishnet at all in the first part, and now I can.

Block 3, Approach:

PRFN1: (Did you find it easy to fly?) Yeah, it seemed with the tunnels, it was good. I'll tell you though, when finally the diamond started to move and I intercepted that, the dog bones, and I know this isn't about the symbology, but the dog bones interfered with it, so I had trouble just focusing on the diamonds. When I started to use the glide slope and the localizer then the dog bone symbology got in the way.

EBGFN3: I see the roads and I also saw a tower to my left. But I actually didn't notice it on the screen here until I saw the real thing. (What about the previous one, do you remember?) No, I don't remember seeing it. (Have you settled on a particular field of view yet?) I still keep it to 60. That seems to be my favorite field of view. The thing is, is that I'm focusing a lot on the needles, making sure I keep them centered, so I'm not really . . . I'm having a hard time paying attention to the terrain to make an assessment of that. I was using the tunnel until I hit the initial waypoint, and then when I turned towards the runway, I began using the needles. But the tunnel was still a good guide, though, so it is useful. It's helpful.

PRFN3: (Now that you are at the lower altitude than yesterday's runs, do you find the resolution of the terrain makes a difference at all between one and three, between one arc-second and three arc-second?) No, nothing material. During the turn at the fix, the boxes tilt, you know, to 20 degrees, and that's really deceiving. That causes me to, I seem to be overturning because of that bank. (Because of the tunnel?) Yeah, I find myself cutting off the turn too soon and . . . When it banks, to let you know you have a turn in there. You know how the box, the tunnel banks? I start to, it causes me to want to bank at that same angle, which I think is too steep for this, for that particular turn.

CCFN1: (From here can you see the mountains?) Yeah, a little bit with the fishnet. Overall, less terrain awareness, but you still have good situational awareness. You could see roads and stuff like that.

PRFN30: Just in general, with all of the ones that I've flown so far, I'm paying less attention, I'm finding myself paying less attention to the terrain and just focusing on flying in the tunnel or

keeping the needles where they're supposed to be. So I'm noticing less of a difference between the various scenarios that you guys are setting up here.

PR1: (So you're still working more with the symbology and less with the terrain in the background?) Still the same thing, focusing more on that. I mean you know, the extra for the photo realistic view is nice, but I find myself not looking at that too much. (Okay, so you're looking more, it's not really something that's dominating what you're . . .) No, it's mainly secondary.

EBGFN1: *Perhaps hit the autopilot button, while cycling FOVs.* It's pretty much the same.

BSBG BL: *60 Deg FOV at start.* Pretty much what I expected, but you had no terrain situational awareness whatsoever. And also, maybe it's because I'm not instrument rated, but it requires a little bit more I think, to pay attention to keep the plane upright.

EBGFN30: Same comments. Nothing is really changing.

CCFN30NT: The tiles definitely assist in both the 30 degree intercept as well as staying on the glide path. So without it, that's definitely a deficiency. Yes, it increases workload.

EBG1: It just had good situational and terrain awareness and it was just easy to fly.

CCFN30: Just a little bit less confidence in terrain awareness in that.

Rare Event:

EBGFN1: I didn't actually realize I was so close to the ground until I saw the tower to my right. And that's what clued me in that something did not look right. It was out the window that I noticed it on my right, and that was definitely above me. No, not the MX20, the out the window. So I didn't actually really pick up the lower terrain. Yeah, then I realized that something doesn't look right with the terrain, and of course, out the window, as well, because everything was right there. It was really close to me. *Noticed a tower go by on the OTW. That was the first clue that something was up. Then, went head-down and realized what was going on. So, bottom line, first clue was OTW within 1nm of terrain.*

Subject 24 (BRD Baseline):

Block 1, High Altitude:

EBG1: I forgot how much of a dog is it, at this altitude. I'm having to get used to this turbulence, too. Yeah, in my training class, those were no problem. I might just note, I don't know if it matters to you, but I noticed even in flying the training plots, I tend to fixate on this heads down display, and I really didn't even notice that the conditions had gone to IMC. Okay, so I guess about now is the turn and descent. Just as another comment, I'm trying to talk a lot since you said that's what you wanted, I started out at the 60 degree, I believe, field of view, and didn't realize until I was in the turn, there just wasn't enough resolution for my pitch ladder for me to see what I was doing, so I had to switch to, I believe I'm on number 30, now. Yes, in the descent, I felt like I needed it a little bit more spread out. Well, I feel like I get good information from this type of display. I mean again, I didn't even notice I had gone to IMC because I was referring mostly to the terrain in the display as opposed to out the window. I felt pretty confident about looking at that terrain in the little display. *11 seconds too fast on descent and also above bank angle briefly.* Well, shoot, that was very good. I hate to start right off with saying something was very good. But I'd say that would have to be a one. Again, I felt comfortable with my situational awareness of where the terrain was, looking at that display. I was actually

using it as a primary indicator of where the terrain was, but like I said, I really wasn't even looking out the window, because I was able to use the wider field of view and actually see more than I could see over the nose, anyway. And I felt like I was able to determine the elevation and the contours of the terrain pretty well with that kind of display that I just had.

CCFN30: (How do you like that field of view, which is your 90 degree field of view?) I just went all the way up to that one just to get as good of an overview of the terrain as I can. I will say, the thing I don't like as much about this display, is that without the, I guess the photo realism sort of thing on, it's a little bit harder to tell what the contours of the land are. And maybe it's the resolution of the display, too, but I mean I can only see the fishnet where it's closest to me, so it's not necessarily giving me a whole lot of information. I'm pretty much sure that any of the fields of view, that was my high resolution, I was just leaning forward and looking at this point, I think it's just the resolution of the display, the little fishnet lines tend to disappear, is what I'm saying, as you get farther away in the terrain. I'm not really sweating the terrain at this point, because I know that I'm very high above it. When you started to say something, I was thinking maybe . . . I'm definitely most comfortable -- I overshot the few things I didn't like -- I'm most comfortable with this 30 degree field of view for making maneuvers. It seems to be the most useful, for me. Specifically the descent, probably. The turn is not quite so necessary, but if I'm looking for a specific edge, at this point, to do a certain rate of descent, it helps a lot to have it. But the unity just feels too big to me. In straight and level, once I'm trimmed up, I kind of like the wide as possible field of view just to get the most idea of what's going on around me. At this particular task, I didn't really have a lot of trouble with it. But again, I didn't feel as confident in knowing what was going on with the terrain as I do with the photo realistic type displays. I guess what I mean to say is, the sort of display I'm looking at right now where it's at, how would you differentiate between the display that I'm looking at right now and the display that I just flew? The display I just flew was all one color with the fishnet. This display here is giving me a lot more contour information. Just in the color. What I mean to say is, the sort of display I'm looking at right now seems to make me feel better about knowing what the height of the terrain is, and what the features are.

EBGFN1: Now this has a fishnet on it, you said, right? Oh, okay, I can't see it now. I can see it in the darker areas of the terrain, but I'm having trouble resolving it in the -- let me just make sure I get my altitude back here -- in some of the lighter parts of the terrain. Yeah, I mean I can only really make out that fishnet maybe at the lower one-fifth of the screen, and even there, it's not really visible for the lighter brown terrain colors, to me. Right off the bat, I would say I don't really think it's adding anything to me. I like this kind of display, fishnet or not. I think it's probably going to be about equivalent for me. (And again, you're using the 90 degree field of view just to get a big picture of what's around you?) Yes, just because it's giving me a better idea of what . . . and I can see more than just . . . If I go too far in, I can't really see the terrain at all. I mean the 60 degree is the smallest field of view that I can actually see terrain enough to make me feel comfortable. I don't know if this is relevant, but the one thing that I am having, not really trouble with, but it would reduce my workload somewhat, is that I don't have an RPM indicator. I understand the power indicator and I'm using that, but I guess I'm just used to being able to say, okay, I want to go to 1,700 RPMs and that's what I go to, as opposed to sort of reacting. I like this type of terrain display, like I said, for the very first one. I don't really know that the fishnet ever really gave me anything extra where I could see it. That's the only comment I'd really have about it. Other than that, I'd say it was good because it was like the first one. This one is also excellent, as I felt very comfortable with it. Again, I felt like I had good awareness of the terrain.

BRD BL: You know, this is a lot more familiar. I can already tell this is going to be a lot worse. And my stress level is also much higher because I'm trying to put myself in the mindset of being in an actual aircraft doing this, and I don't, I can tell I'm not going to like it, because I won't have a good feel for where the ground is. Even if I look at a map and it tells me where it is, there's something about having it on an instrument in front of you that makes you feel better, I think. This is not good. I'm watching the out the window display this time. That's scary! It's not the same as having the digital readout I had a minute ago. *One comment on the gages is that the DG isn't quite marked right, and he's having a hard time trying to find 50. He's flying really well.* Wow, I sure wouldn't have thought I got desired on that one. I'll definitely give that a four, if that's the lowest I can give it. Obviously it's your standard instrument situation so I've seen that kind of thing before, but after having flown the other things, I certainly didn't feel as comfortable in knowing that there was high terrain below me. I certainly didn't feel as comfortable in the descent, as I would have if I had had the heads down display in front of me. So from that standpoint, I would say that the deficiency is because I didn't have all the information I could have had with the other display.

CCFN1: I'm much more comfortable with this display, actually, than the gauges. I actually feel like I can, because I'm just looking now and I can see some more detail in the terrain than what I could see before. And I've got it all the way out to the 90 degree field of view and I'm looking at stuff that I guess is almost running into me. I can see that sort of thing much better, than in the 60, where I sort of, that sort of seems to be my default field of view. I like to be in it for the en route. I can certainly see things. I do feel like I have a better idea of what's down there. Now at this altitude, one versus the other doesn't matter that much to me, because as long as the big peaks are captured . . . But certainly, I can make out more features. I do find myself sometimes leaning towards this display, though, to get a better idea of what's on it, whereas the non-constant color display, I didn't find myself doing that as much. I felt like I could sort of glean what it was saying a lot better at a glance, than I can with this kind of display. It takes longer for me to comprehend what it's telling me, I think, in terms of the terrain features. You know, the only danger I see from these heads down displays is that I do tend to watch them instead of outside. Granted, it may be because of my, because of this task that I'm doing, but I tend to fixate on the display, whereas I didn't on the steam gauges. (Can you see the airport out there, over to your maybe 1 o'clock?) I can see it on the heads down display. It's not as good as . . . I mean the constant color is just not the best it could be, but with the fishnet on it, I did feel like I had some better understanding of what the terrain was doing. Yeah, I know you're out there. I don't need immediate gratification. And I just realized that I said that with the fishnet. What I meant to say was with the higher resolution display. The one versus 30, I mean I was able to see more of the terrain and I felt a little bit more comfortable about it.

EBGFN3: I was just actually trying to transition back and forth like you were saying, between the two, right now, and kind of looking at how they compare. And I need to watch my altitude while I'm doing that. I guess my comment is that I like this type of display, and I don't immediately see that this is any better or worse than the other EBG ones that I have looked at. Again, the thing I like about this display is that it's giving me a lot better feel for the contour of the land than those constant color ones do. And I can draw some correlation here between what I'm seeing on the screen and what I'm seeing out there, so that makes me feel good, of course. I can see this whole valley in front of me on the out the window display. I don't think it's any more difficult than it is for me to transition to gauges and back. It's just, I guess, like I said before, it is kind of a task. Just like if I were doing instrument training, I guess, I'm tending to keep my head inside the cockpit. Alright, I'm starting my turn here. Wow, that's a nice picture. I like that. I can't say that I really find the fishnet to give me that much extra on any of these things. The shading on this type of display is what really tends to give me confidence in what I'm

looking at, I guess, more so than the fishnet. Yeah, this close to the terrain, I actually like pulling all the way out to that 90 degrees, so I can see everything I can. But if I were actually going to the airport, I would be on probably the 30. I actually don't recall what I did, because I was flipping around a lot. My pattern of use on that display is tending to be, I think, I like to be in the 90 if I'm just straight and level. I tend to go to 30 to do the descent just so I can get better resolution on the pitch ladder, and then I usually go back out to about the 90. But I'm sure it's going to be different on the approach. If I'm actually getting a little closer, then I'm sure I'm going to want to go to unity, but for this task, I seem to be going between those two, 30 and 90. I mean all these EBG ones, I feel are ones, because I really feel confident in them. Now that you give me a photo realistic, I may want to go to a zero, because I might feel like that's even better, but certainly I think the EBG ones are more than adequate for the sort of situation I was just in.

PRFN3: Now immediately, the thing I like about this is that I can draw a direct correlation between what I'm seeing on the display and what I'm seeing outside. I don't have to sort of translate in my mind. Of course, the EBG was different colors for terrain than I would see outside, but this looks just like what I'm seeing outside. However, I don't necessarily feel like I have the same awareness of elevation changes as I did with the EBG. That may change once I get lower, but at this altitude, that's the impression I get. It does give me some confidence, though, like I said, that I can actually look outside and say oh, okay, I see that feature right out there. I don't know if it's confidence in the instrument. I'm just now noticing the fishnet. It didn't really even jump out at me before, but now I'm seeing it on some of the darker terrain, so again, it's, I don't want to prejudge it from this altitude, but it doesn't seem useful to me at this altitude, but when I get lower, maybe it will give me more clues as to how to resolve the elevation of the terrain. Okay, there goes the out the window. Now I'm losing altitude. Okay, I'm going into the turn now. Oh, that was interesting. I hadn't seen that before. Yeah, I over-banked, and it expanded. I didn't know it did that. That's pretty neat. Oh, my gosh, I was so busy looking at that, I overshot my heading. Too busy looking at the gee whiz stuff. And despite the fact that I said I wanted an RPM indicator before, I do like this little acceleration cue next to the velocity vector. That's actually pretty useful to have. You know, the only thing I don't like about it, I do like the photo realism and the only thing I don't like about it is, like I said, I don't necessarily feel like I have as much feel for the height of the terrain as I did with the EBG, actually. *So busy looking at the bank angle expand that he overshot his heading - 020, but corrected within 15 seconds.* So even if I did a complete 180, a 360, I guess, as long as I did it within 30 seconds, it would be okay? Alright, I'd actually just give that one a two, I think, just because like I said, I didn't feel as confident about the elevation of the terrain below me, which when I'm in a cloud, I really want to know. I didn't feel like I could see at a glance as easily, how far something was below me. Whereas with the EBG, it seems a lot more obvious.

PRFN30: Now I guess the sort of danger of the photo realistic thing is I think it sort of makes me believe that it's exactly perfect in terms of elevation as well, so I don't know that my brain will really process that there's only 30 arc-second elevation data associated with the textures that are on here. Do you understand what I'm saying? If I don't see . . . It's harder with this texture for me to see like the break points in the data, and I think I'd probably just assume that it looks just the same as the other one. On my first few runs, I was concentrating on only conditions. Now I'm concentrating on looking at the display and the lineup. Okay, I'm starting the turn. Let's see if I can roll out on the right angle this time, and fly the heading. Now that's nice on the fishnet right there, that I can see. I can see that that's rising towards me, what's basically right in front, below me here. That does give me some good awareness there. I guess the fishnet does help in that sense. I like the 90 degree field of view, but one problem with it is that if I'm using this as my primary instrument, there's not enough resolution in the pitch ladder when I'm on the 90 degrees, for me to be very precise. For en route, 60 degrees probably has a good enough

resolution and pitch ladder. That actually might be a good compromise. That's not, probably not a good thing to say. Gee, all of them have the utility. I don't know which one I would prefer to have if I can only choose one. Maybe I'll be able to form an opinion on that before this is all over. Again, the 90 degree field of view is real useful for this en route stuff, and to be able to see what's under me and stuff too, almost under me. And like I said when we were doing this run before, the fishnet, I can actually see some utility for it here because I can see, I can actually use it to figure out where the contours of the terrain are, in this particular case. But this is pretty rapidly rising terrain here, so. Yeah, see the only concern I have about that, and I think I mentioned that when she was in here, too, is the texture and as well, the fishnet, are the same no matter what the data is. And I guess the fishnet is not necessarily the same. In fact, it may never be the same resolution as the data itself, so I think I tend to expect at each point in that fishnet is a data point. Do you know what I mean? So I might actually be putting more weight to the fishnet than I probably should, if it's only like 30 arc-second data. I mean, I feel good about it, but maybe I shouldn't have felt good about it, is what I'm trying to say. I felt like I knew where the top of that ridge was, but maybe I didn't. Without seeing them side by side, I couldn't really say that I did. But I also don't know what the difference is and the number of data points that define that ridge, basically, between the two different resolutions of the data sets. But I would say with both of them, I felt like I knew what was there. I mean you know, I guess from the data, you know whether it actually is better or not. From my viewpoint, I felt good about it either way. I guess that's all I can really say about it. Just because except for -- and maybe this is where it's most important -- but except for where there's extremely large extrusions in the terrain, like that ridge, I didn't really feel like I could tell the elevation information, or not as much as I could with the EBG display.

PR1: I have to tell you, if one of these things goes to production, I think that the selectable field of view from the yoke is probably the way to go, because that's real useful. I find myself switching a lot. I wouldn't want to have to choose one field of view, and I wouldn't want to have to take my hand off the yoke to switch to another one, either. (Now that you're at the one arc-second, the highest resolution, do you see anything that stands out immediately?) Like I said before, the photo realistic, I like it because I can immediately see the correlation between what I see on the screen and what I see out the window. But the photo realistic textures tend to kluge somewhat, the elevation information to me, it seems. I mean some of what I'm seeing here, I don't know if the trees are a different color or if the elevation is a different height or if there's some kind of shading going on, if you understand what I mean, there. Because it's higher, the data is a better resolution. I would guess so. I feel like I can resolve it better, but I don't know if it's just because I'm getting used to this display, or if it's because of the high resolution. I guess I would suspect it's because of the high resolution. Because I'm looking at some little foot hills right here in front of me, and I feel like I can see some elevation contour to them, whereas before I didn't. It all looked like one big sheet before. So actually, I guess the answer to your question is probably yes. I can actually, I feel like I'm making out the elevation better, assuming I'm interpreting what I'm seeing correctly. Alright, I'm starting the turn here. I definitely feel like I can make out that ridge below me a lot better with this resolution, actually. Yeah, I feel like I can see the contours on the top of it and everything now, whereas I didn't feel that way before. And there's features right in front of it that I don't think I really even perceived with the 30-arc-second. I was sort of pooh-poohing the photo realistic versus the EBG before, but this actually looks really good with this resolution of data, because I can get information about the elevation from it. It actually looks pretty good when I look out in front of me, whereas I guess, maybe it was just the 30 arc-second data that was making me feel like I couldn't see any features elevation-wise. Because I did feel a lot better about the elevation with that higher resolution data, I did feel like I kind of knew what was going on a lot better. I guess just reiterating what I just said a little while ago, which is that I guess with the 30 arc-second data I didn't really like the

photo realistic terrain that much. I liked the EBG better, but with that one arc-second data, I think I actually liked the photo realistic better. We'll see now that we're doing some EBG, maybe?

EBGFN30: Okay, I'm just looking at correlation with the out the window display here, and I'm seeing this little valley in front of me. I feel like I can see a lot more, as I've said before, in terms of the terrain contour on here, but I may be fooling myself, that I think I've got better information on it than I do with the photo realistic data base. I know this is 30 arc-second data, so maybe it just looks better to me than it really is, if you understand what I'm saying. Again, I have to really stare at the display to perceive that fishnet. I don't think it really adds much from my point of view. I can really see the, even if I didn't know it was 30 arc-second, I think I could tell, because I can see the coarseness of the terrain data below me. Yeah. And let me just say, in that too, I'm looking at that little rise right in front of me, and it looks like it's defined by just a few points. And you can tell it's not . . . it's fairly low resolution. And you know, I think I said before, if I knew where all the important points were in terms of the highest stuff, it wouldn't bother me, but I think it probably tends to lessen my confidence in the instrument if it's that low resolution. Just because I think that lower resolution data, particularly affected my ability to really . . . It sort of affected my confidence of where the terrain was, was probably the most important thing. And I could tell that it was not very high resolution. Just what I was saying, the same comment that that fishnet, I don't know how useful that really is. It's not all that visible to me unless I fixate on the instrument and really stare at it for a little while, then I can start to perceive it. I think just the shading for the EBG or the shadows and shading on the photo realistic are probably giving sufficient elevation cues.

