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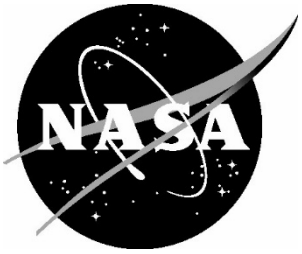

Flight Simulation Scenarios for Commercial Pilot Training and Crew State Monitoring

James R. Comstock, Jr., Lawrence J. Prinzel, Angela R. Harrivel,
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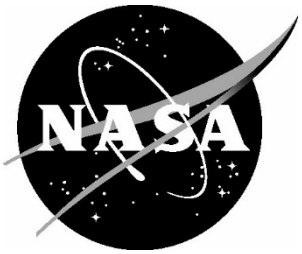

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Acronyms

AHPLS	Attention-related Human Performance Limiting States
ATC	Air Traffic Control
CAST	Commercial Aviation Safety Team
CSM	Crew State Monitoring
EFB	Electronic Flight Bag
EICAS	Engine Indicating and Crew Alerting System
FAA	Federal Aviation Administration
FMC	Flight Management Computer
F.O.	First Officer
KMEM	Memphis, TN Airport Identifier
LaRC	Langley Research Center
LOFT	Line Oriented Flight Training
LOS	Line Oriented Simulation
MCP	Mode Control Panel
MSL	Mean Sea Level
NOTECH	Non-Technical Skills
ND	Navigation Display
nmi	Nautical miles
OTW	Out The Window
PFD	Primary Flight Display
PM	Pilot Monitoring
SE	Safety Enhancement
SHARP	Scenarios for Human Attention Restoration Using Psychophysiology
SPOT	Special Purpose Operational Training
TCAS	Traffic Alert and Collision Avoidance System

Abstract

NASA Langley researchers addressed the Commercial Aviation Safety Team Safety Enhancement 211 through a series of studies to address "Attention-related Human Performance Limiting States" which include channelized attention, diverted attention, startle/surprise, and confirmation bias. The present report focuses on the development of improved training scenarios for operationally realistic Line-Oriented Flight Training scenarios. Areas addressed in the report include: (1) Highlights of events in the LOFT scenario used; (2) Interesting findings with implications for simulator motion; (3) Eye-tracking heat maps in proximity to failure events; (4) Researcher observations of crews as test subjects versus a pilot and a research team co-pilot; and (5) The results of a follow-up questionnaire completed by pilot participants regarding their usual training as well as the scenarios employed in the SHARP studies. These pilot ratings and comments are of value to simulation training developers.

Background

The Commercial Aviation Safety Team (CAST) analyzed international airplane accidents between 2001 and 2010. Of these accidents, 18 were attributed to loss of control inflight, and distraction was identified as common across all 18 accidents. CAST identified a number of Safety Enhancements to address issues common to these accidents (Cast, 2014).

NASA Langley researchers addressed the CAST identified Safety Enhancement (SE) 211 through two piloted simulation studies entitled "Scenarios for Human Attention Restoration Using Psycho-physiology" (SHARP) (Harrivel et al., 2016; Harrivel et al., 2017; Prinzel, 2016; Stephens, Prinzel, et al., 2017; . The "SHARP" acronym was adopted to differentiate the research from the SE-200 unusual attitude recovery technology study being conducted jointly. See Prinzel et al. (2017, 2018) for more information on the Unusual Attitude Recovery work.

The SHARP studies were designed to use candidate Crew State Monitoring techniques to assess what are referred to as "Attention-related human performance limiting states" (AHPLS) which include channelized attention, diverted attention, startle/surprise, and confirmation bias. Indicators of these AHPLS were assessed through multiple physiological as well as eye-tracking sensors to look for measurable indicators in response to key events embedded in the flight simulation scenarios that the pilots encountered.

Key to studying pilot responses during the SHARP simulation testing was the development of improved training scenarios for operationally realistic Line-Oriented Flight Training (LOFT) and Special Purpose Operational Training (SPOT) scenarios. The present report will focus on: (1) development of the scenarios used; (2) interesting findings with implications for simulator motion; (3) eye-tracking heat maps in proximity to failure events; (4) observations of crews as test subjects versus a pilot and a research team co-pilot; and (5) the results of follow-up questionnaire evaluations completed by pilot participants regarding their usual training as well as the scenarios employed in the SHARP studies.

Results of the candidate Psychophysiological sensors are beyond the scope of the present report but initial findings may be found in Stephens et al. (2017), Harrivel et al. (2016), and Harrivel et al. (2017). Prinzel (2016) further provides detailed analyses of individual event sets for SHARP-1 study.

SHARP-1 Study

The SHARP-1 study was conducted in the Research Flight Deck in the Cockpit Motion Facility at the NASA Langley Research Center. The simulator has full-mission, Level D type capabilities with the flight deck displays emulating a B-787, but with a B-757 aerodynamic model, and with sidestick controls providing feedback of the position of the opposite side control stick.

A Line Oriented Simulation (LOS) scenario was designed to provide a high-fidelity simulation of line operations with event sets designed to induce AHPLS, including channelized attention, diverted attention, and startle/surprise. NASA Langley Research Center subject matter experts (SMEs) and line-operational commercial airline pilots with combined experience of more than 30 years assisted in the design of the LOS event set. The scenario was also developed by reference to FAA Advisory Circular (AC) 120-35D which presents the guidelines for the design, implementation, and validation of LOFT. The LOS used a gate-to-gate (from pushback to taxi-in) scenario with multiple event sets designed to induce AHPLS.