PRFN1: This is probably one I'm going to like the best. This is probably the most expensive one to actually implement. Well, again, the fishnet, I don't really perceive it except like in the lower 20 percent of the display. As the terrain gets farther away, I guess the line gets aliased out or something, because it's not really visible to me. And that's, so with like the 90 degree field of view dialed in, I can kind of see what's right under me. If I'm going to like the 60 degree, I can see it somewhat there, what's right out in front of me. I guess what I'm trying to get at is that for VFR flying, I'm just going to be glancing at this one would hope, from time to time, and I don't know how much the fishnet would add. For IFR, it might be better since I'm going to be staring at it some more, but in this task I'm doing right here, I'm not really finding that the fishnet adds that much to my perception of what the elevation is. I may change that. I'm reserving the right to change that maybe when I get to lower altitudes in the later tasks. I don't feel it really adds anything to my experience. Okay, I'm starting my turn. Yeah, it's nice to see that fishnet overlay where I'm going here, but I think I'd be able to, I think I was able to perceive the terrain elevation just about as well without it, is my impression. Although, as I'm getting closer to the terrain, I like what I'm seeing at the bottom of that with the fishnet. I can see maybe a few more little details in the terrain than I was able to see without the fishnet. I'm contradicting myself. I said that as I get lower here to the ridge, I did notice that when I was in the 90 degree field of view, I was able to see a lot more details in the terrain that was right below and in front of me. Because of that fishnet, I guess I could see how it was, all the contours and I could see some details in the elevation that I probably couldn't make out just from the color difference alone before. I don't know how useful that is, but I certainly was able to get a better perception of what the terrain looked like. Because I feel like that photo realistic texture is helping me to be able to correlate with the out the window display, which I like. The very high resolution elevation data gives the terrain enough features that I can actually pick out the elevation fairly well from the shading and all that stuff, and the fishnet, like I said, I guess it did help me somewhat when I was getting close to terrain, which I haven't done really much before I made that comment, so . . . I mean obviously that's the most computationally intensive solution to do and it is the prettiest, so I guess it's obvious people are going to like that one, but anyway, one.

Block 2, Low Altitude:

PRFN3: I would say, what I guess I've probably sort of alluded to at the end of the last thing is, as I'm getting closer to the terrain, that fishnet does seem to be a little bit more visible to me, and a little bit more useful, because it's giving me a little bit more detail in what I can see. Well, I'm just saying I think if it's useful for me in a display, it's probably most useful for photo realistic. Okay, starting the descent and the turn. Okay, this is interesting, because now I'm much closer to the terrain than we were before, so the fishnet is much more visible to me now than it was. Even in the unity view there, I can actually see it, because I'm closer to it. So perhaps the reason before I was saying that, you know, it's not particularly that big a deal to me, may have been because I wasn't close enough to the terrain to care. There's some kind of little tower off to my left there. And I can actually see some stuff out the, well, there's a tower out the window. It gave me good confidence in what was going on there, and I was able to correlate everything I saw with the out the window display particularly there getting close to that ridge, I felt like I had a good situational awareness of the terrain, even using the heads down display there. Just like I said before, that I think the fishnet is becoming more useful to me as I get closer to the terrain. It's actually becoming more visible.

PR1: I think I'm limited to a certain number of field of view changes. I shouldn't go between them so quickly. I really like the one arc-second resolution, photo realistic, because I feel like that terrain down there has some texture, some contour to it. I feel like I can perceive the elevation and again, the good thing about the photo realism, the photo realistic textures, is that I can look outside and I can directly correlate – gee I see that sort of brown area in the valley outside, and I also see it on my display here. So I guess, subconsciously, it probably gives me a little more confidence in that what I'm seeing is the truth. That's probably the main advantage to me to having the photo realistic textures. I really like the way this stuff looks, the one arc-second with the photo realistic terrain, because it really looks to me like I'm looking out a little porthole outside. It looks natural to me. And it's giving me the natural cues that my eyes, I think, would expect to see the terrain elevations of, the contours in the terrain. . I mean I don't seem to perceive them the way I saw before, and I can't, I don't know whether that's true. It just looked that way to me, that the tower was partially embedded in the ground, before. But I don't see that sort of effect. Luckily I switched to unity right before it crashed. Yeah, I've got the airport. And a whole bunch of towers between here and there, which is another feel good sort of thing. Basically for the reasons I've been saying. It gives me a lot of confidence. It lowers my workload because it gives me confidence. I don't feel like I have to second guess it, and with the one arc-second data, in a photo realistic terrain, my perception of it is that it looks right.

EBGFN3: There's the fishnet. At this altitude, it's not really very visible to me. And I don't know if that's really helping me perceive what the elevation changes are, but I'm expecting in my . . . My attitude may change after I make this turn and get a little bit closer to the ground. I guess I continue to say the only real problem I have with the EBG is that it's harder to correlate with what I see out the window than it is to correlate the photo realistic stuff, but at the lower resolutions, it's actually easier, it seems to me, to perceive what the elevation changes are on the EBG than it is on the photo realistic. Let's look around here. Boy I can really see the ridge. This looks good, but again, I think I'm going to have to say the fishnet doesn't really do it for me on this. I don't find it particularly useful. I think I'd be able to perceive the contours just about as well without it, for this particular kind of display. I'm flying over a couple of towers. (So you actually found that it was more useful than photo realistic?) Yeah, I did. And I think the reason for that is because the photo realistic loses some of the elevation information that you get from this EBG, to me, because of the color differential of the various elevations on this kind of display. You lose information in the photo realistic, but you also get the textures that you can correlate

with the out the window display, so it's a trade off. (So basically what you're saying is that with the EBG is not really, it's not necessary to have it?) In my opinion, that's correct. I mean it was, it certainly gave me all the information I needed. I didn't feel like there were any deficiencies, particularly in what it was showing me.

CCFN30: Oh, man, the CC30 is the next one? This is the least desirable one to me, so far. But I'm keeping an open mind. Now immediately the problem that I have with this, of course, is that I just feel like there's almost no . . . To me, it almost looks flat below. Even with the fishnet there, I don't really perceive much in the way of terrain, although I can look out the window and see that there's a lot of rolling hills and things, I don't really perceive that through the display. I can see that the fishnet is showing me things, but it's hard for me to just glance at it and tell exactly what it's showing me. It's not as intuitive as the EBG or even the photo realistic data base seems to be. Here we go. One good thing about this is that I can clearly pick out the obstructions. I can clearly see those towers in front of me, as well as the towers way out there. It's a little bit harder to pick those out in the photo realistic data base just because of all the textures and stuff I was looking at. Closer to the ground, I can actually kind of see what it's trying to show me here, because it's obviously it's more pronounced, what the fishnet is doing, as I'm getting closer to the ground. But it's still not as intuitive to me as some of the other display methods were. I feel uncomfortably close to that ridge under me. I can see it. Yeah, you know if I had never seen the photo realistic one, I might find this acceptable. But knowing what the alternatives are, I don't like it as much. My reason for that is because I actually gave it the highest stress rating that I've given anything so far, just because I made the comment that at those ridges, it really looked like I was, I was afraid I was going to impact it, even though I knew I was high enough, just from going by symbology alone on the heads down display. It kind of looked like I might have been in danger of impacting it and I don't know if that was because of the resolution of the data, or just because of the way that the data was presented, and the way that I perceived just that fishnet. But it made me uncomfortable.

EBG1: Okay, the thing that I like about the EBG is I can look outside and I can look at my display and I can immediately just go back and forth between the two. I don't feel like I have that, I don't feel like it's that easy with the CC. With the EBG it's a lot easier to do that. I can look outside and see that valley and I can look in and see that valley on my display, so I feel good about what it's showing me. With this resolution, I can also see a lot of little . . . I feel like I can see a lot more little contours and ridges and things in there, so I feel like it's showing me everything I need to know. It's telling me there's a river there, and I can look outside and see there's a river there, and that's good enough, because I'm not worried about running into a river. The thing that I guess I'm concerned about is just making sure it's showing me enough detail on the terrain, which is what I keep bringing up, and if I can look inside and outside, and feel like I'm looking at similar things, then I feel a lot better about the display. This looks really good, because I can see a lot of detail around where those towers are, so I feel a lot more, obviously a lot of this stuff is just psychological. I feel a lot more comfortable about believing this display and when it tells me where terrain is, because it looks reasonable. I can see the edge of that ridge outside. Here come the towers that I can see. See I'm in the 60 right now, right? More and more I'm liking the 60 degree field of view because it's a good compromise between the 90 and the 30, and because it actually, even though it's not exactly right in terms of the field of view if I were looking through a window, it seems to correlate well with what I'm going to see out in front of me. Do you understand what I mean? And I don't miss the fishnet. Those contours look really nice. I can tell exactly what that terrain is doing. Like I was saying there at the end, I could see a lot of little contours in the terrain. I felt confident about what it was showing me. I was getting good situational awareness from it.

BRD BL: This one kind of intimidates me now, because I'm not used to using these old round gauges. It's a much higher workload with these guys than it is with a single integrated display. I'm not going to be happy when I go back to flying a regular plane. I was just thinking, I was noticing I was descending at 500 feet per minute, and with the other display, I think I was usually at closer to 1,000 feet per minute descent, and I think it's just psychological that gee, I don't know exactly what's down there, even if I looked at my chart and know that I'm safe. I can see some terrain rolling by below me there. That's just a little bit disconcerting.

CCFN1: It's amazing to me how it seems to me that my control, or at least my perception of my control improves a lot more with this symbology that we have here as opposed to just using the regular old gauges. I still am not real enamored with this particular display type. Of course, it's certainly better with this resolution than it was with the 30 arc-second resolution. I can see some detail down there. I can see the valley that that river is flowing through. It still is a little difficult for me to quickly make a correlation between what I see on the display in front of me and what I see outside the window. If I study it I can do it. I can see a valley out there, and I can see this river and I can see this river, and I can say okay, that's the same as that. But it's not quite as intuitive or quick as it is with the other types. I might be a little behind on the turn this time. Even this is so much better than using those steam gauges. There's the towers. Certainly this is a lot better, as I've sort of alluded to before, this is a lot better than the 30 arc-second CC display, because I can actually see some features down there that I couldn't even see before, really. I can actually see things in the terrain. Before, a lot of it looked pretty flat, but with the one arc-second data, I can actually make out some terrain features. Okay, where are those towers? Whoa. That was pilot error right there. That's the problem with getting newfangled toys in your cockpit. You run into the ground with them. I really did. I was looking all around here and . . . Well, we recovered. Yeah, I guess the main problem that I have with this kind of display is that it's not giving me a lot of information very far away from where I am. I know I've got the lower third of the terrain display to me is very useful. Beyond that, it starts looking all orange. Because it's better than the 30 arc, but it's not as good as either the EBG or the photo realistic. From my point of view, it's not giving me as much of a good feeling about where the terrain is. It's not as intuitive again, to me, exactly, what I'm seeing in that type of display.

EBGFN30: Well, the only reason I know is because I've been seeing them all, all the different kinds today, and I recognized the 30 arc-second data looks more eroded, if you know what I mean. You can't see the peaks that you can see in the higher resolution data. Now I can't really tell by looking out the window with the, the way I'm able to tell the terrain out the window, I'm not really able to tell that there's a big problem with correlation between what's on this display and what's on the out the window display but . . . I may have a different idea when I get a little closer to the ground. We'll see. With the 30 arc-second it looks like the Appalachians and with the one arc-second, it looks like the Rockies. Either this turbulence is getting worse, or my arms are just getting tired. I don't know. The shadowing on the back sides? Is that what you're saying? Yeah, actually yeah. That's particularly the biggest clue in the photo realistic data base, but it's useful in this data base as well. Because I don't know, from my point of view, it's just more intuitive to expect it to look that way. My brain is used to being able to interpret that sort of data from looking out the window. It looks more like what's outside the window, I guess. It's just easiest for me to just block it immediately or whatever. Yes, I would say probably so. There are the towers. Yeah, I like the 60 because I can almost watch things pass under me out the window, as I watch them pass under me on the display with the 60 degree field of view. I mean that could be a two or a one. The only reason I call it a two is because again, I knew it was lower resolution data and I didn't see the peaks that I expected to see on some of the things out there, so I felt like I didn't have quite as good an idea of what the terrain was doing because of that.

EBGFN1: I guess it's kind of ironic that I said before that the 30 arc-second data looks like the Appalachians, since I'm flying over the Appalachians but this looks more like the Appalachians than the 30 arc-second data did. I mean I can really tell when you go to the one arc-second data. There's just so much more detail there that you can immediately see it. And it just, it's more easily correlated with what's outside. I can see just small features I see out the window. Outside my window, I can see them more easily in here. And that gives you more little hooks for your brain to hang on and figure out exactly what it's looking at, I think. Again, at this altitude I wouldn't even notice if the fishnet was there or not, really. I'll tell you what: Air speed control is about a factor of 10 easier with this than it is with the air speed indicator. Alright, I'm getting close to the turn. Now I'm between two ridges, here. I know it's much more computation intensive to use the one arc-second data, but it looks so much better and feels so much more confidence inspiring. It's a big difference. Because again, it's very confidence inspiring and it looks good, both in the, it looks good to me in VMC, so I tend to trust it in IMC. I felt like I had very good situational awareness from it.

PRFN1: This is the one I get to take home, right? I haven't really said anything about this, but it's just like this morning. This one I know is just obvious that it should be the best one. I mean I think. Maybe it's not. But it seems like it is to me. This is probably the hardest one and most computationally difficult to do, but this would give you the best situational awareness in terms of me being able to look at it and see a feature immediately identified on the display, and say okay, I see that little area over there. I see that on my display. And yet, at the one arc-second resolution, it still gives me plenty of . . . I'm talking and not paying attention to my flying. It still gives me plenty of awareness of what the elevation is, too, so . . . You know, I think most of my flying has been over green parts of the terrain so I don't really know. I haven't actually gotten to any of that lighter brown stuff I don't think. I mean, whenever something gets that far away, I can't see the fishnet anyway, because it gets like I said, aliased out or whatever. I can only see it right here in front of me. Again, like I said before, I don't feel like it would be a big loss if it were not there in front of me. I think I could get the information I need about the terrain elevation without it. There are my towers. This display gives me a really high comfort level because like I said, when I was in VMC I was able to look at it and feel comfortable with what I was seeing, so when I'm in IMC, I feel comfortable with what it's showing. Because I like it. Because I feel like it gives me the highest confidence in what I'm doing of any of the ones I've seen.

PRFN30: (Do you have any immediate comments on this one versus seeing the higher resolution?) Not immediately. I mean I'm looking at some of the ridges and things on the data base and I can see that they're not as well defined in the heads down display as they are in my out the window display. All I can say is that might affect my confidence in the display whenever I actually get instrument conditions. What I'm saying is like for the one and three arc-second data, particularly for the one arc-second data, I can see a direct correlation between what I'm seeing in the heads down display and what I'm seeing in the out the window display. I can look at a ridge and it pretty much looks the same. In fact, with this 30 arc-second data, I can look at a ridge out there and see some definition that I don't see in here. I can see where, when I get into instrument conditions, that might affect my confidence in what the heads down display is telling me. I'm assuming out the window is the true data so confidence doesn't matter. I find that the 30 degree field of view is about the most comfortable for me. It's probably the most comfortable for me in terms of trying to seek an attitude, so if I'm doing a descent or something like that, it's easiest for me to use the 30 degree, because I have better resolution in the pitch ladder and stuff like that. But if I want to do terrain avoidance, I like to go out to this 90 degree field of view because I can see more about what's around me and what's almost immediately under me, and what's coming up. So it's sort of a trade off. In fact, I had also made the comment earlier, if one of these things actually goes to production, it would be nice to actually have essentially what we've got here,

which is where you change the field of view on the fly from the yoke, rather than having to reach up and change it, or whatever, because I find both of these fields of view pretty useful. I see those towers out there. I didn't get to level out yet on that one. I'm still just thinking for en route stuff, the widest field of view possible is one that I'm typically going to select, because it's the one that's most comfortable. It gives me the most situational awareness. The photo realistic is good, because again, I can identify features down there, but I can also look out there and see some elevation features and I can see shading out the window that I don't see on my heads down display because it doesn't have a high enough resolution, or that's my perception. I'm making the turn now. Again, I can see having seen the higher resolution data base, I can see this just looks very flat to me, and I don't see all the detail in the terrain I would expect to see. Again, if I didn't know any better, but having seen the better one, I can see that ridge out in front of me here on the unity field of view, and I think I pointed out before with one of these 30 arc-second data bases, it just looks a bit odd, because it has one, it looks like one point that's up high. It looks like it's defined by one point, basically, so, I guess just seeing things like that gives me a little less confidence in what I'm seeing, if I'm depending on this thing to tell me when I'm going to hit something. Just because if I was right about the obstruction not exactly looking right, I'm assuming that would be a factor, that would be because of the resolution of the data being 30 arc-seconds. I mean it was something I could actually see as opposed to something that I just would feel. One might be better than three. I could actually see it. I could perceive the problem there with the 30 arc-second data. It gives me good awareness, but some of the anomalies of having the 30 arc-second data make me tend to not be as confident in what it's telling me down to the . . . Because it's obvious that it's not giving me the best resolution it could, so I'm a little bit less confident, the closer I get to the terrain.

Block 3, Approach:

EBGFN3: I don't really have any comments on the terrain yet. One thing I will say right away is that I pretty quickly went to the 90 degree field of view because when I was initially lining up I felt better with having more squares there. More tunnel to fly through. We'll see if I change here in a minute. I'm not sure. As far as the terrain, I am perceiving the fishnet a lot better than I was before. I don't know if it was just because of the approach or the fact that now, as opposed to en route, I'm closer to the ground, but I can see the fishnet well, and I can perceive what it's telling me fairly easily. I just went to the 30 degree field of view because just like yesterday, or the day before yesterday, whenever I was doing the en route stuff, I felt like I can get a better idea of what my angles are, my attitude is, in that field of view, so I was trying to set a pitch angle for my descent, so I needed the high resolution for the pitch ladder. Because I didn't perceive any problems at all with it. I could see the terrain. When I was able to tear my eyes away from the tunnel, the out the window terrain seemed to correlate well with what I was seeing on the display. (So you could correlate the terrain well with what was out the window?) Yes, I could easily . . . what I was looking for in the en route, and I'm assuming that's what I'm looking for in the approach here, too, is that I could easily look down at the display and then look out the window and be able to tell correlations between the features there, so that I felt like when I could see the features, I could feel confident in what it was showing me when I couldn't see the features out the window.

EBG1: I missed that before, because I was I guess kind of, sort of getting used to things here, but I was aware the MX20 has got the path on it, but with this tunnel, I'm not really even looking at that at all. I'm just flying the tunnel. And of course, I know sort of what the numbers are supposed to be in terms of headings and all that sort of thing, so I'm checking those as well. I'm not completely depending on the tunnel, but the tunnel is my primary feedback to what I'm doing right now. You can definitely tell there's more turbulence today. As I said the other day, the EBG to me, even without the fishnet, I mean it looks really good. I feel as though I'm able to get

good elevation information from it because of the contours and because of the shading. I mean my brain processes that fairly readily, so I feel confident with what I'm seeing down there, even without the fishnet. Once again, I was just flipping through fields of view a minute ago there. I like the 60 because I looked up and saw a tower out the window and when I flip to 60 what I see on the 60 degree field of view pretty much corresponds to what I see on this out the window display, so I was able to pick up that tower and see it there. I'm just not really sure why I would want to do that, if I can see it outside, why I would want to pull it up here. I guess, just for my own peace of mind, I just wanted to see it in my instrument here. But I wanted to go back to the 30 degree field of view to get good pitch information here. Because I felt good, the features that I saw outside, seeing those in the display, and I didn't feel I was able to perceive the information on the display peripherally, if you know what I mean. I didn't have to concentrate on the display to see what I was supposed to see in terms of terrain. (Okay, so you didn't have to concentrate on the display to see what you needed to see?) Yeah, some of these displays, I mean my perception is somewhat colored by what I did on Wednesday, but some of the displays I know on Wednesday, I had to kind of concentrate on -- particularly constant color -- I had to concentrate on somewhat, to figure out exactly what I think it was telling me, whereas I'm not having that problem really with the EBG or the photo realistic.

EBGFN1: Just as a comment on this terrain display methodology, again, I can easily make out what the terrain is supposed to look like -- the contours of it a lot more easily than I can with the constant color, which is just what I keep thinking in my mind. But again, the fishnet, I can kind of take or leave. I think it may add somewhat to my perception of the contours of the terrain, but I think the shading on this particular type of terrain display here is probably just about enough. I did notice that whenever I look over at the MX20 I was actually zooming in on it a minute ago, to look at my path, every time I do that, I tend to lose my path over here. It's much nicer to just have that path displayed in the same place as my altitude and speed and all that stuff displayed. I kind of screwed up the turn on this particular run, and I think one reason I did that is because I had forgotten to switch to this 90 degree field of view. I was looking at the 60, and just having the squares coming through more often actually makes a big difference, I think. It makes it a lot easier. Yeah. I would probably like the 60 degree maybe with this number of squares or whatever, the tunnel, for the approach phase. I'd probably use that more if I had them. I'm going to the 30 degree, just because that's the easiest to use here for putting my velocity vector on the runway and looking at my pitch attitude and all that stuff, once I'm on glide slope. Just for the same reasons I've said for the EBG before, only more since this is the one arc-second data.

PRFN1: Okay, similar to my comments on Wednesday, I like the EBG but the photo realistic kind of takes that and makes it even better because it's a lot easier for me to see, while I can see, now that I'm losing visibility. It's a lot easier for me to make an immediate correlation the first time I see out the window and something that I see on this display because the texture obviously gives you much better clues as to what you're looking at on the display. And typically, doing a fairly high workload task like an ILS approach like this, it's important to me to be able to just be able to grope what I'm seeing and perceive it as quickly as possible without having to think about it, if you know what I mean. There's just something about seeing one of these squares go by me that makes me feel good about being on course. So the 90 degree view with the squares going by me fairly often just sort of makes me feel better and get initially set up. I just switched to the 60 to look at the features between here and outside and again, I just like the photo realistic because it's a lot easier to just glance between what I see outside and what I see here, and go yeah, okay, this is the same thing. This has the fishnet on it, right? (Correct.) See it's not even terribly visible to me. When I switched it to the 60, at first I thought it was some roads criss-crossing the data base. It might actually even be distracting with the photo realistic data base, particularly at this altitude. What separates it from the EBG only more so, I mean I think it lessens my work

load, actually more than the EBG does. The EBG is acceptable, but I think the photo realistic is much better. If I were to find myself in some kind of high stress situation and a high work load and everything, but if a couple more things were added on and something happened and I was trying to avoid a thunder storm near the airport or something, then I would like to have the photo realistic there just to give me a little more good feeling about the terrain, I think.

PRFN3: One thing about the, well the three arc-second maybe not so much as the 30, is that I can somewhat see some differences in the contours of the terrain out the window with what I'm seeing on my display, so obviously the one arc-second is a lot better about that than this one. I like looking at that a lot more because it more closely represents what I'm seeing. It was no deficiencies from my point of view. I mean everything worked well for me. I got the same kind of comments as I gave yesterday on that. The photo realistic just . . . I was thinking that my attitudes about some of these types of terrain displays might change in the approach phase, but most of the approach phase is flown pretty much like the second en route stuff that we flew, where I went down about 1,000 feet above the ground, so I think mostly I'm feeling pretty much the same as I did on Wednesday . . . so far.

BRD BL: Well, of course I hate it, because it's much harder to immediately get all the information that I need. I mean I'm doing my scan like I'm supposed to do, and I'm still not as easy to read it all quickly as it was with the other kind of heads down display. And of course, without the tunnel, I don't have quite the same feedback that I'm doing exactly what I'm supposed to be doing. And certainly, of course, as the weather conditions deteriorate, it makes my stress level go up a lot, because I don't have any indication other than this MX20 as to what's going on with the terrain. And while the MX20 is kind of nice there, it's just not as intuitive. I'm not using all my resources here. Well, I screwed up there because I wasn't watching. I flew right through the localizer, but now I think I've finally got it re-established. (As you said, you missed your turn. You got back on it pretty well, but it was just a little bit too long to fall within the desired bounds.) Because that was pilot error. I did that enough times. Obviously, I do it better, because I better if I want to get an instrument rating. But I'll say five. I'm going to say that the whole problem with that is that I've sort of gotten used to being able to see all the information I needed right together. Plus, there is the added fact that whenever I did get off conditions, there were a couple of times where I got below glide slope, which is really a no-no, and particularly if I have no clue what the terrain is without . . . I mean from the MX20, I got some gross information about the terrain, but I certainly didn't have the SVS here to give me some clue of what the terrain was doing, so that greatly added to the stress level. (I'm just curious, did you use the MX20 on your turn at all?) Once I had missed the turn I did. I was concentrating on holding my initial condition there, and then I looked at the needles and I had already blown through the localizer. So at that point, I looked over at the MX20 to help me get re-established on the localizer, to look at a good intercept angle to come back in.

PRFN30: As I have said before, the thing that I immediately notice about this data base is that I don't see all the undulations in the terrain that I see out my window, so it makes me a little less confident in it, whenever I can't see out the window. You know, I was thinking while I was resting, had I actually had all the physical sensations of what I was doing in that last run, I probably would have been a lot worse off than I was, even in the simulator. I mean I was doing some fairly abrupt maneuvering to try to stay as close to conditions as I could. I probably would have confused myself, confused my inner ear and so forth, and I might have had an even worse performance if I had really been moving around. I don't know why I'm telling you that, but I just happened to think about that, that it's really making me want to have one of these little things in my airplane. As I was saying before, I pretty much park it on the 90 degree field of view because of the higher frequency of the squares going by me, it just gives me a warm fuzzy to have one go

by me as often as possible. I'm not really sure why that is. I'm just thinking when I'm on condition, all this stuff is fine and dandy. Whenever I get way off conditions and try to track back and the turbulence is kind of doing stuff to my head at the same time, it's a whole other effect. And again, just switching to the 30 degree here just to get a better resolution on my pitch ladder, so I can set up for my approach here. There was a little bit of over-control in roll. I noticed whenever I was trying to correct off condition there in the last run, I think probably because I couldn't feel the roll, I had a little bit of trouble correcting with the throttle here, just because the throttle is real sensitive. Other than that, I don't guess so. (Do you see the mountain range beyond the airport?) Oh, yeah, yeah. (Does that give you enough information that you could maneuver a go around if something were to happen and you couldn't land?) Yes, that's true. Yes, I would be aware that there is rising terrain, yes. Of course, I ought to be aware of that from the approach point, too, but yes, that would give me, if something unforeseen happened that would give me some indication of what I needed to do. *Parking of FOV90, because he likes the frequency of the tunnel boxes flying by him. Switched to 30FOV on GS to set of for approach and get better resolution on pitch ladder.* Just because like I said, whenever I was comparing it without the window, I could see that not all the contours of the ground were adequately, from my point of view, represented in the display, so it hurt my confidence in the display a little bit. No, and particularly, I've been trying to be conscientious about the final little bit of the approach, watching for the runway to appear, because that's what I would be doing on a real approach. Yeah, I've been trying to do that. And no, I didn't really have a lot of trouble. And I think a real good part of that is the velocity vector on this heads down display, because it's another thing of just being able to look at it and immediately kind of tell if anything has changed about my conditions since the last time I looked at it. It's a little easier to perceive what it's telling me quickly, than it is with the conventional gauges.

CCFN1: It always takes me a few seconds to pick up that power indicator from the pitch ladder and everything else whenever we start up. I'm looking at the 60 degree field of view here, which kind of gives me a good correlation of what I'm looking at out the window. Again, I can't really look at what I'm seeing on the display and immediately identify the terrain feature that goes with it out there. It's very difficult for me to make a one to one correlation here, and to do it, I kind of have to stair at the terrain on the display, and then look outside and go okay, yeah, I think that's what that is. I just don't have the level of confidence that I've had in the other types of displays. Yeah, I mean if I think about it long enough and look at it, I feel like I have to use more brain power to figure out what it's showing, because it's not, I guess, what I'm used to seeing. The photo realistic is close to what my brain is used to processing, so I can immediately sort of understand what it's telling me, but the constant color with the fishnet just seems somehow unnatural, I guess. So to try to figure it out takes a little bit longer. I mean I guess I can get the information I need, it's just harder to do it. So it elevates the stress level a little bit, when you're already in a high stress task. Although also, I think I don't necessarily feel confident drawing the right conclusions from what I'm seeing either, just because I don't know, I can look at those lines and I kind of think I know what they're telling me, but maybe I'm interpreting them a little bit wrong. I don't have quite the confidence in the display that I had the other types. (In your display, can you distinguish the fishnet from the series of roads that you have down there on your display?) Yeah, but I guess it's only because they're not going in the same direction. If there were roads, they'd have to be parallel to some of the fishnetting. I'll tell you what, I love the velocity vector on this approach thing, though. It gives me a lot of confidence to just aim that velocity vector at the runway and know that's where I'm going. (Can you see the ridge beyond the runway at this point?) Sure, yes, I can. Again, that would give me some indication that I would need to be ready to climb and do a go-around, and there's rapidly rising terrain there. I can see from the fishnet -- it's just now becoming visible on that part of the terrain. I can see it's

rapidly rising from the fishnet. I can determine what I need to determine from the display, it's just not the optimal way of getting information into my brain from a terrain standpoint, of course.

CCFN30NT: I was just going to say that even just without the tunnel and with the worst possible terrain representation, it's much easier to use, of course, than using the regular gauges. I'm probably most comfortable here at the 60 degree field of view, just because that seems to be the best view for me for most tasks. The only reason I was in the 90 before was to get more little rectangles. That's the problem with the MX20; whenever I look over there it's easy to let the turbulence get me off condition. I have a feeling that might not be as bad in a real aircraft, because I'll probably feel myself being rolled. I'll look over here and see that my roll angle has changed, whenever I am fooling with the MX20. Yeah, that's kind of what I was talking about before, when I was asking if anybody had ever done this sort of thing in a motion base, I mean any kind of GA stuff in a motion base, because it's a fairly significant contributor in the turbulence. Because I know with turbulence, it's often hard to even hit the button that you're aiming for on something like an MX20. It's a whole other thing to consider, that I guess, than you really think about for this. I mean it's nice to have the tunnel and all that stuff just right there and sort of whole task thing where if I need to change field of view, I've got it on the yoke and I don't have to take my hands off the yoke. Whereas, to change something over here on the MX20, to zoom in or something like that, I've got to divert my attention and try to hit the button and I might be in moderate turbulence or something like you've got here, and it might be worse than just sitting on the ground trying to touch a button, you know? I haven't really been paying that much attention to the terrain, by the way, on this display. I've been watching my path on the MX20 and I've been watching my needles and all the indications that this symbology gives me. Although I am noticing on the terrain, the towers are in front of me, so that's a good thing. Okay, established on the glide slope now. I'm a little off my localizer there, looking at the towers. Let's see if we can get back on here. It is nice having that picture of a runway out in front of me that I can aim for. A little bit better situational awareness there, having that, even without the tunnel and stuff. Okay, starting to look for the runway. And there's the runway. That's what I've been doing even with the tunnel or not. I mean it's just whenever I know that I needed to establish a descent, and I have in mind about what the pitch attitude I'm looking for is, to get the descent rate that I'm looking for, I switch to that 30 to get the pitch ladder bigger. *After looking at score sheet, saw that he had an adequate (over 10% by 6 seconds).* The tunnel adds considerably to my confidence and actually flying that, and also it's a lot better feedback than trying to track the needles or anything like that, or glance over at the MX20. The problem with the MX20, it doesn't have my primary things like air speed and altitude and that sort of thing on it, so I can't spend a lot of time. I can scan over to it, but I can't spend a lot of time on it. With the SVS HDD, I'm able to just with very small eye movements, take in everything that's going on and a lot of it, I mean like the tunnel, you can just get by peripheral vision. If I'm looking at air speed, I can still see what's going on in the tunnel. So not having the tunnel is a big factor. And also, of course, the CC with the fishnet is just not as confidence inspiring to me in terms of telling me where the terrain is. I noticed I could see the towers and stuff and it was a good thing, but hills and stuff which I'm worried about around here, I'm just not feeling as good about.

EBGFN30: Just looking at this terrain again, my mind is a little bit confused because I'm looking at some shading in the terrain that doesn't seem to be reflected in the display in front of me. I'm not sure if I'm interpreting it correctly there, but . . . The thing that's weird looking to me, as I am interpreting it, it looks like the fishnet is saying that the terrain below me is basically flat. I'm seeing a lot of little features in the contours and I don't know if that's a function of the resolution of the grid of the fishnet, or if there's just something else going on there. Maybe we can talk about it at the end of the run. The tunnel makes a huge difference. One thing that's hard to ignore, I mean my needles are off to one side, and where I'm typically looking, I'm looking out

at my air speed and I'm looking out at my altitude, and I'm looking at my velocity vector to see where I'm going. So the tunnel is just sort of automatically in my scan there, but it feels like I have to make a conscious effort to go over and look at it, and I think that's sort of why I blew through the localizer before. I was concentrating on my conditions and I had not included the needles in my scan enough when I looked down there and I was a little late on the turn. So the good thing about the tunnel is that it sort of forces me to have that information in my scan. I've got my towers. Another problem with my unity field of view is in a crosswind, my velocity vector wouldn't even be within that, I guess, so . . . I guess I'll have to give it a one. I didn't really notice any problems. I know that was the 30 arc-second data. Maybe I just wasn't looking close enough at the terrain, but I didn't notice anything objectionable. It's just similar to the rest of the EBG. Oh, you know what? I did notice something objectionable, because I asked you about it. I asked you about that difference between the shading and the fishnet. The coloring is not based on the DEM data, it's just a texture that's made from the known contours. I did not realize that. Okay, well, I'll give that a **two**, because it's confused me a little bit. I wasn't, I mean I called it out. I said these aren't telling me the same thing and that was a little bit disconcerting.

PR1: My initial comment is just that this is the one I like the best, because it looks like what I would see out the window and I don't have to use any other part of my brain than what I was only using to look out the window and analyze what the terrain looks like. Like I said before, I don't think the fishnet really adds much. In fact, in some cases, it's actually a little bit confusing. With this resolution of the data, I think the photo realistic looks really good. The question, with say a 30 degree field of view, is that 30 degrees each way to the center, or is that 30 degrees total across the entire thing? I don't really have any additional comments on this terrain type except to say that again, I kind of find it the easiest to use. It gives me a good feeling. It's sort of a psychological thing, I think. See, I really feel like I have a better idea of what that mountain range is doing, than from the other displays because I can see even at this distance, I can see the detail of the texturing on it, but also the contours and stuff on it's side. I also feel like I have a better feel, certainly, than I did with the CC display. A better feel for how far away that thing is. I just noticed, I remember in the briefing, you were talking about sometimes people like to go to unity in the final bit of the approach, but I haven't done that. Let me try that and see how I feel about that. I can see the utility of this, though. I haven't really used it yet because I felt pretty good that it was the 30 degree field of view but I can see the utility of this for setting that glide slope line if I want to use that. I've been kind of watching for the runway around the time the middle marker starts beeping at me, and I'm seeing the runway early enough that I'm sort of transitioning to visual without making a descent down, like a higher category descent than what I'm legally allowed to do. I might find that glide slope line useful. I haven't really used it in anything I've done today because there's the runway, so what I immediately do if I were really flying this approach is just not even look in here except to look at my air speed, and now I'm just watching the runway. I didn't really find a need for going to unity unless I were wanting to use that glide slope line and I haven't really used that glide slope line. I kind of tried to, but it's hard to be precise with it from a distance. I was trying to use it and by the time I really get close enough that I can . . . okay, now I can set it and get my three degrees, then I've already seen the runway, so I'm flying on visual cues anyway. I feel like I can immediately gain the information I need from that display without any undue brain processing.

CCFN30: Only that the lower . . . this is just for all the CC things . . . Only that the lower 40 or 50 percent seems to give me the most useful information in terms of being able to tell kind of what the contour of the land is. But even that, I can look outside and what I see seems to be doing a lot more than what this fishnet is doing. I'm assuming that's a result of the resolution of the data that was used to generate the data base here. Yes, I mean the CC30 really gives me the

least confidence of any of these concepts because I'm not convinced it's going to show me everything I need to know. I haven't made a smooth turn through these tunnels yet. It's difficult to know exactly when to start the turn and try to do a standard rate turn, but I don't know if it's lined up exactly right. It's some kind of pilot error thing going on here. Well, I'm staying in the squares, and I'm staying less than a dot, I think, but I really would like to keep those dog bones right on the center if I can. It's just my nature I guess, but I haven't really done that once, I don't think. I'm not really getting any terrain information on this. It's just an orange it's just an orange blob to me perceptually it seems like. There go those towers. (How did you feel about your turn that time, any better?) I was much smoother on it. I did get over to one dot off on the dog bone near the end. I should have tightened it up a little more at the end, but I felt a little bit better about it. Yeah, I can't think of any other comments on the display itself. Just what I've been saying about the CC, I just don't feel like it gives me all that good of information in the 30 arc-second. I'm not even, when I can see features of the terrain I can't pick them out in the CC very well, so . . . (I think you said before it was a big orange blob. Was that you?) Yes, that was me. Yeah. I mean it almost just looks like the sky and terrain. I can see a little bit of the fishnet right at the bottom, you know. Like I said, maybe the lower 40 percent, 30 or 40 percent of the display has some usable stuff, but even what I can see isn't all that usable, particularly at this resolution. I mean I felt like my performance was good because of the tunnel and everything. I felt good about flying the approach. I just didn't feel a lot of confidence in my knowledge of the terrain. Just because all that I didn't have off of that one was, I didn't feel real confident about the terrain. Yes, it almost would have been equivalent to just having, I mean literally having an orange constant color with no fishnet. It almost would have been the same to me. Only it was nice to see, the one thing that I got out of that display is, I could see some obstructions, which obviously would concern me, getting as low as I am. And I can see the runway. But you know, I didn't feel confident that it was showing me the contours of the earth very well, or that I could understand what it was showing me, when it was showing me the contours.

Rare Event:

PR1: Yeah, like I keep saying, I really like this one because I can look outside and look down and see virtually the same thing, because of the photo realistic textures and also with the one arc-second resolution, I can see all the contours three dimensionally here that I'm expected to see, and I can see outside. Again, in the en route environment here, I really like the 60 degree field of view because it feels natural in terms of when I look up, what I kind of see with my forward and peripheral vision, and it sort of matches up with what I'm looking at down here on the display here in front of me, so . . . It's easy for me to draw comparisons between what I'm looking at on the display and what I'm looking at outside. I like the 90 degree from time to time. If I'm flying over something high like an obstruction or something, I've gone to the 90 degrees to look at things as they're going by me, but generally, it's the 60 degree I like to stay on. Again, the photo realistic is good because I can easily call out, and I can see the little valley out the window in front of me as it goes off into the distance and I can usually see that down here on the display. And now as my vision is starting to fade, I have some good confidence in this heads down display because I know it shows me the same thing I was just seeing a minute ago outside, so . . . Okay, I'm switching to the 30 degree because I'm starting my turn. Okay, while I'm on the descent here, I'm just staying on the 30 degree field of view again, just so I can keep an eye on my pitch attitude. It's a little easier to control it that way. I can see some terrain out over my nose, but I'm seeing the same thing at my display, so I'm not worried about it. I'm not as worried as I would be without the display. Although looking at this, now the one thing that it would be nice to know is exactly what my height is above the terrain. Because it's looking awfully low. I said you know what? I'm going to forget descending to 5,000 feet and save my virtual life. I was getting the impression that things were closer to me so that's why I was starting to make the comment, gee it would be nice to know my rate of altitude or something. (I hate to say it, but we had to

give you an adequate, just for the mere fact that at the beginning of this, you were talking a lot, and you drifted up above 9,600 feet for more than 30 seconds.) *Was too high at the beginning for more than 30 seconds, because he was talking and not paying attention. 3:37 mentioned that he could see terrain off his nose, and it matches up with the display, so he's not worried about it. 4:11, would like Radar Alt to see how far away from the ground he was (started ascending about now, and was at around 5200ft on his altimeter), because at 4:17 he said that he seems to be really too close to the terrain.*

Subject 25 (BRD Baseline):

Block 1, High Altitude:

PR1: Overwhelming. I guess it's the getting used to the display. You know, I'm used to different instruments and I think there was a lot of turbulence or something. I had to really fight the plane. (A little bit too fast for the 30 seconds.) I think that's a five. I think the turbulence. I mean I really had to fight the aircraft trying to do one thing and then I realized I was off on the other. So it was doable and, you know, next time will definitely do better, but right now it was a lot of things that I had to deal with. So it's – I'm moderately satisfied about what I did, and I think that I can definitely, you know, do better. So then minor deficiencies so to speak. Just pure practice will do. (Did you notice at all any of the terrain below while you were flying?) The thing is I probably looked more at it initially in the beginning. After flying, just looking at the screen in that thing, then once I start getting to the IMC I was really looking at the SVS. When we got into the bad weather, into the clouds or fog, whatever you want to call it, I was really flying on the SVS. I didn't really use the terrain – the MX20.