Thirteen flight crews were paired based on pilot role (Captain, First Officer) and from the same airline. Each flight crew had considerable experience with both B-757 and B-787 aircraft. The LOFT scenario included debriefing, dispatch paperwork, and other materials and instruction that airlines typically provide for LOFTs (based on information from two major airlines and a manufacturer that had partnered with NASA for this research).

SHARP-2 Study

The SHARP-2 study was conducted a year after the SHARP-1 study and used the same simulation cab except the cab was no longer on the motion legs, so no motion capability was available. A second difference was that participants (total of 12) were airline Captains in the left seat and the right-seat First Officer role was accomplished by either a NASA pilot or an airline pilot who was a member of the research team. This test used different physiological and eye-tracking equipment as the systems under test were to be more portable, representing systems that might be taken to an airline training facility for subsequent testing.

Construction of the LOFT scenario

The LOFT scenario was created with pilot input from both the airlines as well as NASA. The overriding design consideration was to make a complex scenario requiring numerous problem events constructed in a way to make things flow as they might in the real world. This meant that an early failure would have consequences later in the simulated flight much like failure events in actual flight. A pictorial drawing of the scenario appears in Figure 1. The major events are described below. In addition to these events there were short duration (approximately 60 seconds) display anomalies embedded in the scenario. These are shown as the blue boxes in Figure 1, and may or may not have been noticed by the test subjects dependent on the workload at the time.

Wake Hazard Event. Following the taxi-out, the first major event consisted of a wake encounter which occurred at 700 ft. mean sea level (MSL) after take-off from Runway 36L at Memphis (KMEM). The event created a startle state due to an aircraft roll upset at low altitude. The simulated wake encounter aerodynamic behaviors were verified by SMEs and calibrated by line-operational commercial airline pilots who had each experienced similar low-altitude wakes.

Hydraulic System/Anti-Skid Failure Events. The second major event was a right hydraulic system pressure and antiskid failure approximately 20 nmi. from the LEOOO waypoint on the BBKNG 4

departure. This event set was designed to induce channelized attention on the part of the flight crews by requiring an extensive sequence of checklist items and decision-making considerations (e.g., alternate airports, systems integrity, landing/stopping distances, availability of controls and gear). The event set provided behavioral indicator checks to determine whether the flight crew was channelized on the basis of: (a) communication patterns and verbiage and attentional management toward other activities (e.g., Air Traffic Control, ATC, responses); and, (b) detection of "proximate" traffic that was also heading to the LEOOO waypoint. The potential incursion traffic was an aircraft that departed from Runway 18C (the scenario design allowed for both north and south traffic departure flows) and party-line communications were provided that indicated that the traffic was cleared to the LEOOO waypoint at an altitude that conflicted with the own ship. The event set was designed to cause a proximate traffic encounter if pilots were channelized in attention, since the traffic was observable and appropriate mitigation responses could be performed (e.g., contact ATC) well before the encounter. The traffic was clearly visible on the navigation display for the entire duration of the event set and SMEs predicted that the traffic should be detected 100% of the time under normal operations and conditions. Depending on how the flight crews navigated and managed the situation, the incursion traffic could become a Traffic alert and Collision Avoidance System, TCAS, "Caution".

Trailing Edge Flap Asymmetry Event. The third major event was a trailing edge flap asymmetry (TE FLAP ASYM) which occurred after flight crews were directed back to KMEM for approach to Runway 36L following the hydraulic leak. Runway 36C is the longer runway at Memphis, but the scenario had the runway occupied and unavailable due to foreign object debris that was on the runway. Because of the weather conditions and poor braking action reported, flight crews had significant cognitive overhead when deciding whether to accept the runway assignment or request to go an alternate airport due to the hydraulic leak and antiskid failures. There were significant variations in how flight crews handled the decision and problem-solving and exhibited threat and error management. However, all flight crews eventually accepted an approach to Runway 36L.

During the approach, the trailing edge flap asymmetry event occurred; the flap asymmetric deployment was alerted to the crew on the Engine Indication and Crew Alerting System. The checklist allowed for a flight crew decision to continue the landing based on the flap configuration but most flight crews requested a go-around and executed the missed approach. For those that elected to continue, ATC issued a go-around (traffic was reported on the runway). The event, combined with the existing issues, was designed to induce channelized attention due to the temporal demands and decisional factors that needed to be considered once the event occurred (e.g., electronic checklist, decision to go-around or land) The amount of cognitive effort was high during the timing of the event (which went caution alert to the go-around and clean-up and climb to Hold), regardless of whether the pilots initiated the go-around and contacted ATC or ATC issued the go-around, to include the subsequent crew coordination, clean-up of aircraft, and discussion on option. The exceptions were the four flight crews (SHARP-1) that immediately executed the missed approach after the TE FLAP ASYM caution was presented on engine indication and crew alerting system (EICAS) display (see discussion below).

Missed Approach Event. After initiating the Runway 36L missed approach, the flight crews climbed and then leveled-off at 3000 ft. on the runway heading and then were turned to a heading of 330 and instructed to proceed to the KALIE waypoint to hold at 5000 ft. ATC then gave vectors to return to KMEM Runway 36C (the longer runway that all pilots preferred earlier was now available). Flight crews were provided speed and vectors to the ILS 36C approach. Due to the trailing edge flap asymmetry, the approach speed was significantly higher than normal (186 knots indicated airspeed).