BRD BL: Just a little bit windy out there. Get that back to altitude. Marker. It's very strange to know that there's wind outside but you don't feel it on the airplane. It's really missing the feel of a real airplane. I know I'm going to be smacked around, but it doesn't feel like it. I don't feel I'm descending. I don't feel I'm ascending. All right, here we go. Descending turn. Standard right turn, 050. More on the standard right turn. Get the power down. Descending to 9 – 8,000 feet. Power down a little bit more. There's 050. A little bit too fast. 8,000 feet coming up. It's like once in a while the yoke gets stuck and doesn't really move. All right. 1,000. Back to the 100 knots. Bring it back to 8,000. I think the biggest thing is the feeling for the yoke and the response of it I get. Sometimes you may make a small correction and you think it doesn't do anything, and give it a little bit more of a swig and suddenly it just shoots – overshoots a little bit. I think I would go with a four: minor but annoying deficiencies. (With an adequate you have to go through five through seven.) That would be a five then. Again, pretty much the same as earlier. I know what I did wrong. I mean I – you know at some point descending too fast. I know that bank angle at some point was more than the standard, and went through 8,000. Should have stayed at 8,000. You know, it's more the frustration of not meeting the exact speeds, altitudes, and heading, but on the other hand I know that I'm not flying into mountains. (Do you think that's a factor of the display at all, or the lack of any type of visual cues?) For me, really personally, it's the feeling of not having the feeling of flying a real airplane, where you can feel what you're doing more than here. You know, I have to look much more at the display to get an idea about what the airplane does versus when you're sitting in a real airplane and you feel what it does at a certain point. I mean, you know, you're flying more from the feeling of what the plane does. And here you really need to get all your information from that display, because you don't feel if you're going up or down. You don't feel you're in straight and level flight. The other thing also, what I've realized I'm doing, I'm not really using a whole lot of the MX20 once I'm into the clouds or mist, whatever we like to call it. Really flying on the instruments, or on the SVS. Probably with the idea like hey, if I stay at my altitude I'm safe. So therefore, you know, I really need that – for my feeling I need this a lot more than knowing what the terrain does. Kind of having the comfort of if I stay at 8,000 feet, or 9,500 feet I'm okay. Does that make any

sense? (Would there be a concern for you, though, that once that ceiling did drop having the display that you did have with the standard gauges, how confident would you be as far as with the terrain though?) With the standard gauges? The feeling is about – is pretty much the same on both runs that I've done, I think the only nice thing about the first one is that the information is nicely, you know, compacted in your viewscreen so to speak. You know, I'm used to the instrument – to the regular gauges, so you do your automatic, you know, eyeball scanning. So in a sense I really didn't feel much more, maybe even a little bit more comfortable, because I was used to looking at those things in the first place.

EBGFN3: Does this thing have a fishnet? It's (the display) really nice. Actually what it does is it almost prevents me from looking outside, because it's a little bit foggy out, and here I got a nice, clear, you know almost like night vision so to speak. I'm kind of tempted to just look at that thing instead of looking outside. I don't see the fishnet. This is really, really nice. It gives you a feeling of flying in clear skies VFR, so to speak. Okay, standard rate of turn and power back, and descending about 500 feet to heading 050. Oops. I overshot that one. Back to 050. All right. And we're at the airspeed, heading, and waiting till we come up to 8,000 feet. It's a very comfortable – comforting display so to speak. I immediately notice I'm doing a lot better than on the other ones. Maybe that's also getting used to the drill, but this flies really nice. Again it's just very reassuring. It's like, you know, right now I don't really care what it's doing outside. Oh, there it goes. Yeah, this is nice. *Software crashed towards the end of the run.* Okay. Can I rate it a three? I think right now, if I follow this correctly, minimum pilot compensation required for desired performance. I think that's pretty much sums it up.

EBG1: (Now that you've seen the three arc second, now you're with the one arc second. Do you notice any significant differences?) To be honest, not really. I'll take them both. I mean they both look – maybe on a larger screen I'd notice the difference, but here not really a whole lot. They both look excellent. This is really neat. All right. Coming up on the marker. Starting my descending turn to 050. I'm getting a little bit more used now to all the little gadgets that I have on here. 050, still going – descending to 8,000 feet. Nice on the speed. (Do you want to try any of the field of views?) That's (60) kind of nice, but on the other hand it's – this (Unity) would be a bit nicer I guess. Now I can see the airfield. Airspeed in there a bit. Okay, coming up on 1,000 feet. Unity gives me a pretty good idea about where I'm at versus the ground. Maybe in different types of situations I might prefer one over the other, but right now what I'm looking at is really not that – I mean I don't like this one as much. Again, every time I do this I'm improving. Probably getting used to things and I'm a little bit better on my speed, altitude, heading, which is something I, you know, said earlier that with a little bit of practice I'd probably improve on that, which I have the feeling that – I think I'm doing better every time. And again, the difference between this display and the last one for me is negligible. They're both very comfortable and I don't see any fishnet. Now it's getting fun.

PRFN30: It's a little bit fuzzier. It's not as nice for the eye so to speak. It's – the other one is very pleasant to look at. It's – again, I think I use the word quite often, comforting. It's nice to – makes you feel like you're flying on a crystal clear day. (Do you have the same sense of the undulation of the mountains as much as you did before?) No. This is definitely less. (You happen to see the fishnet in this one?) I don't see any fishnets. All right. Climb back to 9,500. Lost some altitude here. All right. Back. Now we're into the clouds. Better too high than too low. Start the descent. That's nice on the speed. And the right turn. Oops. Overshot the 050. Okay. The display is a little bit less detailed, although it doesn't really, you know, bother me much, but it's – the other one is again more comforting than this one. Right now I – for some reason was more battling the airplane trying to stay on the numbers than anything else. I think right now the feeling if I have is that, you know, this will definitely work or do. The other one is

just, it seems to me almost if you buy a more expensive toy so to speak. This one I would say four. I mean I really needed to, you know, as a pilot I can definitely improve there. It's just staying on the numbers. I'm not sure if I'm really appreciating the MX20 that much. I think right now because you're flying every time the same scenario, you know, you kind of know you're safe if you stay above these altitudes. I think on average I maybe look like once or twice. I kind of glance at it, but I'm not using it a whole lot.

PRFN3: Looks a little bit better than the previous one. Again, I think you appreciate it a lot more when you have a bigger screen. This is all pretty tiny and the details are pretty tiny. Yeah. I was thinking; at some point if they start taking out the other instruments, you'd have more space. Right? (Right. There you go. You don't need all of those other instruments. Just get rid of all of them and just have bipanel.) Exactly. Descending turn. Do it as 500 feet per minute. Watch what I'm doing, there we go. Going down. There's 050. I think I'm getting obsessed with fine-tuning this thing. Yeah, I think the performance was pretty good. I always have a problem giving myself a one. Pilot compensation not a factor for desired performance. Well I think a two will definitely be on this place. I think I'm getting more and more comfortable with flying, so it's, you know, I'm better on the numbers. And I think with the displays it really comes down to, you know, driving an old Ford to work or driving a nice Mercedes to work. It probably both gets the job done. They're – the one is definitely preferable over the other.

EBGFN30: Again, the fishnet thing on this one it's the first one actually, the one that we have right now, that's test number seven. Run number seven. It's the first time I see the fishnet. But it really, it both looks good. Yeah. This is nice. This is definitely my top favorite. (This is the EBG. The elevation based generic.) This is just pleasant flying. I mean I think what actually happened, and one comment I'd like to make, is that, you know, once it starts really getting a little bit fuzzy outside, the high resolution inside the cockpit kind of drives your eyes towards that. You're more prone to look at something that's nice and clear and well-defined rather than when things become a little bit, you know, fuzzed out outside. (You're more inclined look at the display when it's less fuzzy?) Yes. Exactly. 050. Leveling out at 8,000. Adding power. This is, again, it's really pleasant to look at. And the thing that really struck me this time is like it gets a little bit fuzzy outside and like, hey, here it's nice and clear. Let's look at this display. And I think also when I get more comfortable I start looking more to the MX20 as well. See what that thing tells me. I think there's a pretty steep learning curve in this. I'd call that a two. You can always do better. Definitely it was good, but I think I could still do better using the roll pointer. Just roll in a little bit smoother and keep that more at a constant rate and keep the speed a little more constant on my descent, like say 500, 700 feet per minute. But I don't think it's really – I think it's a negligible deficiency. It's not making my life very hard.

CCFN1: Flying. It really looks a lot like my own. What I have in the airplane. It doesn't really tell me a whole lot. Not a lot of – I think I see a river, but, you know, I really have to start staring at it to really make up something and I don't want to do that. I'd rather make sure that my heading stays correct and my airspeed and my altitude. I really need more time to look at it to fish out some details that I want. So I just don't bother with it. (Are you getting a sense of the elevation in relation to the mountains at all?) Not a whole lot. Actually it all looks like to me it's pretty bland. Doesn't give me much information on terrain at all. (You see the fishnet in this?) Yeah, if I really move up close. Back to the 140 here. All right. Start our turn. That's a little too much. That's nice. Up on 50. (In relation to like the cultural features on the display, do you get any sense of those cultural features in any particular display? Whether it's this one or the others?) Not a whole lot on this one. Nope. Again, I really have to look at it very concentrated. Almost stare at it to get some information out of it, so I rather don't do it. Because I know if I stay on my speed, altitude, I'll be good. I don't think there's a lot of information there that can

help me right now. Again, I'd – you know, to be very honest I don't think that I would be very upset if I just had to use my regular instruments. You know what I mean? Just the brown bottom/blue top. This is really, you know, I don't see any – I was hoping to see a little bit more mountains, or get a more idea of elevation, but you barely see it. And you can barely see the fishnet, so I guess that also takes out a little bit of the feeling of the contours. But that might also be because we're too high. We're at 9,500 (MSL). Eventually down to eight (8000 MSL). So maybe when we're doing the lower levels I might see more, but at this altitude it, you know, to me it doesn't really matter having the classic instruments (with the regular attitude indicator) versus this. (So you don't consider that last display much of an improvement over a regular attitude indicator?) No. I mean if people say like, hey, you can get this thing if it costs you \$100 extra, I would say I don't know. You know, don't bother. I'd say here like a three. I mean the display characteristics are fair. It definitely doesn't match up with the other stuff.

PRFN1: Interesting crosswinds there. All right, starting our descending turn. (Any comments about those fields of view again? I think you switched them towards the end.) Yeah, the first one was definitely a lot nicer. This one here is – it's fuzzy, so it kind of makes it – kind of funny, kind of makes it more unpleasant to look at although there's still enough contours, you know, where you have high obstacles and what not, even at this altitude. But at – the other one is definitely – the first one I started out with really looked good. And the display we started out with, it was definitely good, so number two. I think it's again what it says here. It's good. Negligible deficiencies and pilot compensation not a factor for desired performance. That pretty much is quite accurate.

EBGFN1: Really nice to look at. I know, I mean I probably still see enough outside, but it's very tempting to start looking inside of the cockpit. Does this thing also show traffic in the air in front of you? (Not right now.) On the MX20 display? (The MX20 it has a traffic capability with ADSB, which of course we don't have.) Yeah. That's the thing that just struck me. It's like, well, in a sense you want to keep looking outside as much as you can, because you want to see, you know, other traffic. And when the weather slightly deteriorates, my first impression is almost you start looking into the SVS display. So that might be compromising safety in the sense of picking up other aircraft in your vicinity. All right, start descending turn. (Do you see any of those towers down below?) Switch displays (FOVs) here. Oh yeah, there we go. Again this works really well. I think I have to play a little bit more maybe with switching FOVs, but at this altitude it doesn't seem to – you know, I'm not really getting – or there's one of them that's really far away, like looking through a straw. That's not nice. But the other three options are, at this altitude, pretty good I guess. And the last one I ended up with I liked best. I think I'll give this one a one. I really, really liked the display and I think it really helped me, you know, complete the exercise. I could fly it really well and it was very easy to compensate even though there was a lot of crosswind and thermals, or whatever they were. Yeah, this is great. When do I get one of those things in my airplane?

CCFN30: All right. Flying. First impressions, again, the same as with the other one. I don't see a lot of resolution. I get some idea of mountains, but not a whole lot. The other thing that I just noticed is that if I go down a little bit I get a little bit better view on the display. I think the problem with these displays is the viewing angle. I think it can be improved a little bit if I go down or that thing tilts a little bit more. I mean it's the same with your laptop, right? That's why you can move the top part and put it at the angle that you like. It would be nice in the airplane if you could just tilt it a little bit. Let's get back to 140. Start the descending turn. I overshot it quite a bit. I think that's just my error. I think the major thing is – what really would be nice, if the display can be, you know, just a few degrees can be tilted – because if I look like this, I actually get a little bit more, you know, detail. And the way I'm sitting, looking down on it, it's,

again, to me it you give me the traditional attitude indicator and I'll be just as happy. On the display I would just call it fair I guess. I mean I'm not sure how to look at it. Is mildly unpleasant deficiencies like it's not as good as the other one, is that the way I look at it? (That's fine.) Minimum pilot compensation required for – yeah, that's true. It'll be three.

Block 2, Low Altitude:

EBGFN30: All right, descending. Something went wrong? I'm getting an error message. *Software crash in the middle of the run, so had to re-run.* All right. (Now that we're at a lower altitude, do you have any significant comments about this particular display?) Well, it just looks as good as the other one. Doesn't really look like I have a lot more information so to speak. It's as comfortable as the other one. I mean on the big screen I can see I'm lower, but on this thing I – yeah, I guess it gives you the impression I'm lower, but doesn't really make a world of difference so to speak. All right, descending. Nice tower. (Do you see the fishnet now?) Yeah. A lot better. (Fishnet helping you any?) Actually, you know what? I don't like the fishnet. Maybe sounds strange, but it tries to bring symmetry in to something that isn't there. I rather like the real shape. I mean if I look out of the window when I'm flying an airplane I don't see a fishnet. It's really not helping me. I'm not sure what people had in mind when they were doing this. The fishnet is really not my thing. (But you were really borderline on the speed.) Okay. I'd say a two. I mean I liked the display. It's good. Again the fishnet is, I'm not really sure what it's helping me with. Doesn't really give me a better depth perception or anything. I mean I think on the other hand I definitely was out of the envelope sometimes on the speed. I think the descending turn went a little bit too fast.

EBGFN1: (You had the 30DEM that you just finished; now you have the one arc second DEM, so it should be a pretty good comparison. Especially down here (at this lower altitude.) The high resolution. It definitely gives a better depth perception than the one I just had before. I mean this one I really notice – it really looks like I'm lower as compared to the other – the maneuvers we did this morning. (A better perception of the mountain range below?) Yes. So it gives me better depth perception, you know, that I'm closer to the ground and actually matches up a lot better what I see out there and here. Right now, for as long as I have good vision so to speak. (Fishnet doing anything for you?) No, I can't see it. I can see it from really up close. Not from up here if I'm sitting straight in my chair. All right, start the descending turn. I overshot that one. I can fix that. (Now that you're a little bit close to the mountains, does that unity view give you a different sense of awareness than you did at the higher altitudes?) Yeah, this is nice. You see the same thing I see right? If I switch? (Yes.) Yeah, this is much better. I can see the little towers on there. That's nice. (Now you're looking at the 60. And now this one's the 90.) Yeah, I mean, 90 and 60 are kind of both good. I think when you fly more scenarios you maybe get a better appreciation of one or the other. But right now you're flying the whole thing over and over again, so it's – I don't know. They both to me looked pretty good. Obviously the 90 gives you a little bit more view on the bottom that's in front of you so to speak. I think that's a two. I mean the display is definitely good. Again, I can see the fishnet, but I just don't like it. And I think except for overshooting on the turn everything else went okay.

CCFN1: It's the same trouble as before. I'm a little bit at too high of an angle. I get a little bit more information out of the display if I'm lower. Then again there's not much terrain information on it. Not much contours. All right, descending turn. (How's your sense of terrain awareness with this display?) Not terribly – I mean I can see the two towers coming up right now. Actually on this one it looks like I'm a lot higher than on the EBG. (Do you think you can get a sense of the terrain undulation without the fishnet in this display?) No. In this case probably not. No it would be all one brown mass. (So the fishnet's actually helping you out?) I think the fishnet will help here, yes. I think this will definitely help if I can tilt it a little bit more,

and you're right that the fishnet in this – when you have just the two-color contrast, blue and brown, it gives you a little bit more information about terrain contour. But definitely doesn't match up with the EBG and the photo realistic version. On display I would call it fair. It's a three. Now it doesn't really give you as good information on the terrain as the other displays do. So it's – I guess it's better than the traditional, the traditional way of flying. I think three would be reasonable.

EBGFN3: I'm still actually looking outside of the window rather than inside. It's kind of funny, I mean it really gives you an idea of what it has to look like outside to get a nice clear view. If this – you know, I like the contrast. It really gives you a good idea about the mountainous area. I like this best. Okay, started descent again to 050. That's going a little bit too fast. (This field of view giving you any additional advantages, or wanted to sample it?) This (FOV60) is nice. Actually, gives good information. The display is pretty good. I like it. I mean it's, again, it doesn't match with the so-called photo overlay so to speak, so I think this is still pretty good. It'll be a two.

BRD BL: (Now that your out-the-window view has dissipated, what do you feel at this moment?) I'm kind of comfortable with it because I've done it before, but it's definitely less reassuring as the other displays, where you kind of have an idea that you can, you now, peep through the clouds and still have an unobstructed view. (Watch your turn.) Turning now to 050. Definitely glad I'm doing this in the simulator. All I know is it's something, you know, even as a VFR pilot you have to practice that with your instructor, so I'm kind of comfortable with it and what I said earlier, it's definitely more comfortable to do it in a flight simulator than in the real thing. But yeah, the thing that you miss is any of the other displays just give you almost, if you can look through the clouds or through the fog and get an unobstructed view it's just much more reassuring. I mean right now since nothing else is going wrong and, I'm watching my dials and I know I'm going okay, but that other one just gives you a little bit more of that, reassurance, to be able to see what's out there versus completely trusting on your instruments. (Were you relying a lot more on your MX20 dealing with terrain or anything?) I looked at it a little bit, but since we're flying these things over and over I know if I stay at 5,000 feet I'm good. And I kind of browsed over it a little bit, but I never saw any red popping up. So I guess when I don't see any red I'm not flying into anything. Plus, I think that the way it's set up that if you – I haven't done it. It hasn't happened today, but if – I guess if I really got below 5,000 I'd probably get some red on the MX20, right? (That's correct.) The thing that confuses me is when you have up here SVS display characteristics. It wasn't an SVS, right? You don't see anything except your gauges. (Well, just try to answer the questions as far as how it affected your performance flying. Like for example, if you felt that you had some minor deficiencies of just looking at that display were kind of annoying, you would give it a four.) Yeah, the thing is there's nothing wrong with the – you have to deal with the equipment that you have. If I have to compare it in light of the other displays then, yeah. It's a deficiency, right? (And that's basically what you're trying to do here.) Yeah, then I would definitely give it a four. I mean it's minor but annoying, because I know now it can get better.

PRFN30: And there's the fog. All right. Starting my descent. (Are you getting a good sense of cultural features there?) Not really. Trying to get a better understanding of the MX20 to see if I can get some red in there, but that didn't really work because I don't want to go too low. I guess good is definitely the best way to describe it. Very easy to fly. Good – get good enough information.

PR1: (Cycling through those fields of view –) Yeah, just trying to get a feel for which one I like best. (Do you have any comments about the terrain at all?) No. This is definitely – looks the

most realistic, no doubt. And that's pleasant. (You see any advantages in this one over any of the other displays?) Except for it's more pleasant, you know, it always gets the questions like if it were to go to such an extent to the level of comfort. I'm not sure if it really tells me a lot more than the other ones. All right, descending, 050. I think this display right now gives you a better idea where the airport is in the distance. I really think this is the best display to fly. This is so – that would definitely be a one. Checking the pilot compensation not a factor. Yeah, it's definitely a one. (Any comments?) No. Just get me one of those things.

PRFN3: (Now do you see the fishnet in that?) Only from up close. If I put my nose to the display I can see it. From here it's very hard to see. There's about a meter in between I guess. That is three feet for you guys. I can see a little bit here. No, right now it just looks like little, you know, like farmland. Little fields. That's my left turn. (Any comments about this display versus the others?) No. Again it's, you know, the fishnet looks like that, again, for me it really doesn't do much. I mean I can live without the fishnet. Lose the fishnet. Maybe there are other situations when you fly that it becomes helpful or something, but – feels like, almost like, flying over you know the old-fashioned globes that had during geography class? And we had all these squares going over it. That's kind of the feeling that you have. You're flying over.

CCFN30: There's a little river or something. I can see the display, but I have to crawl my nose onto the display. (You getting any sense of the mountains below you?) Not on this display. Not a little bit. In the distance, you know, where the horizon breaks, that's where you have some idea there is some – cycle through these a little bit. No. All right, descending. (Does the fishnet help at least give you some sense –) It gives me some sense, but not, not a whole lot. Definitely, I mean it gives you more of a sense of what's right below you, but not what's really coming ahead of you.

PRFN1: Again, it's, you know, this is definitely, photo realistic is definitely the best. And I like this setting the best, because you can see most of the terrain below me. This definitely gives a better idea about what's coming up. Not only what's below you, but also what's coming up in the distance. (What about the fishnet?) Lose the fishnet. All right, descending. Turn to 050. (Wanted to go ahead and storm through those valleys huh?) Yeah, I was playing around a little with the – I shouldn't have done that. Certainly going through the 5,000 feet here. Starting to get to the point where I am losing concentration. It's just doing it again and again and again. We're right on 050, 5,000 feet. It was definitely good.