Runway Incursion Event. The Runway 36C runway incursion event was designed to induce startle/surprise. In SHARP-1 the incursion was triggered by an aircraft that had erroneously crossed the active runway. Because the landing speed is higher than a nominal approach, the reaction time to such an event was reduced creating the conditions for a startle/surprise response. The aircraft timing was intended to purposely not cause a collision on the runway but to simulate a Category B runway incursion event. Due to flight crew decisions or timing issues, in a few cases, the runway incursion aircraft was blocking the runway when the aircraft landed; in such cases, the pilots were briefed that the event was not as intended. In SHARP-2, to avoid the timing issue of the runway crossing aircraft, a fire truck was placed at the same runway intersection, even with the edge of the runway. This event still was capable of providing the desired response without the timing issue of the crossing traffic used in the SHARP-1 study.

ATC Taxi Clearance Event. After the flight crew turned off the runway, ATC instructed the aircraft to hold on the taxiway and contact ground. Ground ATC issued a plausible and almost correct taxi clearance that would require the flight crews to carefully consider the path prior to execution to avoid an error in taxi. Depending upon their exit, they were either given a taxi clearance which crossed a runway (without a hold short of or clearance to cross the runway in the ATC taxi clearance) or were given a clearance that had a discontinuity (the cleared route omitted a taxiway). If the flight crews communicated that they had an issue with the clearance, ATC immediately corrected it. It is standard practice for pilots to immediately read-back the clearance to ATC verbatim (which in this case was an intentionally generated ATC error), or 'Roger' or call sign or other (which is not recommended SOP but this would not be marked as an error if done), but they then should review and verify the route on chart. Often, this is done while the aircraft is taxiing, but in this case the aircraft was stopped on taxi-way and there were no temporal pressures to begin taxi until the pilots were ready (due to the runway incursion event ATC had located the aircraft where they were as a non-issue for other aircraft and ATC told the pilots they could begin when ready). However, if the flight crew did not identify the error and contact ATC before taxiing, this was not considered as an error; only, if the flight crews did not detect the routing deficiency prior to arriving at the route error was it marked as an error (recognizing that the original error was ATC).