EBG1: I like this; from the EBGs I like this one the best. Very realistic. I am extremely happy that the fishnet's not there. All right, there's the turn. This is nice. Would gladly have it.

Block 3, Approach:

PRFN30: Why don't I have this thing in a real airplane? This is awesome. This is really, really, nice. This is sweet. This is so nice. Actually I think it added another – another obsession to flying. Right, to keep in the little box. (You feel like that's easier?) It is, it is. And actually the funny thing is, I know that if I stay in the box I'm safe. I mean, that brings me to the runway. And what you do anyway is you kind of glance to your altimeter strip and to your tape and to the speed, you know, keeping the speed was – I had to pay more attention to that, because I want to try to get it to keep at 90. And once in a while you look at the MX20, but you start looking outside and you start losing sight and it's so easy, there's no barrier at all to start looking at the SVS. It's like just the most natural thing to do. I'll take this home with me anytime. I think right now and maybe when you get really good at it you start looking around a little bit more, but right now the trick is to stay into the box and the terrain definitely plays in the background. But I actually, it looks like I'm looking more to the MX20. Because I'm getting really low compared

to the other flights that we've done last time, remember? The ones that we were at, what was it? 9,500 and 6,500 feet? (Yes.) You were really high so you didn't see a lot of red. Right now you just sit here looking at the SVS and in the corner of your eye you really see, you know, you're getting low, so, you know red means bad, so you automatically start looking more at the terrain what's around you. So I'm using the MX20 a lot more. (So you used that actually for terrain awareness more?) Yes. But it's maybe more because of all the red that's in there, because the lower you get the more red you get, right? Close to the ground. (Okay.)

EBGFN1: (Are you able to see the fishnet on the ground?) Yes, I am. (What about roads?) I see roads, yes. Okay, getting close. I could definitely do better on my side. I kind of lost the heading a little bit messing around with the speed, so the display's excellent; it's just that the pilot could do better here. (So it's mainly your own performance?) Yes. Nothing to do with the display. (Compared to the previous one, which one do you like better?) Display-wise, I think to me they're both very equal. I mean one of them looks a little bit nicer than the other, but I don't think that makes my life any better so to speak. So the rating what I'm doing right now is that I take both in account, right? The display and the pilot. I mean if it's the display I would give it a one again, but right now I would say it's minimum pilot compensation required for desired performance. (The rating is based on both the display and your own performance.) It's just excellent. Fun stuff. A must-have toy. Again, as with any laptop computer, the same type of LCD display would be nice if you can tilt it a little bit so I have a better viewing angle. I'm kind of tall, so I look down and I have better resolution if, I see better if I crouch in a little bit. If you're a smaller person it probably doesn't matter, but I sit up straight and I start losing the quality of the display, so I'm thinking the real thing that would be nice is if that thing could just, you know, rotate, tip around just like a regular laptop, which you can also adjust to your own position.

EBGFN3: I played a little bit with the FOV, but I like this one best. (FOV60) I always end up at 60. Took us a while to figure out last week, but I'm consistent. Again, the display is excellent and for me it was very easy to follow it and with minimum compensations. The symbology and, you know, just again keeping the tunnel. It's like driving on the road, right? If you stay on the road you're not going to hit a tree. You know, I don't think I notice really much of a difference (between this display and the last one). Maybe when you fly around in this for a long time you start appreciating it, but right now I'm, so to speak, busy with the task. The SVS gives me a really good idea what's below me, in front of me, and I'm not really sure if high resolution is going to make my life a lot easier flying the airplane. You know, it's always nice to get higher resolution, right? That's why we pay many dollars on our video games, but for me it isn't really necessary.

BRD BL: *A lot of coaching up front, revisiting target speeds, altitudes, and headings. No comments during the actual run.* (You're about three miles off final approach course, the runway's to your right. You were basically paralleling it, more than a dot off. Your vertical path was fairly good. But you were still high.) Just looking at the diamond. (But most of the time you sensed that correctly on the way down.) Yeah, so that looked good and right now I was working my way over to the right to get back onto the localizer for the runway. (At one point, you had had full-scale deflection on the needle on the diamond.) Yeah, I saw that. (Did you notice it was amber?) I didn't notice it was amber. No, it was all the way to the right, so I was trying to go back to it and intercept it again. (So you were cognizant that the runway is to your right?) Oh yes. Yeah. I was good on my vertical slope, and I was trying to intercept my course, so to speak, to get parallel to the runway, or onto the runway. I was pretty confident I would find it.

PRFN3: *Transcriptions are missing for this run, so these are notes that the PI took.* Display characteristics were excellent. Easy to fly. Didn't notice any difference between DEM30 and DEM3.

CCFN30NT: *Transcriptions are missing for the first part of this run, which was before the software crash in the middle of the run and subsequent re-run. The following are PI notes prior to the software crash:* Could see the river and towers (but not the runway.) Display will work very well if he got used to it. Wish it had a tunnel. Needed more attention without the tunnel. *The following are actual transcripts during the re-run:* (Carrying some rudder input for some reason there or flying sideways for some particular reason?) I'm adding right rudder to keep the velocity vector in the center. But for some unknown reason I'm not getting a lot of throttle out of this thing. It's only going 69, and I'm flying pretty much straight and level flight. (You're flying sideways in a significant way. That's why I was wondering if you were holding some rudder input.) Yeah, I'm playing with the rudder. (Yeah, so that would kind of slow you down a lot.) That much? (Yeah, you're flying sideways pretty good there.) Wow. (Are you able to see the runway now?) Oh yeah. The reasoning is I think the display actually would work really well if I get a little bit more used to, as a pilot, I think I get a little bit more used to using the diamonds, getting a better sense for that. Getting a better sense for that, you know, the sensitivity. It's already going a lot better than I started out with, but I think when that learning curve is there, you know, it will definitely be a five. (Okay, and what about the tunnel?) Oh, give me the tunnel any time. Actually what I really notice is my grading – this needs a lot of attention, you know, I really need to fly the airplane, look where I'm at. While the tunnel I have so much, I think a lot more time to communicate and, you know, do other tasks. That's really the thing I notice immediately. Like just fly the tunnel and you have time to do other things. (At one point during the flight, you applied a lot of rudder.) Yeah, I was trying to get the airplane, for any reason I had the feeling that I had to keep it in the center of the – of my SVS. (So you were trying to center the circle, which is the velocity vector?) Yeah, the velocity vector. (To the center of the display?) Yeah. (Okay, which is also where the pitch reference is.) Yes. (Okay. Well, you don't really have to do that.) I know now. Because I lose all my airspeed. The strange thing is to have the side wind in a simulator like this is that you don't really experience it. When you're really flying an airplane you feel it, right? I mean if you put in rudder or – (Right, you don't have sensation.) Exactly. And that's a major disadvantage for me.

PRFN1: (Can you see that mountain range beyond the runway? Do you think it gives you enough information if you were to have to do a go around?) Oh yes. More than enough. (It looked like you kept with the field of view of 60 throughout that entire run.) Yeah. Same thing as last week. Sixty seems to do the best for me. I like it. It looks like it gives me the best, you know, broad view, but also the, you know, below the airplane so to speak. If you're playing around with 30, 60, 90, then 60 is the one I'm most comfortable with. The displays work really nice and I didn't have to do much compensation. It was just follow the yellow brick road, right?

PR1: (No fishnet.) All right. Good. I really like it that there is no fishnet. You didn't have to listen that much to me complain about the fishnet last week. I was going off on it. One reason I don't like it is it confuses me. It gets harder to see the contours of the landscape. Is that a road or a river? Right now it's, you know, if I look out of the airplane, out of the window of a real airplane I don't see a fishnet either. So I'm not sure if it's really supposed to give me more depth perception or not, but it really doesn't do it for me. Yeah, it just adds something unrealistic to it while the whole idea is if you go for making things realistic, leave it that way. Don't put the fishnet in. And it becomes a lot easier, I mean a lot of times when you're flying the little square, the acres? So, you know, that's really helpful in knowing where you are. If you get the stupid fishnet over it, it just confuses things more. But again, that's a personal opinion. And I think

right now that the quality of the display itself and, you know, what's on there, is of such a quality that it gives me enough idea of contrast and, you know, the ups and downs in the landscape. I don't think that the fishnet for me really adds a lot more information to that. I'm not sure. We need to get this to someone at the FAA to really tell them that this really works. Really, really great. It has a real potential to save a lot of people's lives. I'm sure your guys have relayed that already. (Well they've been here on site. We have had some certification types down here to take a look at it and they're in total agreement with you.) Okay. Great. So we're going to have this next year on our airplanes, right? (That's a little optimistic.) *Software crashed in the middle of the run, so had to re-run.* Get me one. This is really nice. Again, there is, you know, plenty of time to do other things, just keep your eyes on the box. I kind of look a little bit at the, you know, the only thing you keep an eye on is the speed. You match up the acceleration vector with the velocity vector. Yeah, you're absolutely fine. Maybe a few knots higher or lower, but it's incredibly nice. (Can you compare EBGs that you flew earlier with the PR?) Again, it's like, yeah, this is a lot nicer. The photo realistic. But, you know, maybe that's more a mental thing because it looks very familiar. It looks, you know, like the way you look out of the cockpit. But again, it's like I would take both of them, you know, at any given time. They're both extremely helpful, and if this is too expensive, or too computer intensive or whatever, you know, the reason, the other one, the EBG, will gladly take it. I would definitely call it a one. It's – the display is really excellent for this type of work and, again, I don't think that the pilot can do anything wrong here. Really have to do it on purpose.

EBGFN30: (Before you mentioned that between the resolutions that you didn't really see much difference – what about now?) Yeah, I can see that there definitely is a difference, but it's not to the point that it is annoying or that it, you know, gives me less information or something like that. (What about the FN?) I mean if it really comes to it I would say that the fishnet would be a little more helpful in the EBG than the photo realistic. You know, there's definitely a slight difference in there, but preference-wise, you know, if it's not there I wouldn't care. (How do you like that mountain range beyond the runway now?) Yeah, it gives me the same information I think what was it, the picture perfect? (Photo realistic?) Photo realistic. You know, definitely give me enough information to know what's out there. And what to do with it in case of a go around. Plus, you know, the MX20, you know, you definitely get a good feel for the mountains are up there. I would also call that a one. You know, we just discussed it. I mean it's excellent. Definitely helps you out a lot. And, again, as a pilot it's not really a factor. I mean you just follow the box. I think what really strikes me as being very helpful on an approach like this, normally in approach that's where it really gets busy and you just follow this you have much more time to, you know, to communicate with the tower, with other airplanes, so this is definitely going to be extremely helpful when you get close to airports. (So it helps alleviate the workload a little bit?) Oh yes. Big time. Yeah, for me it definitely does. I mean for me it's, you know, flying is easy as long as I'm alone. Because I only got 30 hours. But once you get to airports that's where you really start checking everything and looking around for other airplanes and things like that. This really lowers your workload by orders of magnitude.

EBG1: Nice. I'll take it any time. I think actually the thing with the EBG is it's maybe less confusing – it doesn't have as much detail clutter as the photo realistic version so to speak. Or you see a lot more detail of more stuff, which I think might give you in certain cases more of a frame of reference, while here it's a little bit quieter for the pilot I guess. You know, it just gives you information not to fly into things. Gives you an idea about what the landscape is below you and in front of you. I like photo realistic most, but I think what also makes a difference is you probably have to fly in these things over different types of landscapes just to see what it does. I mean right now when you're flying through the mountains, I think I've got more than enough information out of the EBG. You know, what's high, what's low, where the mountains are. Be

better with the MX20, so from the point of view that the photo realistic might, you know, put too much information there that I really don't think I'd use. Probably cheaper as well, right? Or easier to do, let me put it that way. I mean also I know the EBG and the photo realistic, you know, at any level and any type of arc second is still going to beat everything else hands down. I mean, going from the traditional instruments that I was flying with earlier, you'll take anything. (How do you like that ridge beyond the runway now?) Really clear. The whole time, I mean, it really gives you a lot of information. The interesting part will be, you know at some point when you're flying on the SVS the whole time and then you've got the impression, okay, you know, outside the runway starts popping up, that's where it gets kind of interesting just then suddenly looking outside back to the OTW. (Do you find it's hard transitioning between head down and out the window?) It's a little – it takes a few seconds to get used to again. To get that whole different perception of looking out of the window. I would call that a one. (For the same reasons as before?) Yes.

CCFN30: The thing is I don't get a lot of information out of the there's not much contouring. And you know the real thing that's really easy again is to just fly in the boxes. So, you know, I'm on a comfortable level pretty much the same as on the other displays although I don't even have as much information on what happens on the ground so to speak, or what's there to see on the ground. It's just, you know, you just do this thing. You fly in the box and you're okay. And it's just a very comfortable feeling. The same thing as your – I think I used the same analogy earlier, it's like you're in your car, you drive on the road, you stay between the white lines and you're going to be safe, right? (If this were the only display available that you would take this display?) Oh yeah. Any time over the classical instruments. Definitely. I think it's just the same as with electronics, right? If you go to televisions you can always get fancier, bigger, better, better resolution and all that stuff, but you know, if this is the easiest to do and easy to realize in real life, the most affordable, et cetera, I'll take it any day. (I think that the fact that you were talking to me during your turn and did okay speaks for itself. Do you find that the fishnet helps you with this display at all?) The thing is that on this display, and I mentioned it earlier, is that I'm a little bit taller, so I sit a little bit high. The resolution – the fishnet kind of falls out for me, so maybe I cannot get to appreciate it as well as I should, because if I really get close to the display, you know, with my head lower, I can see a little bit better and I can see what you mean. There's a little bit better terrain contours et cetera. But then when I sit up straight, the way I like to sit, I kind of miss out on that. So I think what would really be helpful in the real thing in real life if it ever gets that far is to make the – make it possible for the display to tilt a little bit so it can be, you know, tailor made. Every pilot comes in can kind of adjust it to the way he wants it. (Can you see the mountain range beyond the runway here?) I can see it. I know it's there because of the other flights, but I don't like this as much. It doesn't really give you the same type of information as the other one. It's definitely less. (If this were your first time flying in and you had seen this display first basically –) Yeah, exactly. I mean if I would, you know, fly every – like every time another scenario, you would have mentioned like mountain range and I would have looked at it again and it's like, "Oh yeah. Yeah, right. They're up there." So the other one was definitely better. Okay, can I rate it with a one? Actually, hold on. Going a little bit too fast. I would say here that, the thing is for me this was very easy to fly, but if you talk about losing some information on this display I would say that a two. I mean it's good, but mountain ridges, a little bit less contours which, you know, are kind of hard to see. So I would be for as a little more – you know, a little bit more clarity into – in the display. Know a little bit more what happens with altitudes. I think what kind of does this to me is I'm going to look more at the MX20. Got more impression about where the other mountaintops are.

CCFN1: *Transcriptions are missing for this run, so these are notes that the PI took.*

Can see a little more of the contours in this one. Other than that, won't really make his day compared to the others. Definitely some things can be fixed for the FN, etc, to make this a little better.

Rare Event:

PRFN1: *Transcriptions are missing for this run, so these are notes that the PI took.*

Had a lock up while trying to start up. Restarted computer. Just a bad day all around when it comes to equipment cooperating. Misses the tunnel. Tunnels are good. Too high at the beginning for more than 30 seconds, because he was talking to me. Transition from OTW to HD is pretty intuitive. Very shallow descent rate at the start. This one he turned a little late, so was to the right of the ridge. So, at 4:36 (traditional impact time) was too far right to impact. However, caught the second ridge, did mention that the terrain OTW didn't match with what he was seeing on the display at 5:15. Thought the OTW was showing he was lower than the HD. Crashed at 5150'. Display works really well, but without tunnels you have to pay more attention to the numbers, and he wasn't used to that.

Subject 26 (BSBG Baseline):

Block 1, High Altitude:

PR1: The small corrections on this is just killing me. (How's that waypoint look?) Looks like I passed it. (Yeah, you need to reference that for your turn.) *Software crashed in the middle of the run, so had to re-run it.* I like this right here. I go to FOV 90 -- that's too much. Unity I don't like at all. Right there. (That's your 60-degree field of view.) Yeah. That's a more realistic look at the ground to me. (How do you like the actual depiction of the ground with the photo realistic and the highest resolution?) Looks good. I like it. Went way past the waypoint on that. I just need to get used to this thing here a little bit. Yeah, I mean I got too involved in the turn looking at that rather than -- it had nothing to do with the terrain though. The terrain looks great. (Overshot his heading went to 000. Also, was way fast on the descent, and descended below 7800.) I'll go with a five. I think it's mainly because I'm just not used to any of this. If I could go through it a few more times it's not going to be near as demanding on me I don't think.

CCFN1: (Could make a couple of comments on this terrain concept?) Well it's almost simpler in a way; there's not as much to confuse you, less to look at. There's not as much to look at, so I'm not as involved in looking at that as I am trying to keep my numbers right. I mean it's letting me know what's there without getting me to -- I don't know. With the photo realistic, you know, it's -- I don't know. I get more involved in looking at the picture. (Looks like you got the turn a little bit better; however, you were a little bit fast on your descent.) I'm still going to go with five. I think it's more me than it is the information I'm getting. Just getting it all sorted out.

EBGFN1: Real nice to look at. Actually I like this pretty well, so far. (You're pretty much sticking with the field of view of 60. Have you settled on that one?) I don't know yet. Very realistic. Very realistic. I actually thought I liked the other one a little bit better, but you know this one here looks so real. (When you say the other one, do you mean the photo realistic or the constant color?) The blue and brown. (Oh, okay. The constant color one.) Yeah. I thought it was less confusing in a way, but after seeing this one here it's almost like looking out the window in a way. (During descent, about 5 seconds too fast, and was below altitude for about 18 seconds.) I'm still going to stick to five. Yeah, I still think it's more me than it is the information I'm getting.

PRFN3: A little more defined than the other one I think. And I still like the 60 better than anything I think, on the field of view. Just the terrain in general, you know. I mean it seems like I can see more detail in the terrain. I can note the elevations a little bit better. (Than the one that

you flew previous to this one?) Yeah. Well, I'm almost more preoccupied with the numbers than I am the terrain. You know what I mean? (So you're concentrating on flying and not necessarily looking at the terrain?) Yeah, I'm more worried about the numbers than I am about the terrain I guess. I'm looking at the numbers here a whole lot more than I am looking at the terrain, not that it's doing me any good. I guess I'll have to go for a four. Maybe more because of the desired performance for the pilot compensation, not so much the deficiencies of the SVS, but just more on the pilot.

PRFN30: (With it being the lowest resolution can you tell a difference at this altitude between this resolution and the one that you just flew previous to this?) Not really. And most of my attention is focused on the numbers and the other information. (Now that you've descended, do you see much of a difference between this one and the one that you just flew?) Not quite as defined. Like I say, most of my attention is still focused on the numbers. Probably can't tell by my flying though. (Your roll was a little too steep and you're about 20 seconds out of bounds on your descent when it came to speed. And then at the end you were a little too low for a little too long a period of time.) I'll stick with the five. Still more me than the information I'm getting. That's – I think it's more me. I mean, there's plenty of information here, I just need to get it all together.

CCFN30: (Do you have any comments?) Terrain-wise, no. Just the brown and the blue, I mean, it just lets me know enough that I'm not on the ground. Otherwise, like I say, most of my attention is still trying to get all the numbers to work together. I'm having to fight with getting focused on one thing. Let's say the heading, and then I lose track of the airspeed. (So you really haven't been able to develop a scan yet?) Not really. I'm working on it. I'll have to go for four mainly because of the pilot compensation. It's just more on the pilot to sort it out.

EBGFN3: Very defined. Actually I looked at the terrain more this time, which on that it seemed like it made it a little bit easier. I don't know why. I've kind of got a circle going for a scan now, which includes that. It does help. I'm still going to go with four. Because it's still a lot of pilot compensation. I mean I still got to see all the information and then act accordingly to all of it, and that's – I don't know; there's a lot of compensation there.

EBGFN30: Seems about the same. (So currently you can't tell much of a difference between this one and the one you just flew?) Not really. (And it looks like you have pretty much settled on the field of view of 60. Is that a correct statement?) Yeah. Same thing. I mean, the information is there, it's just up to me to get it all worked together.

EBG1: For me at the higher altitude it doesn't make a whole lot of difference what the terrain looks like. You know what I mean? (You think it's just not a factor since you're up high enough?) Yeah. Once you get closer to the ground this looks real good. I mean I find myself looking at the terrain a lot more if I'm closer to the ground. I got to admit most of my focus is still on trying to get all the numbers where I want them. Sticking with four, same reason as before. Still for the pilot. Information's there. The pilot's the one that has to just sort it out.