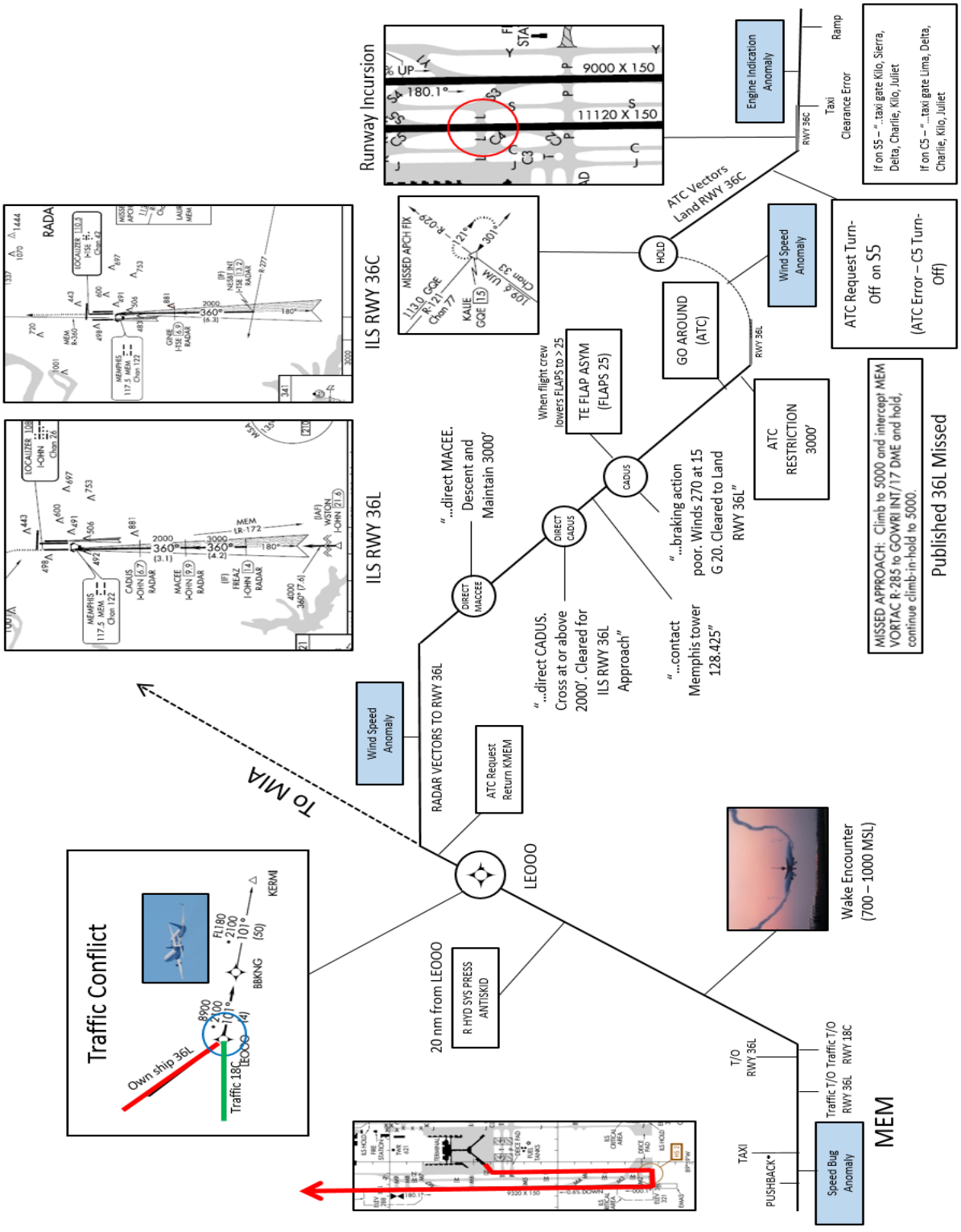

Figure 1. LOFT-like Scenario developed for the SHARP studies

Evaluation of the SHARP-1 LOFT scenario and current training

The SHARP-1 data results for the LOFT scenario show that the scenario was rated to be "excellent" / "very good" (82%) with 68% of pilots responding that NASA LOFT scenario was of higher quality than airline LOFT scenarios they had experienced. The NASA LOFT scenario was also judged to average "excellent" to "very good" in comparison of realism to actual commercial flight operations and hazards encountered on the line.

One pilot rated the scenario as "fair" but commented that the reason for this rating was due to issues with the simulator (i.e., non-standard flight displays and controls). The NASA LOFT scenario was also judged to average "excellent" to "very good" in comparison of realism to actual commercial flight operations and hazards encountered on the line.

The LOFT scenario was found to be highly effective at producing startle/surprise responses for the wake encounter and runway incursion event set (when the event occurred as implemented without technical issues) and channelized attention event set #1 (hydraulic system and antiskid failures). The second channelized attention event set was marginally effective owing largely to the highly variable nature of the scenario segment which, to maintain realism, allowed degrees of freedom for pilot responses; as a consequence, the TE FLAP ASYM and behavioral indicators were not always manifest in the LOFT scenario in SHARP-1 testing.

Overall, the flight crews exhibited acceptable threat and error management and non-technical skills (NOTECH) and Line/LOS behavioral markers were found to be good to acceptable across pilots. Pilot Technical Standards were found to meet FAA published standards and were evaluated against multiple phases of operations during the LOFT scenario. Communication analyses were also performed for each event set and general LOFT and the results characterize the verbal exchanges during task execution and demonstrate that type of speech act to discriminate between event set categories. Finally, the ATC taxi clearance error event set demonstrated that approximately half of the flight crews accepted the erroneous taxi-in clearance without cross-checking and verification.

Pilot responses to the SHARP-1 final questionnaire (see Appendix) provided a wealth of data in terms of current LOFT scenario implementation at airline training centers and substantial information for further work for LOFT scenario development. Thirty-four questions were asked that revealed significant and valuable data for how to enhance LOFT scenarios and implementations and potential avenues to explore for further scenario development specific to construction of training for attention management scenario and related constructs (confirmation bias, diverted attention, startle/surprise, channelized attention). The Appendix contains pilot response graphs and transcribed pilot comments. Prinzel (2016) provides detailed analyses of the SHARP-1 study findings summarized above.

SHARP-2 Eye-Tracking Heat Maps during two failure events

A head worn eye-tracking system was used in the SHARP-2 study. Figure 2 shows the eye-tracker Areas of Interest for the Research Flight Deck simulator. Figure 3 shows the eye-tracking heat map for the period of time just beginning with the Hydraulic System Pressure Problem. Note the cluster of looks at the EICAS warning message area. Also noted are numerous cross cockpit looks at the First Officer's Electronic Flight Bag (EFB) while the pilot not-flying is handling the checklist items.

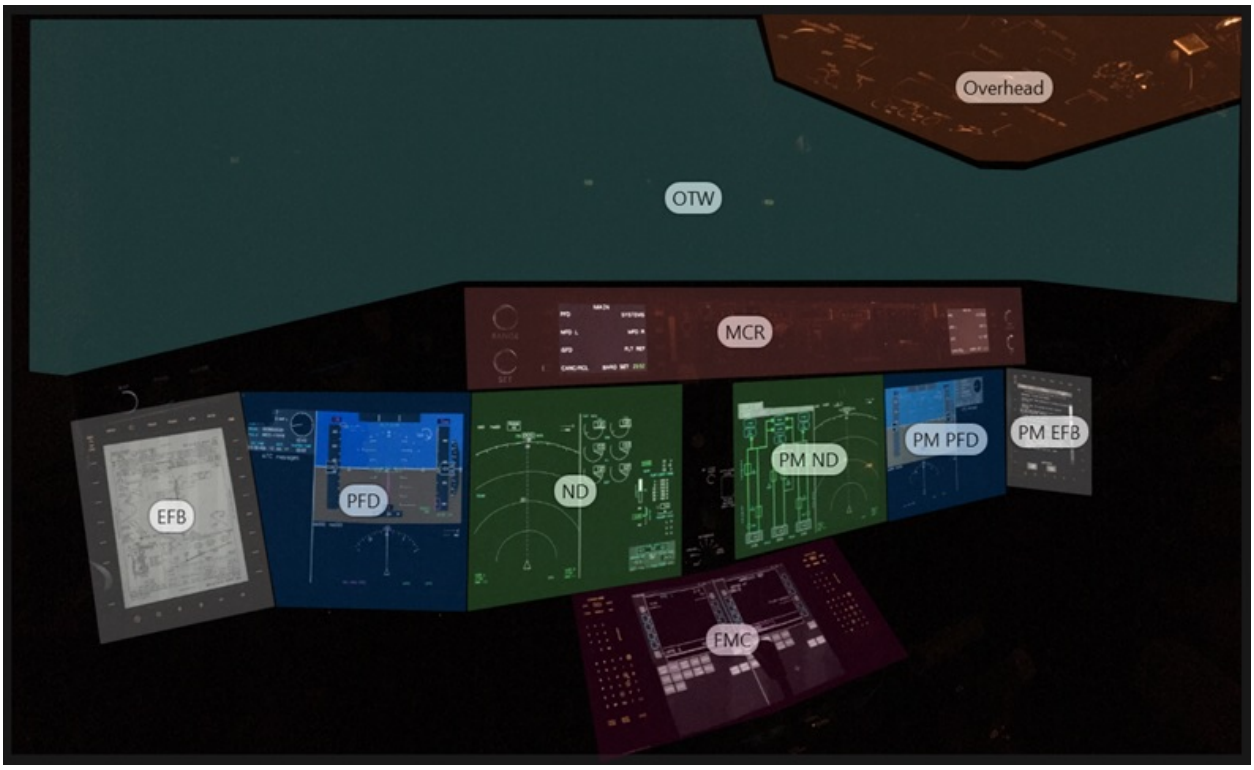

Figure 2. SHARP-2 Eye-tracker Areas of Interest in the NASA LaRC Research Flight Deck simulator

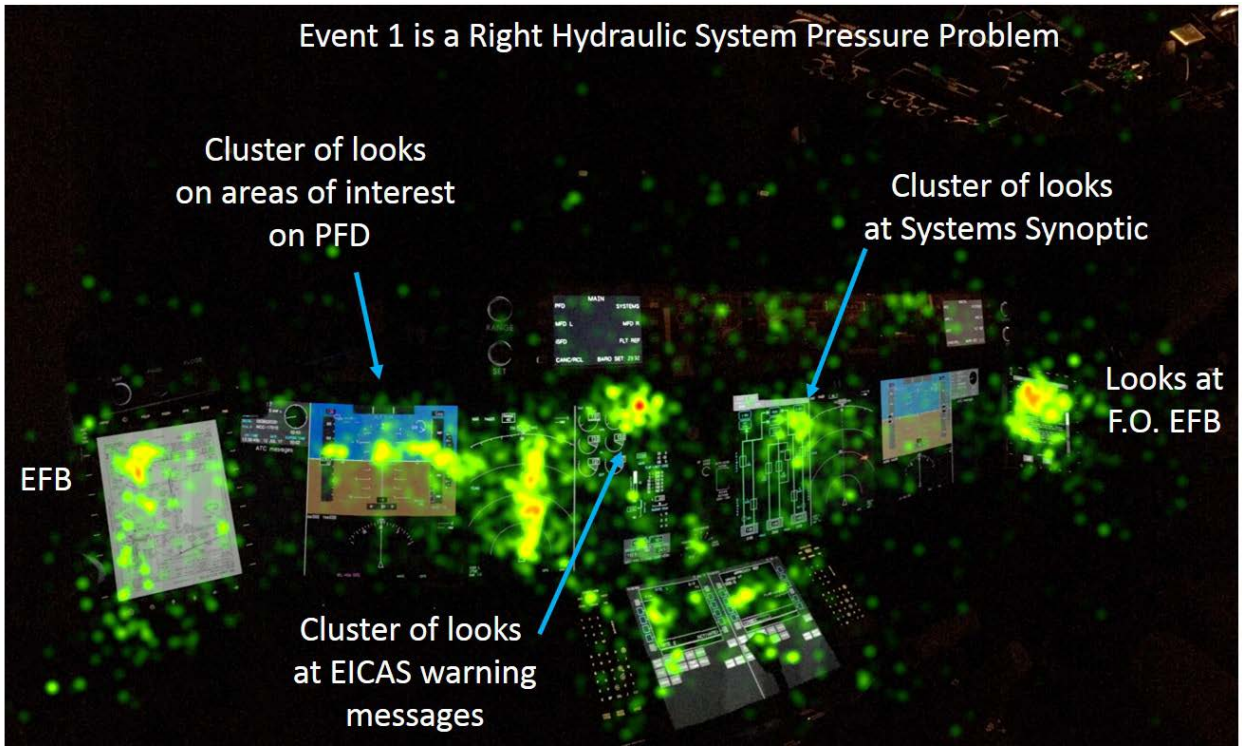

Figure 3. SHARP-2 Eye Tracking Heat Maps for Channelized Attention Event 1, Subjects 1 to 12

Figure 4 shows the eye-tracking heat maps beginning with the Trailing Edge Flap Asymmetry problem. The figure shows clusters of looks at the flap setting display area as well as on the Engine Indicating and Crew Alerting System (EICAS) areas. For additional background information on pilot monitoring strategies and eye-tracking see Sarter, Mumaw, and Wickens (2007).