BSBG BL: *No comments during the run.* (Do you have any comments on that one and the lack of terrain. Do you miss the terrain information or if you knew that you were high enough that you didn't need the terrain information?) It's almost less confusing, because there's less to distract you from the numbers. (At one point you were a little too slow, a little too high, and a little too far to the right on your heading for a little too long.) Five. I'm going to have to stick with what I've been saying all along. It's more just getting the scan going and keeping all the

information sorted out, so I have this tendency to focus on one thing at a time. Like I'll focus on the heading and forget the airspeed. Or I'll focus on the heading and forget my altitude.

PRFN1: I'm looking more at the numbers than I am at the terrain. When I get lower, I like that. The definition of the terrain – that photo realistic thing, I don't know, I just find that – I don't have a good word for it. (Comforting? Or not along those lines?) I don't know. Realistic? It seems more like looking out the window. I'm going to stick with four. It's not so much the – what's in front of me, it's me knowing what to do with it.

Block 2, Low Altitude:

CCFN1: (Can you give us a couple of comments on this terrain now that you're flying a little closer to the ground?) It's better. It's a lot better than when I was up high. I can actually tell where terrain is. Kind of surprising, though, I looked up my terrain on the big screen, which I saw on the display too. The information is there to make the decisions. I mean it's there, I just need to make my decisions quicker or better.

PRFN30: It looks good so far. I'm looking big screen and looking at the small screen and it looks exactly the same to me. (Can you see the fishnet?) Barely. (Now that you're a little closer to the ground, what do you think of the terrain?) Good. Good. I can see the ground real well. I can see the fishnet real well now. I'm not sure the fishnet really helps me out any though. I'm going to have to stick with four. Same reason as always.

EBGFN1: I love the way it looks. I can get a better feel of what the ground really is for some reason. (From the photo realistic that you just saw?) Yeah, I like this. I get a real good feeling of what the ground is, and where it's at. (In terms of elevation?) Yeah. (Is the fishnet helping you at this point?) I'm not so sure – no, I really don't think it's the fishnet. (And at the beginning of the run you mentioned that you could get a better feel for how the ground looks that the one that you just flew.) Yeah. (Do you think that's because of the actual coloring of the terrain here, or do you think it's because this one's a higher resolution than the one you just flew.) Yeah. I think it's probably the resolution, but the shading of the ground I think that helps a lot too. I'm might go up to three on this one. I think that's mainly because I'm getting a little bit more familiar with it.

PRFN1: I like this pretty well, but the fishnet's not helping at all I don't think. It's almost distracting in a way. (Now that you've made the descent, what do you think?) Yeah. I like it real well. The fishnet, I don't know, it's – it could not be there and be just fine with me. (Well how about compared to the one that you just flew?) I think I like it (EBG) better. It gives me a little bit better feel of what the terrain is like. Even with the fishnet on here it still looks flat in a way, but not completely flat. I'll go for three again. I think it's mainly more because I'm getting a little bit more accustomed to the feel of this whole thing.

PR1: This is good. This feels real. (So you definitely like it without the fishnet?) Yeah. I'd say that I like it a lot better without the fishnet. (Do you have an opinion on whether or not you like this better than the elevation-based generic? I'd almost call them even. I still think that the elevation based is – probably gives me a better feel of what the elevations really are. It's like the elevations are more defined than what they are in the photo realistic. It's a lot better when I get closer to the ground. A lot more defined. I'll go three again. Like I say, I think it's more because I'm getting accustomed to the displays and maneuvers. However, I did really like that picture. It was pretty good.

PRFN3: Not too bad from this altitude. I don't particularly like the fishnet though. I can't see it now. I could a minute ago. Now I can't really see it. At the lower altitude, lose the fishnet. (And this is the three-arc second, so this is the medium resolution. The one that you flew previous to this was the one-arc second. Can you tell much of a difference at this altitude?) Yeah, some, but it's not really enough to make that big of a difference to me. I'm going to have to stick with three. Because two says pilot compensation not a factor and now I can't see how a pilot compensation would never be a factor.

CCFN30: Not near as much to look at, I'll tell you that. (Can you see the fishnet on this one?) Just real close in at the bottom of the display and then I can't really see it at all. (Now that you were a little closer to the ground on that one, do you have any additional comments?) Don't like it. It's too easy to get lost in the brown. I mean it's just like flying into a brown field. You know what I mean? There's no definition to me. (You were too low and too slow for two periods of time for over 30 seconds.) I'm going to say a five and a half. Tell you it's just the brown and the blue. I mean, what happened when I got too low is I just kind of got mesmerized by the brown. Just going into the brown.

EBGFN30: I like this one. I just get a better feel for the ground, at least from this altitude. (When you say you get a better feel for the ground, are you talking in terms of comparing it to the constant color that you just flew?) Oh yeah. Actually just about anything. The different color for the elevation, I don't know, it just helps me define how high they are. It gets worse as you get close to the ground. Yeah, right now I don't have any – the terrain looks almost flat to me. (Do you attribute that to the resolution since this is a 30?) Probably, yeah. Resolution only. (How's the fishnet?) Worthless to me. I'm going to go with a four. It's up to the pilot to decipher all of the info. I would not call it minimal compensation – you have to be thinking pretty good to keep it all together.

EBGFN3: (Can you tell a difference at this altitude between those two?) Yeah. A little better defined. (And, after the descent, now that you're a little closer to this terrain, what do you think of this display concept?) Better. Better. Much better. Fishnet doesn't help though. It's more the shading – color shading that helps. (When you say it's better, do you mean better than the one you just flew? Yeah, better defined than the last one. I liked that pretty well. The color shading, like I said before, that gives me a better idea of the terrain elevations than anything else. Same reason. It's still up to me to process the information.

BSBG BL: (Do you miss the terrain information that you would have had with a SVS display?) Yeah, I guess I would. I really have no awareness of the terrain to me. (Is that something that you would like to have?) Yeah. I guess. I don't know why, but it just makes me feel better. I'm going to have to stick with four. The same reason as always.

EBG1: I like it; real defined. At target altitude: This is good, very good. I can tell the terrain real well. Like I said before, it's the color shading of it. (For this series of flights you stuck with the field of view of 60.) Yeah. I like it. When I went through them earlier all the others just didn't look quite right to me. Sticking with four. (Four for the same reason?) Oh yeah.

Block 3, Approach:

Transcriptions are missing for the first six runs, so these are the notes that the PI took:

EBGFN3: Before and during turn, was low (more than a dot) for 20 seconds. Very quiet on this run (as most subjects are on their first run). 25 sec low on GS/vertical path as GS was coming in (over one dot high). Played with FOV a lot. Transitioning between FOV was hard for him. Stayed

low on short final for awhile. Said it's very hard to keep it in the box. Worked hard to keep it in the box, and didn't really look at the terrain. It's really hard to keep it in the box.

EBGFN1: Thinks he likes FOV60 until short final, then goes to Unity. Stayed in 60 during turn on this one, is much more controlled than the last one. Was 10 seconds outside of path during the turn. Still focused on the box and the numbers, not looking at terrain. Was low on the GS for over 60 seconds at the end. Still really hard to keep it in the box.

CCFN1: About 5 sec out of path on turn. Software crashed at 4:32, so had to re-run. Still concentrating on boxes, but saw the range beyond the RWY. Likes the other better, but this does give enough info to go in for making a go-around. Did much better on this one. Still up to the pilot to use the info and make it work.

CCFN30: In and out of parameters once or twice for 5 seconds, but not enough to surpass into adequate. Likes 60FOV, still, at the start, but then scrolls to Unity right about the outer marker. Ridge beyond RWY is not as defined, but can tell that it's there. Same as always - the info is there, it's up to the pilot.

PR1: About 5 sec out of path on turn. Not overcorrecting as much as the first two runs. Still looking at the boxes, and not really paying attention to terrain. Range at end of RWY is a lot more noticeable than on the CC. Gets a lot more info from this one than the CC. Was a little low at the end, but not enough to give him adequate.

EBG1: At the beginning, had a little trouble (vertically, and speed). Got close to the ridge, but corrected. Probably was around 10 seconds. Software crashed at 2260ft (860ft above where we normally stop), 4:31. We decided to keep it, because he's got a flight at 2pm, and he had enough info to go on. Same as always, but it is getting easier, since he's flying it so often. He loves this, this is his favorite picture.

Transcriptions resume from this point on, for this subject.

PRFN1: (This is the photo realistic, the highest resolution. And with the fishnet does it do anything for you as far as ground perspective? Terrain features?) Not a lot. Fishnet, I don't know, is almost more confusing than just looking at the ground and most of my attention is focused on a green square. Now the closer I get to the ground the more the terrain features show up to me. Elevations like these towers coming up here. I mean they're real prominent to me. (Field of view strategy remains 60 degrees?) Yeah, until right about now when I hear that outer marker. I'll make sure I'm pretty much centered up here and then I'll usually go in here so I can get a better look at the end of the runway. (How do you like that mountain range at the end on this one?) Yeah. That works too. (And the fishnet doesn't help you too much?) Not really, no. I'm going to stick with four. (And for the same reason as before?) Oh yeah.

PRFN3: (Have you had a chance to look at this terrain?) Yeah. I'm still mainly focused on the needles and the tunnel. (Can you tell much difference between the range at the end of the runway on this one and the one you previously flew?) Not a lot. No. Yeah, I mean it's still defined enough that I could get up over it if I had to. That's right. You guessed it. Number four. (And the same reason as before?) Yeah. Terrain doesn't seem to be much - I mean I don't even look at it really until I get real close. (So you have enough faith in the tunnel that it's providing you correct information that you don't need terrain information?) Yeah. Not until I get real close.

PRFN30: I'm concentrating on the boxes. *Software crashed at 1380ft (500 ft above normal run end. Since this subject was pressed for time, we had to keep this data.* (Did you have a chance to

see the range at the end of RWY?) Yeah, I could see the range at the end. I like the higher resolution better, but that's – that's enough to get me to miss it.

BSBG BL: (On all the other runs you were pretty focused on the symbology, but you weren't too focused on the terrain on the other ones. Are you missing the terrain information that you would have had on this one, or is this an adequate display for you?) At the moment this is fine. Now when I get a little bit closer in to the runway I think the terrain would be a little bit nicer. (Did you miss the airport shown on your display?) Yeah, a little different.
CH (Performance: desired) – CHR 4.

CCFN30NT: What the heck? Well this is not working. (Okay, as a reminder the final approach course is 334. You do have a crosswind. The runway's to your left. So you want to fly to your diamond. There you go. You're picking it up now. Okay, you want to fly to your needle there. The runway's to your left. You're paralleling.) The diamond down on the bottom of the screen? (Yeah. That's it.) Now I've gotten all used to that tunnel and now it's not there. I should keep banking left until the diamond starts to move? (Yeah. You want to fly to your diamond. You're starting to sense it now.) There it is. (And your vertical the same way. And you want to take out the turn here going into runway 33. So you miss that tunnel huh?) Oh gosh yes. I want my green square back. I'll go with a nine. And with just a little bit more I probably would have been in the ground. (How do you think it would have ended up had you not had the coaching during the run?) Not good. I don't think it would have been very good at all. I'd have been flying around in circles. I know that much.

EBG30: *Running EBG30 as opposed to EBGFN30, because the computers kept locking up on that display concept. So, we went to EBG30 as a back-up.* I like that green box. I think I will with a three this time. Just because I'm getting more used to the box – the tunnel itself. And the more used to it I become, the easier it gets.

EBGFN3: Don't really care for the little white lines (fishnet). Really doesn't do much for me. (So they don't provide you any beneficial information at all?) I don't think so, no. (Do they detract?) Not really. Closer to the terrain, it's a little better. The fishnet doesn't really help me that much though. It's still more the shading that's a bigger clue to me what's going on. (Are you climbing for a reason?) Yeah, it looks like the ground's right here. *Was a little fast during descent, for about 10 seconds. 3:45, slowed his descent rate. 4:16 started climbing without saying anything.* (Can you see out the window? Your out the window.) Yeah. (The ground is right there. We played a trick on you on that one.) Evidently. It kept saying 5,000 feet and I'm like well, wait a minute now. (We failed your altimeter. You were actually 1,500 feet below what – it's showing you at 5,100 right now. You're actually 1,500 feet below that. And the only true information that you had was the terrain on your display.) That's why I was trying to pull up. I mean the ground looked like it was right there. I'm going to have to go with four. The information's there. Just – I don't know, seeing the ground that close on the display kind of – I don't know what I want to say here. It made my mind want to work just a little bit quicker, because it looked so close. (Did you see it on head-down before the out-the-window?) Well, you know I really can't tell you. I'd have to say I saw it on the head-down first because I was looking more at it than I was out the window.

Subject 27 (BRD Baseline):

Block 1, High Altitude:

BRD BL: All right. Going to do my left turn. Descending left turn. Looking for 050 and 8,000. Really descending. 8,000 is coming up. Things kind of got a little – started descending pretty quick there for a while and tried to correct on that, so kind of went out the window a little

bit. Other than that, yeah, trying to get familiarized with everything. (At the beginning you were about ten seconds too low and about ten seconds off your speed during your descent, but it wasn't enough to bring you out of the desired category, so you got a desired.) Well, based on desired being the key word that would go for the four. Number four. Pilot compensation needed a moderate amount to bring it back to different things kind of getting out of hand and I guess that would – I mean, based on that alone or based on the display characteristics as well? (Well actually it's a combination of that.) Okay. Yeah, because I mean as far as terrain awareness didn't really tell where things were. And it was just kind of based on, you know, known position prior and hoping that you were still within that out there.

EBGFN30: (Should be at your turn point.) All right. Oops. Reduce speed, descending. 050? (Correct.) 8,500. 8,000. *Software crashed before he got to his target altitude, so had to re-run.* Spent a lot of – trying to get reacquainted with everything there. Kind of got different things and – got my assigned altitude and the heading both. To be truthful I was spending a lot of time checking the other display and I think when I did go to check some of the field of view, that that's when I started kind of getting a little bit away, but now that I'm getting a little more refreshed here – (So currently you're concentrating enough on your symbology that you're not really noticing the terrain that much?) Right. Yeah, trying to maintain the headings and all that is keeping me pretty well busy. If I can get it all kind of squared up that'd give me a little more time so I could maintain it, but yeah, kind of the turbulence or what not keeps throwing everything off. Keeping an eye out for my turn point. Looks like it's still out there. Yep. Got no visibility, so, you know, we can keep an eye on here. (Should be there by now, for the turn.) All right. There it goes. All right, descending left turn here. Keep her turning. Keep her turning. Too much bank. All right, get the descent rate. Looking for 050. Rolling over to 50. Continue descent. For 8,000. Looking for 8,000. Still coming up. 050. Mountains down there. Bringing the power back in. Went through altitude a little bit. Bring it back over as I bring the power in. 050. Bank's squared off here a little bit. Yeah, you can kind of see the mountain range. That kind of gave you at least an awareness of where you were. I mean, seeing that was kind of like you didn't have the outside reference so, it kind of gave you the same feeling as kind of being there in a way. I mean you can look down and you had – you knew that you were at least at a safe altitude. And you had that comfort feeling. I mean that was kind of in the back of your head, I mean with the altimeter being what it was with the surrounding area, but you know that kind of put it all in perspective. I thinking number three on this one since it still took a fair amount of compensation on my part just to, you know, kind of keeping everything there. As far as the display, I mean it gave good rendering type thing, but I mean, wasn't the same as looking out the window, but I mean it at least gave me an awareness of what the terrain kind of looked like in a generic type of fashion. So I'd choose three for that reason.

EBGFN3: It's looking pretty good. I mean it's giving a little bit like a nice bright day view on there. Seems like a little more realistic. (At this altitude can you tell a difference between this display concept and the one you just flew? This being the medium resolution, the three-arc second, and the one you just flew was the 30-arc second, which is the lowest resolution.) From toggling through there, yeah, it just seems a little more definition, or a few more of the peaks and valleys to me. It's a little tighter mesh. All right. Looks like we're coming up on the turn here. And I'm going to start to turn. Come through 050 and descend to 8,000. 050. Nice view of the terrain out there it looks like. I just backed out a little bit to a different FOV just so I'm not fluctuating as much on the control here. (You made your turn with the unity field of view and this is the 30-degree field of view.) Now I got things in here stabilizing a little bit. Still keeping an eye out for altitude and heading, and it looks like we're following a ridge, so I'm going to kind of use that for a reference point rather than have to read the readout all the time. It keeps moving all the same though. That descent rate going. Now we need to arrest the descent rate and level

off to 8,000. Got that squared away I might kind of toggle through some of these. I can see a little bit more what's underneath me there. Looks like we're near terrain. (And can you compare the ridge that you're seeing now with the ridge that you saw in the last display?) It just seemed to see a little bit more of the associated valleys and stuff. I mean it's a little more detailed. A little more realistic. But I mean as far as a pro aspect, it still gave me an indication you knew you were still a fair amount of altitude. So I mean it wasn't critical I guess at that point in being able to see that, but it's nice to have if it's there. We're going to tend to put that one back at a three as well. I still felt like I needed to keep on top of things. I don't know if it was just because the scenario's – I mean, being that I had done similar that I was a little more – knew the numbers a little bit better, but as far as that display was a little more robust, but I mean it was – it didn't vary a whole lot from last time. It was just a little more tight display, but – so, go with a three with that.

EBGFN1: (Do you have any initial comments on this display concept? Looks like you're in the 90-degree field of view.) I went to that one to just kind of get an overall sense of what I could still see outside at that time, but just to kind of get an overall feel for what was out there knowing that it was going to deteriorate, and it just seems like need to be a little smoother on the controls a little bit or anticipate it from when I can initially see. I mean as far as the other displays, as far as the pitch and everything, so, but now I'm thinking I might move in not quite that much. Maybe a little bit out so that now that it's – can't see outside anymore that I want to keep things a little more tightly. (In terms of your symbology?) Yeah. Now it's moving just a little bit too much (at Unity), so I wanted to back out a little bit. – down there, but not too much. Keep it in the turn. Going for 050. Descent rate. Airspeed is – drop that down a little bit. 050 is coming around. Okay. Drop the nose a bit. Still trying to get everything squared away, so I'm not looking at the terrain a whole lot at this point. I know I went through a lot of my numbers here and kind of missed the mark on some of them, so going to try to get this a little bit better back on. Back out to scale here a little bit, then starting to come around a little bit. So maintain 050, bring it back – altitude back up just a tad. Get it back up to 8,000. Airspeed is still a little slow. Got a little more of the smaller hills seem to be popping up out of the ground and everything. I mean, I guess part of the thing is sometimes, you know, when looking at the terrain I'm sometimes adjusting the field of view just so that I can get the symbology on the screen that displays differently, so that I can kind of get the different sensitivity of the – like the attitude type thing. Pitch up, pitch down and all that. So it's gets a little more readable. Not necessarily because that I want to see the terrain, but rather that I want to get the sensitivity of the symbology. Haven't really locked in on anything yet, but I know initially starting off I kind of like a little bit further out. I don't know whether it's the 90 or maybe the 60 is kind of giving a more overall feel, then once the weather starts closing down bring it in. Not necessarily unity, but that seems to – sometimes I think I'm chasing a little too much, but maybe back out around 30. Kind of get things set up, and then once things are a little more stable then I kind of want to move in or – I mean if I want to look at the terrain, I would probably still be more around 30 or something like that just so I can see a little bit what's underneath me or around me. I mean I'd have to give that one probably a three as well just based on similar type thing. I mean the display was there, but awareness level was probably about the same except for I think I let things get a little bit out of hand. That I was cycling through a little bit. So for that I'm going to give it a three. (If I heard you correctly, you don't feel that this display is too much different from the display you just flew. Is that correct?) I mean it wasn't something at that point at that altitude that I was paying a considerable amount of attention to. I mean, when I had more time to do it then it became good, but I mean as far as otherwise it was – it didn't vary considerably from the other ones.

PR1: Like this display right now is kind of matching up with what we see outside, so – and at that field of view kind of seems to match pretty much what I'm seeing out there. (FOV60).

Yeah, the 90 seemed just a little too much, but the 60 seemed to be pretty well on. Changing to the 30 I believe just to get a little more control here. Going to go ahead with the turn. I changed the field of view a little bit just so I can try to tighten that up as far as my tolerances trying to get things a little more on. I might back it out a little bit there. Need a little more descent. Looking for about 050. We'll get that squared away. Bring that nose back down. Get that descent rate going. Bring the power down a little bit. That might help out. Down a little bit more. Back to 050. Far as right now with controllability I kind of like this setting of field of view. (FOV 30). I'm getting away from my target heading – I need 050. Got to get that back over there. Coming up on 8,000. Coming in with the power. Back to 050. Eight thousand. (What do you think of the terrain portrayal on the display?) With the photo realistic, feels like I'm kind of right there. See that we're safely above it and can probably even – I mean if you're familiar enough with the area you can probably navigate from it as far as picking out landmarks and stuff. As far as the terrain display, I mean was great. Super. As far as me fluctuating through the control or symbology of the – like the pitch and the velocity vector, that (symbology) remained constant, for me, but the other ones through now (terrain-wise) weren't as realistic, so because of that that still need to do different things, so being the combination between the two (constant symbology and better terrain) I would choose number two.

PRFN3: All right, as far as this terrain display right now it looks pretty much similar to the last one. I can't recall any difference, at least at this altitude. It all matches what we see outside. Okay, I'm getting ready to start the turn right about now. Oh, I passed my heading there a bit. Bit bouncy out there. All right, we want 050. A little descent. Add airspeed back in. Keeping it on this terrain thing right now until I kind of get stabilized a little bit. (At the target altitude, can you see the fishnet?) Yeah I can see it in the one direction, but I don't see it the other direction quite a lot right now. It doesn't add a whole lot right now with just that one direction like that. I can see that it kind of changes a bit, but it's not adding a whole lot at this point. The photo realistic is similar to the last one. I guess if I saw them side-by-side I would notice the difference, but as far as flying along in the background it wasn't real pronounced from at least that altitude. I believe this will be probably the same as the last one. A two. In that it was still pilot compensation needed to keep everything going. As far as display it seemed similar at least at that altitude. So for those reasons I'll go with two. As far as like the overlay of like the fishnet, I can only see it going in that one direction, and because of that I guess I couldn't really tell if it was going up and down or not, so at that point it really didn't add much for me on that.

CCFN30: Well, not a whole lot to see as far as display right now. I can see some rivers and stuff that seem to match up, or a road. (But as far as the terrain itself is concerned you don't really have much info from this display?) No. Kind of like it on this setting (FOV60). Not because of the terrain, but it seems to be for cruising about the best. Kind of like this field of view for making the turn. I can see a little bit of the fishnet when I back way out, otherwise don't see much. You can see that airport and towers pretty decent once you're in unity, near the airport it's pretty decent. As far as controlling the plane it's a little easier if I back it out a little bit. I can still see the airport from here though. That one did have the fishnet on it, but you know it seemed like when you're in closer, or on the other fields of view that I really couldn't see it as much. I think I'm going to go with a three with that one. Because the pilot input was still a fair amount as always. The display – I didn't get a whole lot of terrain information other than, like I say, pointing out the airport and the towers which, you know, those type of landmarks really stand out and knowing where the airport was added to the situation awareness and having an idea, so because of that I would go with 3.

EBG1: I feel like I've been there before. I mean with that one. But I guess minus the fishnet, but yeah, it's got a good terrain feel to it. And yeah, I can kind of orient myself looking out the

window and on here at the same time. Similar. Kind of fluctuating through some of the – kind of like that one for cruising. Sixty. Getting a little high, so I got to bring her down a little bit. The outside is gone (inaudible). Turn is coming up. Keeping an eye out for that. Get the altitude down just a little bit. And I'm going to go with the turn right about – about now. Kind of overshot my turn a little bit there. Got to keep that descent going. Back on 050. See the ridge in sight. See the airport off in the distance. And on that field of view (30) is kind of handy for controls, and I can see the ground all at the same time. Power coming up for 8,000. Got to get that airspeed back up there. Yeah I see the ridge back now a little bit. Still make out the airport way out in the distance. That airspeed back up there. (And how do you like the terrain portrayal itself?) Looks pretty good. I can make out pretty much what I need to see there as far as the ridge tops and airport off in the distance. Looks pretty good. And with the color code and everything seems to work out pretty well. I mean the mountains really stood out on that one with the green for the valley and kind of the brown for the mountain. (At the beginning you were a little high for over 20 seconds and during your descent you were too slow for a good 30 seconds.) I think I'll go with the five, because I liked the display. It really wasn't the display's fault; I think it was pretty much pilot error, so because of that mix there, pilot compensation was required.

CCFN1: I see the river down there. The river on the display. (How about the terrain itself, is it giving you any more information?) Not at this setting. I'll flip through a couple more. No, I'm not really getting anything too useful, at this altitude at least. (Do you see a difference between CCFN30 (flown two runs ago) and this?) No. Not at all. Coming up on the turn. I'm going to actually go to a different field of view (FOV30) to see if I can get the turn a little bit better. Well I'm going to go with that during the turn. And get that airspeed back up so I'll add a little power. Keeping the nose down. Still want the rate of descent to be in there. 050. Descent, bring that airspeed back in. Keeping it on this field of view I can see some features on the ground in the background there. For 8,000 got about 100 to go. Powering up. Bring her to 8,000. (Now can you find much of a difference between this display concept and the CCFN30?) Yeah, I can see the fishnet down there. Yeah, when I set it to 90. Yeah, you can start making it out a little bit, but I mean it's not enough to really tell specifically. Well, I can see the airport. I mean that's a good visual clue, but as far as the terrain I'm not getting, you know, a whole lot. But the feature display is nice to know. I can see some of the – like the towers down there. I didn't pick up a whole lot more additional terrain information from that than versus the other one. I mean the airport and the towers were good information, but as far as actually making out the lay of the land I didn't get that warm fuzzy feeling on it. I'm going to choose three for this one basically because of pilot workload. Still needed to keep aware of different things. The display was there and I could see the airports and the towers – good information. The terrain had some information that, like the 90 field of view you could see down there, but it still wasn't real robust. So for those reasons I would choose three.

PRFN30: Okay, there was or wasn't a fishnet with this terrain? (There is a fishnet.) There is? Okay. Yeah, I can't really seem to make it out at this initial altitude. (Any comments on the terrain itself in terms of it being the lowest resolution?) I mean it still looks pretty decent here. I mean being photo realistic I can compare it to what I see outside the window and it looks, you know, it looks good. I can orient myself and it's moving the same as what I see out there. It's kind of a good depiction of the real world. I mean it still has enough terrain information that I can tell where it's hilly and bouncy and bumpy. Ready for the turn, so going to a different field of view. Getting the power in there. Good rate of descent. Try not to over bank. Looking for 050. And here it comes. And here it went. Chasing it around. Keeping the nose down. I can see the fishnet once I back out there a little bit. I need to be in a little bit tighter for control at this point. Coming in with the power. For 8,000, 050. Get the airspeed to 100. *Software crashed towards the end of the run, so we re-ran it.* Heading for the turn here. I can see the fishnet down

there like you said. (How do you like the way that ridge is portrayed?) There, I can see it pretty good on that one. I think if I was down lower I'd be able to make it out a bit better possibly. I mean up here I can't say it's adding – I'm getting a whole lot from it. (Now you can see the airport?) Yep. And it almost looks like the fishnet's floating above it sometimes. I don't know if that's just an illusion from this height. It's not like it's really defining the terrain that much right there. I'm going to go with a number two on this one. Basically for the reasoning that it's still pilot compensation still needed to interact there. The display is good. Gives good awareness. I think on the fishnet I probably could have done without one there, so for that reasoning, the combination of the two, I'd probably go with a number two.

PRFN1: I was just saying that, yeah, it's got good outside display as previous. I was looking for the fishnet, and there I see it down there. I mean it's not adding a whole lot at this point from this altitude. I can only see it, it seems, in the 90 field of view. That's about where I really notice it. Once again I'm going with like the 30 field of view at cruise. That seems to work best for me for maintaining. (Well right here you're at the field of view of 60.) Oh, 60, okay. Well let's see. (That's 30.) That's 30. Okay, 60. I'm sorry. And coming up on the turn I want to go back in to 30 there. I tried Unity and I like that too. Either/or for the turn. (So just a clarification right now you are at the field of view of 30.) Yeah, that one's probably my favorite for the turns and descent as far as controllability. I mean that kind of nice toggling through the other displays just to get kind of situation awareness and what the terrain is and trying to see what that mesh looks like. (So now that you're a little bit closer in to the ground on this one, how do you like this display concept?) Looks pretty good. It seems like I still don't see the mesh unless I'm further out on the field of view. I really don't perceive it here. I mean it's so slight that it's not adding a whole lot. I can tell it's there, but not enough to really stand out. Maybe it's just me. It was similar to the previous one. It's another one of those that, unless I see them side-by-side I kind of get the same feel coming away from it. (When you say the previous one, you're talking about the 30-arc second one?) Right. I'm going to choose number two here for the reasons that just the pilot workload – pilot needed to do – still needed to be done. As far as the display, it's a good display. Looked good. I like it with the photo realistic. The fishnet, I mean it was there, but it added a little bit once you were down lower, but at the higher altitude it, didn't really add a whole lot for me. So I'm going to give it a two.

Block 2, Low Altitude:

EBGFN30: It's looking good so far. I mean, yeah it looks like it's got pretty good resolution on there. It's matching what I'm seeing outside looking out the window here. (Can you tell much of a difference between the flying characteristics between the higher and the lower altitude run?) Yeah, it seems a little tighter. A little more responsive. Yeah, I can feel that. Right. Okay, getting ready for the turn coming up here. Descending to 40 – to 5,000. Looking for a roll out at 050. Keeping the descent rate going. Yeah, I can definitely tell we are lower down here. Thing feels a little more solid, or more responsive. Coming up on 5,000. (Now that you're even closer to the ground, how do you like that terrain display?) Yeah, it seems like now if I back off a little bit I can see more of the mesh than I did before. It adds to it. At the same time depending on the colors sometimes if you lose that cross-directional thing, if you just get the one direction, for me it doesn't give the true flavor of the height unless I can see where they intersect or whether it's kind of angled up or down. Based on those choices I'm going to go with three. Pilot performance – I don't know if it was because the lowered altitude. It felt a little bit different there. But the display was decent. The mesh-net – I guess if I could see both directions instead of sometimes just seeing the one. The lines running parallel one direction kind of brought it down a little bit, so a combination of factors make it a three.

CCFN30: I can see mesh when we're all the way out, but as far as getting any kind of real awareness of the ground – other than seeing the river, that's about it. Got it set for the 30 field of view since the turn's coming up. Trying to control it a little bit better. All right, getting altitude down. Getting ready for the turn, and turning now. And a little bit of the terrain is showing up. I see some towers down there. Keep the descent rate going. Still not picking up anything within 2,000 feet on the MX20. *Software crashed in the middle of this run, so had to re-run.* Coming up on the turn. And turning now. We have towers down there. Green's coming in. I mean the green on the MX20. Getting some kind of crosswind or something. It feels like it. Like we're drifting off. (That may just be your turbulence.) Ah, that's probably it. Well, we're kind of right down there on it. I can see outside the window – saw some towers or something right outside. (And what do you think of this terrain now that you're a little bit closer to it? Can you find the ridge?) I can see one off in the distance, but as far as being beneath me I can't really make it out. I can see the airport off in the distance. (And are you still preferring the 30-degree field of view?) Yeah, once it's smoothed out a little bit. Yeah, it seems like I can back it out a little bit then, but I mean this feels a little bit smoother right here. I mean before it's turbulence and stuff. Now I see some tower outside. I thought I would have seen a little bit more terrain on there (MX20). I thought we were closer than that, but we're not. I think I'll have to go with a four on that one. Basically just kind of a gut feeling on it. The way I kind of felt flying it. The display, you could see a little bit but it wasn't a whole lot other than the landmarks which were the helpful things. The terrain wasn't necessarily obvious to me as far as the ridge we were flying over, so for those reasons I'll go with the four.

EBG1: Looks like we've got a nice view outside that matches up as far as mountains. I mean you can tell where the valleys and the mountains are. I can see that kind of valley straight ahead of us. It's kind of off to the right a little bit versus the mountains there. So yeah, that's – orient ourselves that way. I mean I'm not making out any landmarks as far as that or anything. I can make out the ridge down there below. (Do you think the terrain is giving you some good information?) From here, yeah. It's making it out pretty clear. I can see that tower straight ahead of us there. Right down below us. (Are you talking about out-the-window or on your head-down display?) Well I saw it on the heads-up display (OTW) first. Actually now I see it right there on the screen in front of me. I guess I better add some power here. 5,000; I went through that, so gain us back a little altitude. Yeah, that one right there I can see the towers up there real plain on the SVS display. This is a lot more distinct (than the previous one). I think the color really does it. Makes it stand out more, and with the resolution and everything, the towers were real pronounced against that. I'm going to go with a two on that one. It felt pretty good with that one. And having seen the towers on the screen, or on the display here even before seeing them on the OTW screen kind of gave a comfortable feeling and confidence in that's what was being depicted as far as the terrain. So with that I'm going to go with a two.

EBGFN3: Okay, there was a fishnet on this one? (Yes, there is.) Yeah, there I'm seeing it now in the green a little bit. (Can you tell a difference between this and the previous display?) A slight bit. I mean the terrain information is still there, so from what I'm seeing right here, I mean it lines up pretty well. I mean not a super amount of difference. And I don't really see the mesh enough to really make a sizeable difference right now. Getting ready for the turn, so moving into the different field of view. And doing the turn about now. Well, I can see the ridgeline down there. Need to get the rate of descent down. Need a little airspeed. I can see the towers down there. The mesh was a lot more noticeable down here at this level. It's a lot more of a help than like when we did the high altitude ones and, I mean, starting to get more of a feel for that. Kind of an added bonus I guess. (So you do find that the fishnet's giving you some added information at the lower altitude?) Yes, if we get a little bit here and there, especially the close up part you can kind of get a feel for it. I think I'll go with a three on that one. I could see the terrain pretty

well. I mean it wasn't as robust as some, but the mesh in this case seemed to help me out. So I'm going to go with a three. (What type of information were you using the FN for?) I guess initially, as we were still descending towards the towers and stuff, you could see kind of the fold in the mountains. It wasn't critical, it just seemed give a little tidbit of information there. Because it actually looked like a mesh at that point. I mean as opposed to when I'd seen it before a lot of times it was more or less kind of parallel lines without the opposing, intersecting lines. (It kind of helped define the terrain a touch more?) Yeah, once I was down low enough to kind of get a feel to it.

BRD BL: Time for the turn. Coming up on 5,000. Try to keep heading. See the MX20, so 2,000 feet so -- we got some green showing there. Off my heading a little bit. All right. I see some outside reference there. I was just getting comfortable with the SVS. This seems like a step backwards towards being sub par, but kind of familiar to what the old style is. But yeah, you don't have any outside or feel for like outside. You just feel like you're flying blind, but you really are in the clouds so all you've got to go on is seeing the green over there, which tells you you've got 2,000 feet clearance, but at the same time you don't know till you look outside and see something like that. (Did you find that you were depending on the MX20 more for some information on this one?) Yeah, in this case that was, besides the altimeter, which gives you an altitude, but at the same time you don't know if you drifted off course. And in this case the MX20 was the only thing otherwise that could reliably tell you how close you are to the terrain below, so that was an indicator there that there was at least some clearance according to that. But it wasn't the same. That situation or having a knowledge of where we were. I mean it was kind of like with the SVS that was almost like having goggles that see through the fog or something. You can actually see the ground and kind of almost navigate according to what you see on the ground. Kind of like seeing the towers and all that even though you knew they weren't outside your view on the terrain out here, you could see them on the cockpit display. (When you were talking about the MX20 I think you mentioned something about 2,000 feet of clearance when there is green.) Right. (I just wanted to make sure that you understood that green means that it's between 500 feet and 2,000.) Okay. So it isn't necessarily 2,000? It's between that, right? So at minimum, it could be 500ft. Right? Okay, that makes sense. (As soon as it crosses into the 500 range it will turn yellow.) Okay. Now I can see in that profile picture in my mind now and the red is at or above everything. So yeah, I gave myself a false sense of security there. (But green is still good.) Not by much though is it? I thought those towers looked awfully close. This display is obviously lacking. I mean the MX20, is good to have, but as I've just demonstrated that isn't always the key I guess. But so yeah, I'd have to go with the fourth of our choices for that one.

PRFN3: I think looking at the display is better than outside. It's like a day without fog in there. So, yeah, it's looking nice. As far as the mesh, I can see it back on like the FOV 90. I can't really tell if it's lumpity-bumpity or what. I mean it doesn't really portray the relief that much. (It looks like you've gone back to the field of view of 60. At least on this run.) Yeah, I've been kind of trying that one out too. Once I kind of get used to the controls a little bit then I can kind of do it from out here, rather than not need the sensitivity of the closer in view, but I still like that one too. Especially going into turns and descents and things like that. Bumping up on the turn. Doing the turn, so went out to the 30 field of view. Coming up on 050. Keep the descent going. Bring the power back a little bit. Rate of descent down. Needle's looking okay. I see the FN is displaying against the green. It shows up pretty good there. (Do you feel like it's giving you some beneficial information?) In this case. Once I back out a little bit, because the green kind of blends together otherwise. So in this case it seems to give you a little bit of feel. I mean off to the left there I can kind of see that it's climbing to the ridge that we're kind of centered over here. And right in this case too it looks like. Yeah, like in this case I can see the ridge right underneath us there. Kind of see it dropping off. (What about the towers and the visibility of the towers, that

type of thing?) I don't see them at all to tell the truth. I don't see them here. I mean the mesh colors showed up good against the green there. Sometimes it's helpful and sometimes you can see like a river or something and you can tell the lines are kind of going over it, so I don't know if it's misleading in that case or not. I mean it's kind of a generalized mesh. In this case it seems like the photo realistic is more realistic than what the DEM was. I'm going to go with two on this one. The display was really good. My performance was not all that good. I was off the mark coming in over the ridge there, but, the display, everything looked good. Really good. So that really brings it up, so I'm going to go with a two.

PRFN30: Oh yeah, it looks like you lose a little resolution on there, but you can still make out the valleys and orient yourself here pretty well. As far as terrain it's a little harder to see from here. I don't know if that's just because we're at altitude or what. (And how are you doing on scrolling through the fields of view? It looks like you keep coming back to the 60.) Yeah, the cruise portion up here it kind of gives me a good feel for what I'm seeing outside. It kind of matches best what I'm seeing right now, so I think that's why I'm kind of gravitating to it at this point at least. And at the 90 it kind of brings it back out. You start seeing a little bit down, beneath you, but I can't really see it at this point outside. Then that one, it's just too sensitive and at this point, at unity. And I don't really need that 30 quite yet, because that's still kind of sensitive at least from the controllability standpoint. Yeah, 60 seems to work right there. Getting ready for the turn so I'm flipping to 30, and bringing down power. Adding a little bit more power. Keep the turn going. Looking for 050. Seeing some fishnet down there. That was good. I can see the ridgeline right there. I can see the tower and see both the display outside and right there. Like right there all I'm seeing is the parallel lines. I'm not seeing the cross ones. It looks better than 30 DEM to me. I don't know. It seems to be a pretty good resolution there. It all looked pretty good on there. Again, I was seeing the tower and that was a helpful thing. Seeing a feature and orientation, and seeing them both outside and in here gave you like that ground truth that you knew where you were at that point. This one I'd go with a two. The display on the screen looked really good. And got that good feeling when I matched up the tower both in here and out there, and with the photo realistic, even at the straight and level heading you could make out the valleys and orient yourself real well there and kind of get a feel for it. Once you were down low you could make out everything pretty good. Even the FN, except towards the end, where I just saw the parallel lines, so at that point the FN was of no assistance. And so for those reasons I'd go with a two.

CCFN1: I'm not getting a whole lot of feel for the terrain readout at this point toggling through the displays. Other than making out the river and navigation features. But terrain, not a real feel for what it's doing down there. (Can you compare this to the standard gauges – the round dials?) Oh, this is still much better. I mean you can still at least look at the fishnet and get an idea of what's down there and which way things are. You can see the river valley and you can see the river and you can tell the terrain's moving up from that. Come in a little bit earlier on the turn here. See if I can get on the ridge. I can see the towers down there. See some mesh but I can't really make out what the fishnet is doing there. You can tell it's kind of up and down, but overall you can't get a feel for what's there at least at this point. Now that I'm a little closer in, like with this field of view – oops. Better keep the power up or I'll come down and see it real close. Yeah, I see some towers over there, both outside and on here. (How about the definition of the ridge?) Not real pronounced. I don't really see it. (But you see where it should be in relationship? Because you by now you should recognize the towers which are sort of on the ridge.) Right. Due to that. But to just pull it from the terrain without the other identifying features – I wouldn't really be able to identify it. It wasn't really distinctive where the ridge was without the associated features to get clues. I'm going to have to go with a four on that one. I got a little low at the end, I guess looking at the terrain, or rather the fishnet, it didn't portray it quite robust enough to really

clue me in as far as the ridge. I mean there was an awareness but not that level of awareness and so for those reasons I'll go with a four.