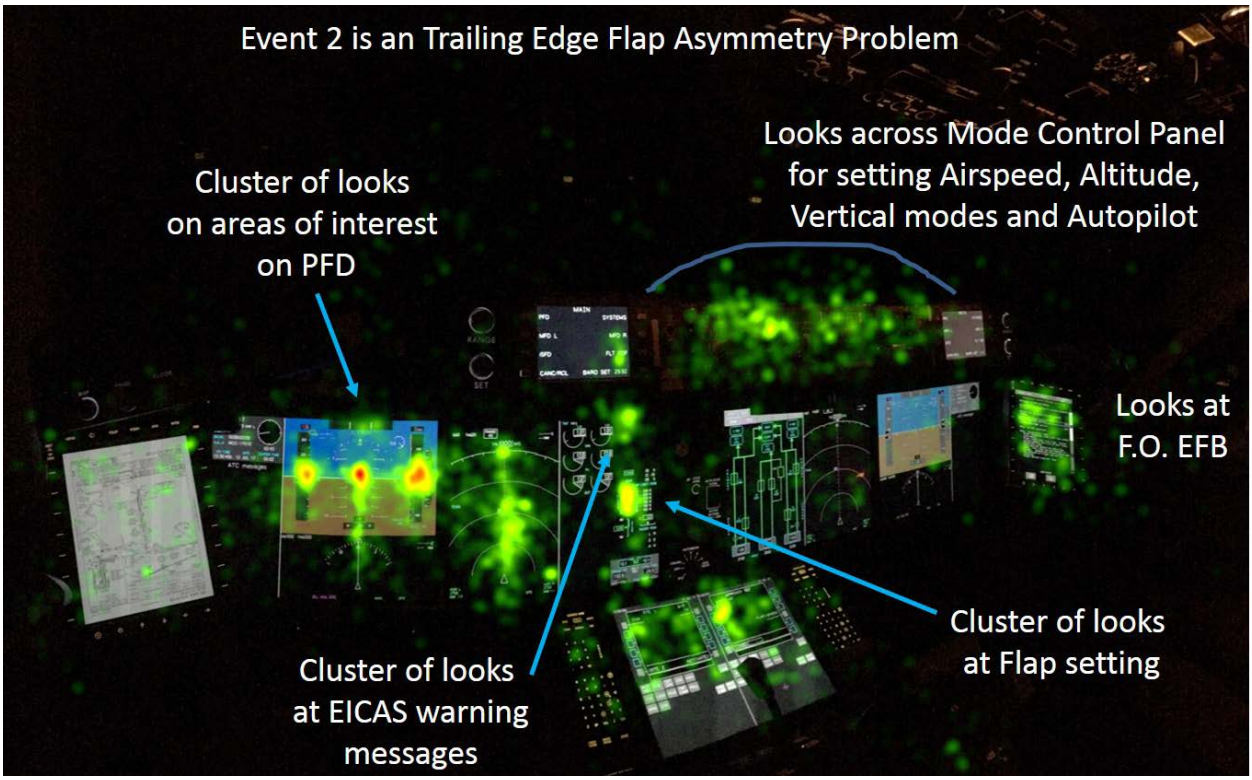

Figure 4. SHARP-2 Eye Tracking Heat Maps Channelized Attention Event 2, Subjects 1 to 12

Special purpose scenario – SHARP-2 Landing Autothrust Anomaly

One of the SPOTs used in the SHARP-2 study conducted at NASA Langley was based on a landing accident that was identified in the CAST report, and involved a Throttle Retard event at about 515 ft above ground level on approach to landing. This event was selected as it was a candidate for generating a surprise response and the nature of the response to the event may reflect channelized attention as well. Figures 5 and 6 show the simulated aircraft performance (altitude and airspeed) in response to the anomaly as a go-around was successfully initiated in 11 out of 12 cases.