PR1: It looks pretty nice and crisp. I mean it's almost like a mirror image of what I'm seeing out the window here. As far as the view of the terrain, I mean it's – you can't really tell how high anything is for that matter, but you can tell that there's relief down there. Coming up on the turn. I'm going to try it with unity on this one. See if I can get a little more sensitivity. A little more crisp on it. Power's coming off. Descending left turn. Yeah, nice display out the window. I feel like I'm flying right over the area. Just looking at the display just seems like I'm flying looking right out the window it's so nice and clear. I mean as far as the view it just looks real crisp. Roll on out on 050. I can see the ridge and the towers. Yeah, I can see the valleys and stuff just from the kind of the shadowing effects. You can see the valleys and the ridges there. And I went through my altitude. I was too busy looking around. Such a nice view. I see a tower's right there. I see one outside. Yeah, that one feels pretty nice. As far as the fields of view, sometimes, that minification makes things seem further away than what they are. Just kind of like seeing that tower from a different view and, if I was at 90 it would make it seem like it was actually further away than what it was in reality seeing it out the window, so I guess that's sometimes why I gravitate more towards the 60 or the 30 just for that – it minimizes that effect. But I mean the 90 is kind of like to me to get overview or kind of a situational-type thing overall picture and then to come back. You know, to use it as a piece of information and then come back in tighter. Plus controls become a little bit more sensitive where I can track it better, since I can't see outside looking on there. The display was excellent. I kind of busted altitude just because I guess I was admiring the view out the window, but other than that, I mean I had great situational awareness. I mean looking at the screen was basically like looking outside and having everything right there. It was great. So I'm going with two basically just because kind of my performance wasn't quite what I wanted it to be. Having all the information I had there it should have been better. So with that I'm going to give it a two. Not because of the display, but basically more for my performance or lack thereof.

PRFN1: I've got a good visual reference as far as the navigation and stuff. The fishnet at this point –I can see it plainly. As far as the information that it's adding isn't real obvious at this point. I mean I can tell it's there, but we're not picking up a lot of added information. Yeah, as we get closer to the mountains down there, yeah, it becomes a little more pronounced. I'm seeing the fishnet on it. Coming up on our turn. I'm going with the 30 field of view. I can see the fishnet down there. I see the towers and ridge. (Can you see the fishnet now at this altitude?) Yeah. (Do you feel it's giving you some good information, or is it just kind of there?) Yeah, I'm just surprised that I don't see it like when we're in like a unity. You can see it, but it's lighter. And it seems like you have to back out to really get a feel for it sometimes. You know, like right there I'm just seeing the parallel lines once again and not the crosssecting ones. So, I mean it's not real value-adding at that point. I guess that's kind of a wishy-washy answer. Sometimes it looks good and sometimes I don't get anything from it. I guess it doesn't hurt to have it there. I could probably do without it. If you've got that good of resolution scene to look at that – I mean if I can see the shadow like in those ridges well enough. Sometimes, it's not so pronounced or sometimes it's more clutter than it is helpful I guess. Again, with the fishnet, sometimes I'm not getting anything additional from it. Especially when it's like the parallel lines without the crosshatch to it. And I guess it was too just kind of downgraded because my turns weren't exactly where they should be. But other than that the view on the screen looked fine. So I'm going to pick a two.

EBGFN1: Yeah, definitely a difference from the last one. You don't have the instantaneous recognition looking at the screen as you would before, but I mean it's still recognizable. It's just

in comparison between the two. I mean you can still orient yourself from the valley and the mountains that you see down there and on the display. Seeing very little mesh at this point, except for way back. (So, do you find the photo realistic a little more intuitive than this one it?) Yeah. Definitely. I mean as far as if it's just terrain type of thing, but if you're looking at it from both the navigation and situational type thing then in that case, yeah, it's more intuitive and you can gain additional information from it (the PR). But as far as just avoiding terrain or knowing where that is, you can actually probably view the terrain relief as well or better with kind of the shading that's on here. Got the turn coming up, so move in to the 30 field of view. Going to turn a little bit early this time. And going to turn about now. Okay, I see the ridge there. Okay, I can make out the ridge pretty good on that. And the FN is helpful in this case because I'm seeing both the crosshatch and the – I mean I can see in all the different flavors. Right there in the foreground especially I guess it kind of fades as it goes back. Yeah, I see the towers there. Now that we got our orientation I can see the airport straight ahead. If I'm oriented towards that I can just turn and navigate towards that. I kind of liked that display too. With the photo realistic you kind of get the added navigational type thing, if you're a VFR pilot like myself, which is nice to have as far as terrain. The way these colors shade on there is making out the relief pretty close to what you see on a photo realistic. So there are advantages to both I guess. I mean as far as – as far as me looking at it. I think I'd prefer photo realistic just because it's just like being there, but this would be my second choice here. I'm going to choose a number two for that one. Like I say, great terrain. I could see what was happening down there. You know, the mesh was helpful in some of the instances. It kind of added to the coloration there. I kind of went through some of the altitudes, so with that on the pilot part, but as far as the displays all looked pretty decent. I could see the towers and the runway off out in the distance. That had good navigational-type qualities too, so with those reasonings I'm going with a two.

Block 3, Approach:

PR1: *No comments during the run.* (Do you have any questions?) Well, you know, it's interesting. I was trying to keep the tunnels in there trying to toggle through the different field of views to see which one kind of gives the best feel. It seemed like initially there when I went out to the 90 that things seemed to happen a little bit slower. And so I was kind of gravitating towards that for a while. (Did you have enough time to look at the terrain or were you mostly concentrating on the symbology for this one?) I was concentrating more on the symbology to be truthful. (I just want to mention that at the end you were a little high. Your diamond was down in this area. And your three-degree glide slope line was a little bit past the aiming point.) Oh it was? Okay. All right, so our aim point should be a little bit lower as far as the glide slope line? (Your aiming point should be the second tick mark past the threshold and I think you were on the fourth.) Okay. I think I'm going to go with a three on this one. For the reasoning that the display was good and with the tunnels and everything there was a lot of information. What probably brought it down some was just piloting error. But the display that we saw on the monitor here was fine. So for those reasonings I'm going with a three.

EBGFN3: (Do you have a chance to look at this terrain concept while you're flying?) Kind of glanced out of the corner of my eye there. I mean I'm still primarily concerned with keeping it in the tunnels, but I can see like the fishnet down there kind of in the background. I do have a basic understanding of what the terrain's doing down there. I'd like to toggle through some of the different FOVs, but I fell like I'm most comfortable with this field of view right now as far as kind of the rate of the tunnels as they approach and kind of being able to see them off in the distance a little bit. This one's pretty good too there, with the 90. (If you decide that you like one or the other better, please let me know. Right now you're in the 90-degree field of view. You started your turn with the 60-degree field of view.) I'll toggle through them once again. I'll stay on this one a little bit. It's kind of comfortable right there. Seems to be at a comfortable rate at

least at this flight setting. I got a view of the runway there. Try to put it there towards this end. Yeah, a little more comfortable with a closer-in field of view at this point. (You're at the 30-degree field of view.) (Can you see the ridge beyond the runway? Do you think it gives you enough information that if you had to do a go-around that you could?) Oh, definitely. It's still staying pretty busy with the tunnels and everything, by looking at the terrain there's good representation there that there'd have been enough information to kind of know the lay of the land. You could see where the ridges were. I believe I'm going to go with a three with this one as well. The terrain was sufficient to see and do things by and get an awareness of where we were and where the ridges were. I still wasn't on the marks that I wanted to be, so a combination of the two makes it a three for me.

EBGFN30: At some of the different settings, I can see the ridges and everything out in the background. Other than that I'm still kind of primarily keeping an eye on the tunnels. And I'm kind of getting off track here. But like the 60 and 90 seem to work better out here giving smaller targets to aim for. So kind of gravitating towards them out here. With this view, the fishnet just kind of looks more matted. It does kind of conflict with the road. The fishnet is pretty apparent here but doesn't really give a whole lot of terrain relief information. I can kind of still tell from the coloration that there's some relief down there, but the fishnet doesn't really portray that as much as just seeing it from the shading of the colors. I can see the airport down at the end of the tunnel down there. (And how about that ridge at the end of the runway?) I can still see it. It's not quite as distinct and robust as last time, but I think I'd have suitable information for avoiding it. I think I like the 30 field of view on the approach part here. I can pick out the airport a little bit better. The boxes seem to be pretty decent speed and size-wise. I felt a little more comfortable as far as the piloting. The fishnet conflicted with the road a little, it seemed to be about the same color for the most part. You could still make them out since they weren't running the same direction, so I guess that was okay as far as that, but because I wasn't really getting a whole lot of additional information from the fishnet. I mean against the green it showed up real nice, but it just looked flatter than what looking at the background display. You could almost see that there was shading so you knew there was some relief there, but the fishnet was spaced widely enough that it wasn't really picking it up and it just looked more or less flat at that point.

CCFN30: As far as terrain goes, I'm not seeing too much down there. I mean you can see the fishnet, but as far as any kind of relief at all you can just kind of tell it's down here. Wouldn't be able to make out whether it's mountains or flat or anything. (It looks like you switched to 90-degree field of view. Is that what you feel you're more comfortable with at this point, or is it still a tossup between the 60 and the 90?) Kind of between 60 and 90. Toggle back through that once. Yeah, between 60 and 90 kind of varies. I think the 90 because it seems to have two more boxes, and they're like smaller so it gives you a more precise, or smaller, thing to kind of aim for. So sometimes I think I'm gravitating towards 90 for that reason. Now for some reason right here seeing 30 seems a little more comfortable because you can tell a little bit more than what the boxes are trying to do at that point. Where they're kind of going down. Yeah, I can see the airport way down at the end of the tunnel. I don't see any ridge information or anything with this terrain display like we saw with the other one. (Are you speaking of the ridge beyond the airport?) Right. The ridge beyond the airport. I could see like the tower and stuff that was down there. Okay. Kind of like this view. It seems like there's more boxes, but I can't quite see the airport quite as well. So it kind of gives me an aiming point when I'm at either unity or at 30. Now I can see the end of the runway I kind of prefer it at this. I can see a little bit of the terrain relief in the background. Enough to tell that it's got a rise in the back, but, not enough to know that it's obvious that it's a real mountain or something like that. (Okay, so if you ran into a little bit of trouble and had to do a go-around on this one, you'd feel a bit less comfortable?) Right. You could tell that there was something there, but you wouldn't know that it's as big as what it is,

or it wasn't as obvious or intuitive. I believe I'm going to choose three for this one as well. Everything felt pretty good down the approach path. The display left something to be desired in comparison to the other ones, but there's at least something there. But it's not a whole lot to go on as far as that, so that brings it down, so with that I would choose a three.

PRFN30: I was trying to get oriented with the tunnels there, and I'm taking a look there and it looks like pretty – from what I can see out the window and see in here match up pretty well. The fishnet is kind of like before. I'm not getting a lot of new additional information at least at this point right here. Like I say, I'm still kind of more or less paying attention to the tunnels right here. Well I can say when you change field of views it kind of throws you off. Sometimes it's easier to stay on one that you're comfortable with. It kind of like seems like in cruise here at least that the 90 seems to be working pretty good just because it seems like I have more boxes and they're smaller, and it's kind of easier to stay oriented. It seems like at least in the past runs that once it kind of comes down for the approach I like going more towards like a 30, so I can kind of see the end of the runway and have an aiming point there. (When you get closer in?) Right. (How do you like that ridge beyond the RWY?) It's more intuitive and obvious on this one at least. It just seems to fit in there, kind of looks more like a mountain. And I don't see a fishnet or anything on it back there, but like I say I think it only displays in the foreground. You could make out that there was a pronounced ridge of some sort there. I'm going to go with a two on this one. I think it was kind of the contrast with the last one, but it just gave a little bit more out there to be seen. Felt pretty good on a different approach looking down the tunnel and everything. So for those reasons I'll be choosing a two.

CCFN30NT: Yeah, I think I can see the airport off in the distance. That's a helpful visual cue. I'll try to keep it up at altitude until outer marker. Try to get back on course here. (Do you miss the tunnel?) Sure do. I would like to have it back. Well that's the Unity field of view so I can see the airport a little bit better. That does give me a little clearer picture on that one. As far as terrain, I got a little bit back there, but not real pronounced. You could just tell that there is some rise off in the distance. But, I wanted to go to that unity there without any other kind of tunnel or references – something that gave me something to shoot for – something to aim for. So I think I kind of went towards that for that reason. Well, I'd have to go with a four on that one. And I missed not having those tunnels around. Workload increased because of it, and you just kind of feel sloppier, just kind of searching a lot of times until you kind of get a clue of where you are or get a real precise fix on kind of a navigation point. Kind of keeps you on track a little bit more that way. As far as the display, there's a little bit of terrain there. Not real pronounced, so I would go with the four for those reasons.

CCFN1: I like seeing the tunnels again. As far as terrain, it's a little more pronounced. I can tell there's a little ridge underneath us. You could tell it's there, but as far as a real intuitive perception I can't quite get all that from it, but you can tell at a glance there's something down there. And I'm still kind of liking the 90 I think at this point. It just seems to be a few more boxes and little easier to follow that way. (Can you tell a difference in that ridge with the different resolutions?) I see additional features. I don't recall having seen like those buildings or something off to the right of the airport. (The buildings were in the last one.) Oh were they? Okay. And as far as the ridge, at this point I can't really see a difference. It is obvious that there's something there, but as far as level of detail I can't get an appreciable difference from last time at this point at least. My piloting wasn't as good as I would have liked. So the combination of factors makes it a three for me.

EBG1: It's matching what I see outside pretty decent. It's kind of got an intuitive feel to it. Showing the lay of the land pretty good. I can't make out any roads or features. I don't know if

there are any in there, but I don't see any at this point. (That's correct: there aren't any at this point.) I can see some features out there now at this setting. (Can you see the ridge beyond the airport right now?) Oh yeah. Yeah that's a lot more intuitive. The color contrast makes it stand out. Gives you the impression that it's much higher than you are. And, you would know if you had to go around to either avoid that or do serious climbing to get over it. I guess didn't see those buildings quite as well with the color combination there, so I guess maybe that's why I had seen them on the other one, but I mean that wasn't as critical as seeing the mountains in the background. And still paying a lot of attention to the tunnels and stuff like that, so – I'd choose a number two for that one. And the terrain seemed pretty robust and with the roads and the rivers showed up pretty good. The buildings I couldn't see real well, but they were able to be seen and the color contrast with the mountains in the background gave the impression of height. So I felt pretty good on that one, so go with a two.

BRD BL: Bring back the tunnels. *No comments during actual run.* Wow. Wow. That was a challenge. Couldn't get myself back on that glide path. Couldn't get it. (Because of the trouble you had with the glide slope and you also had a little bit of trouble with the localizer.) Right. I think I'm going to choose a number six for that one. My performance was way down, but that was basically me. I mean it was doable with the display as it was, it just required a lot more effort and concentration and just didn't have the same type of awareness as what we had before. Just kind of trying to figure out where you were or just kind of that unknown feeling in the back of your mind the whole time. So I'm going to go with six for those different reasons. (Did you use your MX20 at all for help your flight path?) Yeah, basically when it came time for the turn on the approach, it that was my reference there. Then kind of judging distance coming up on the outer marker. Then yeah, I probably should refer back more to it there to see if I was off there. Then I was trying to get the glide path going and I couldn't quite get that thing squared away, so that was taking up a lot of my time and attention on that. That was a new experience there. (You did okay for a VFR guy on that last one. You would have gotten to the runway. Don't you agree?) When I could finally see it. (So, it got you to the environment.) Right.

PRFN3: I've got a nice view from both outside and inside. They match up pretty well here. (Does the fishnet do anything for you?) No. (Are you just experimenting with the field of view?) Pretty much. Just kind of flipping through there and seeing if there's anything new or different from what I experienced before. At least for my comfort level, I kind of gravitate towards the 90 here at the cruise. Just the rate of the boxes coming out and that this seems to, for me, be able to stay a little bit more on track at the rate that they're coming and the size of the boxes and with the background proximity you can kind of see a little bit below me and just kind of anticipate what's coming up a little bit more this way. *Software crashed in the middle of the run, so had to re-run. Software crashed in the middle of the second run. Didn't run again, due to learning affects.* (Can you see the mountain range beyond there? Maybe you can make some comments about the terrain itself?) It looks pretty intuitive and very realistic there. From that you can kind of put in perspective to the other features that you see around there and kind of get a feel for that it's a sizeable height. I mean I don't see a fishnet, but you can still from the shadowing get the impression that it's got some sizeable height to it. I'm going to go with a number two on that one. The photo realistic really helps out. You can get a – everything's kind of intuitive because it's, you know, you get the feel like you're actually seeing the ground there and kind of make out the different terrain effects. And kind of using the other features in conjunction; being able to see kind of the towns and stuff a little bit, or the coloration of that.

PRFN1: A little better resolution on the picture quality. The fishnet looks pretty good like it's kind of hitting some of the peaks and valleys right there. That's just that particular area. But yeah, you can pick out things pretty decent. *Software crashed in the middle of the run, so had to*

re-run. (Can you see the ridge beyond the runway on this one?) Yeah. (Describe it a little bit maybe in comparison to the one that you flew, the photo realistic fishnet with the three-arc second. Can you tell much of a difference?) From out here? Not really. I can see the fishnet overlaying it a little bit from right here, but it's not real pronounced from right here. From a distance here I don't really note a big difference. I mean I liked the display. I guess if I was going to give one of them a one, this would probably be the one. But I see that the pilot compensation doesn't differ between number one and two, so as far as display characteristics the determining thing here is what we see on the display and that one was, I think, the best of what I've probably seen or experienced, so because of that I would give it a one.

EBGFN1: It seems pretty good, but after the last one, the photo realistic, you could place yourself at least when you're looking outside easier. But yeah, this is still decent. Yeah the fishnet seems to work pretty good right here in this environment that we're in the mountains. I can see it having its effect right there. Like this ridge coming up is real pronounced with the color shading. Different levels. Yeah, nice view of the ridge and the roads down there. (So you feel you have enough information to make a maneuver if you needed to surpass the runway I guess?) Oh yeah, that would be quite sufficient. (Are you getting the roads confused with the fishnet or not? No. Not in this case. Not here. I would say that one seemed pretty suitable too. I mean you get a real good terrain and situational awareness. And the roads showed up pretty decent. I don't know if it was just that angle or it seems a little thicker maybe now that we're down lower or something that they showed up okay back there with the fishnet combination. I'm going to choose a number two for this one. It was a good display and everything. I guess the only thing kept it from being higher is that the photo realistic to me just felt more intuitive, but this with the resolution on it and everything – the resolution seemed decent, and the color scheme and everything and the other features like the roads were viewable, so for those reasons I would go with a number two.

Rare Event:

Was supposed to be PRFN3, but locked up as we were trying to load it. Had to reboot. Then lost mouse/keyboard control from both SVSHD positions. Rebooted five times, total, at minimum. Ended up running PR3 instead, and that seemed to work.

PR3: It looks quite suitable. It looks good. It's looking like what I see out the window here. And I've got a good feel for what's going on. I don't see it (the FN) and I'm not really missing it at this point. I mean, at least in this area with the terrain looking the way it does. Where you can make out the dark areas as the valleys and the greener areas on the hills. The shading kind of makes sense on this. It just looks realistic. It looks like what we see out the window. You kind of see the modeling effect of the valleys being darkened and the green for the top of the hills. And yeah, it just looks like a picture of the ground. (You kept it in the 30-degree field of view during that turn?) Yeah. Looks like I'm heading right into some mountain. (And what would you do in a real airplane?) I'd power up and I'd pitch up and I'd fly out of here. Or I might turn back to the left rather than heading straight towards it. One of the two. Well, that's a good test. That makes sense. Because I was looking on there and was like, wait, that sure looks like I'm heading right into it, but it looks similar because it has the towers on there and everything. It looks like I'm running right into it. I had plenty of info to do what I needed to do. It save me from running into the mountain.

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14. ABSTRACT The Terrain Portrayal for Head-Down Displays (TP-HDD) simulation experiment addressed multiple objectives involving twelve display concepts (two baseline concepts without terrain and ten synthetic vision system (SVS) variations), four evaluation maneuvers (two en route and one approach maneuver, plus a rare-event scenario), and three pilot group classifications. The TP-HDD SVS simulation was conducted in the NASA Langley Research Center's (LaRC's) General Aviation WorkStation (GAWS) facility. The results from this simulation establish the relationship between terrain portrayal fidelity and pilot situation awareness, workload, stress, and performance and are published in the NASA TP entitled Terrain Portrayal for Synthetic Vision Systems Head-Down Displays Evaluation Results. This is a collection of pilot comments during each run of the TP-HDD simulation experiment. These comments are not the full transcripts, but a condensed version where only the salient remarks that applied to the scenario, the maneuver, or the actual research itself were compiled.						
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