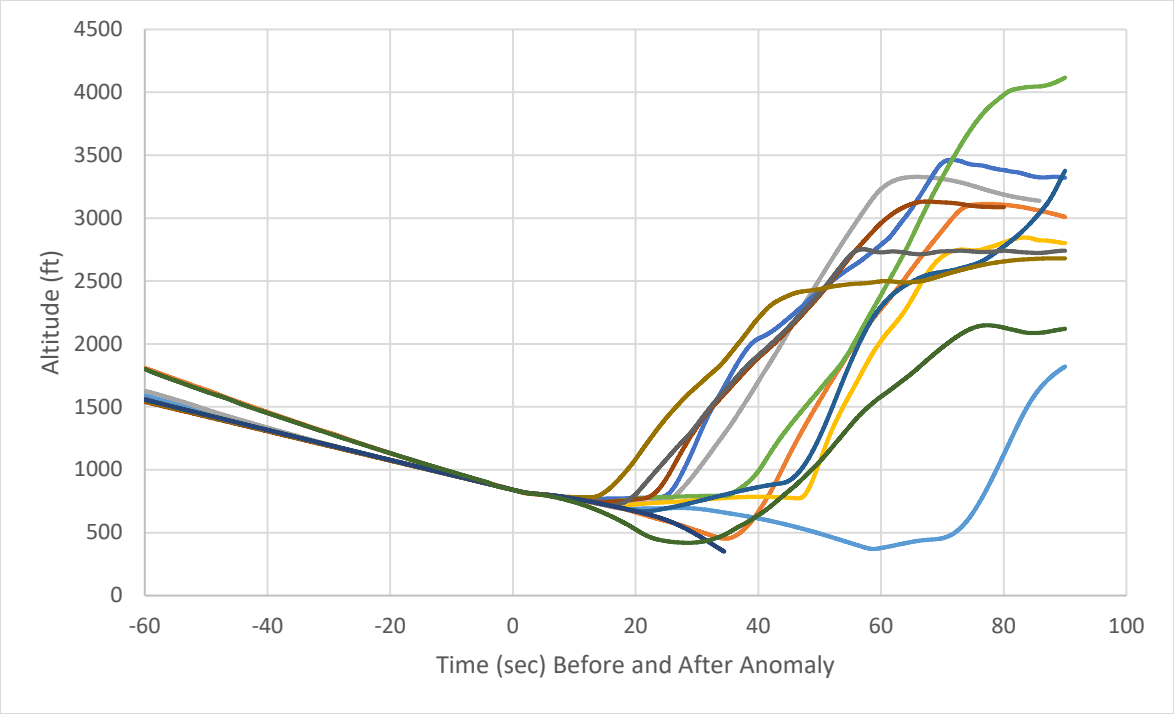

Figure 5. Altitude plots for a Throttle Retard event at time 0, for 12 test subjects.

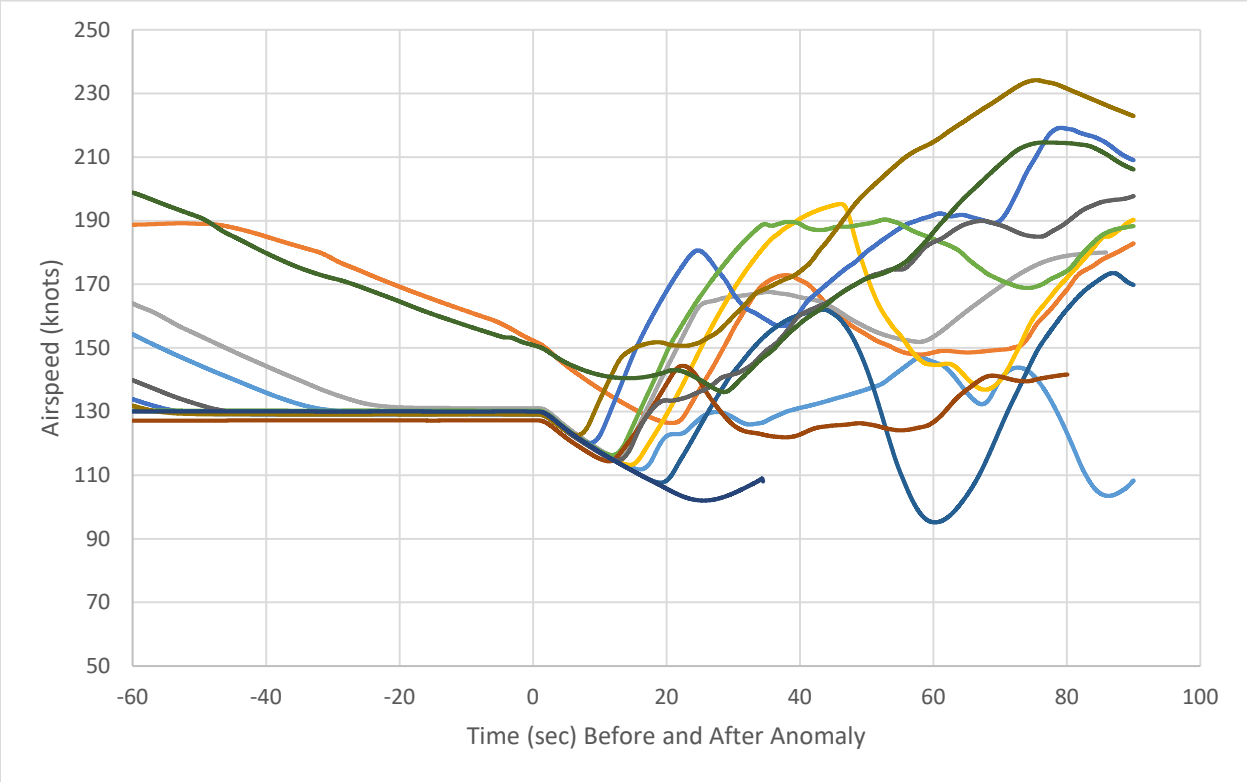

Figure 6. Airspeed plots for a Throttle Retard event at time 0, for 12 test subjects.

This set of data illustrates variability in response across the test subjects on both altitude and airspeed. It should be noted (based on pilot reports) that the side-stick pitch gains in the simulator may be higher than the pilots are expecting, which may be reflected in the higher variability in the high workload situation that this scenario creates. It should also be noted that this set of data is from the SHARP-2 study, which did not incorporate simulator motion. This study also had the left seat Pilot (Captain) as the test subject with the right seat first officer role conducted by a research team pilot who was knowledge-able about the event, so may not have provided the level of problem solving that would have been found in a two-crew as test subjects situation.

Simulator Motion versus No-Motion

Although a comparison between simulation scenarios conducted with and without motion was not planned at the onset of the present studies, simulation facility scheduling and motion base availability made such a comparison possible for certain events in the scenarios tested. As noted previously, the SHARP-1 study was conducted in the NASA Langley Research Center Research Flight Deck (RFD) simulator with motion on. A year later, the SHARP-2 study was conducted in the same simulator, but this time the simulator cab was fixed-base and not mounted on the motion legs.

The event that was evaluated was a wake encounter that occurred after KMEM takeoff in the LOFT scenarios at 700 ft AGL. To examine pilot response to the wake encounter, which caused the simulated aircraft to roll, the time from wake onset until the pilot made an input exceeding 5 degrees using the side-stick controller was calculated. The distribution of response times for the motion and no motion studies is shown in Figure 7.

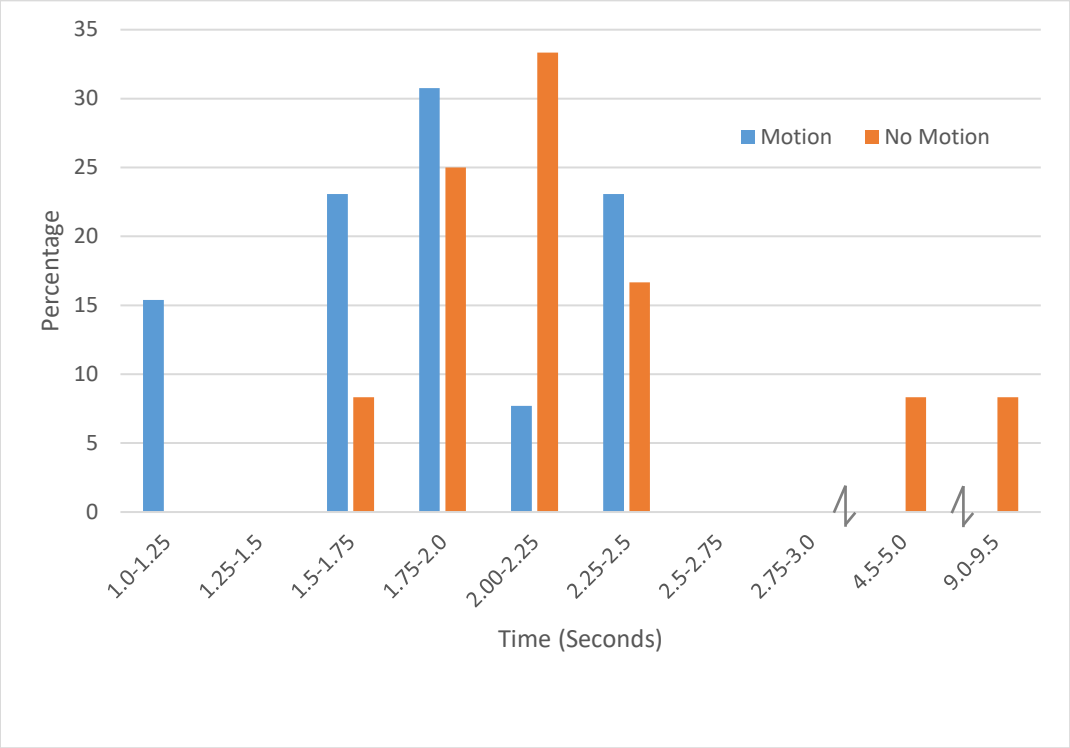

Figure 7. Wake Encounter response showing time until first stick input exceeding 5 degrees for Motion and No-motion testing.

The set of data shown in Figure 7 are from 13 pilots in the SHARP-1 study (motion) and 12 pilots in the SHARP-2 study (no-motion). Mean response time for pilots in the motion study was 1.83 seconds and for the no-motion study was 2.88 seconds. A comparison of Log(base2) transformed response times, to correct for response time skew, showed a significantly faster response time when motion was used (t-value =2.144, $p<.05$, magnitude of effect Cohen's d = 0.846). The faster response times with motion have implications for the training environment when unusual attitude or upset recovery scenarios are practiced.

This is an important finding as training organizations seek to improve the efficiency and cost effectiveness of pilot training. There are many aspects of training for a particular aircraft type or procedures where simulator motion would not make a difference, however, for scenarios in which detecting the onset of the event is critical, simulator motion makes a difference. From a sensory standpoint, human motion perception is good at detecting change but not absolute position or subthreshold changes. As evidence of this, earlier research on eye-tracking and simulator motion (Comstock, 1984) showed that both correct and even reverse-direction pitch motion resulted in faster response times in simulator testing of responses to pitch disturbances.

Two-Crew versus Pilot and Research Team Pilot

As noted earlier, the SHARP-1 study was conducted with flight crews from the same airline for the simulation runs occupying both left and right seats in the cab. SHARP-2 was conducted with an airline pilot in the left seat and a research team pilot in the right seat. While the primary research objectives of the SHARP-2 study could be achieved with this configuration, it should be noted that in order to make the problem recognition, procedure following, and problem solving as much like the real world as possible, the two crew configuration was observed to be far better. The research team pilot in the right seat obviously knows what is going to happen so has to be helpful with handling appropriate tasks but not too helpful since what is or has happened is known, which is different from having the two in a crew working to recognize and resolve issues unknown to both of them.

Summary

As noted earlier, the SHARP studies were designed to use candidate Crew State Monitoring techniques to assess what are referred to as “Attention-related human performance limiting states” (AHPLS) which include channelized attention, diverted attention, startle/surprise, and confirmation bias. See Null, et al. (2019) for additional information on human performance contributions to aviation safety, and Casner, Geven, and Williams (2013) for information on airline pilot training for abnormal events.

The present report is focused primarily on the simulation scenarios developed for the SHARP series of studies. For the LOFT scenario the main design consideration was to make a complex scenario requiring numerous problem events constructed in a way to make things flow as they might in the real world. This meant that an early failure would have consequences later in the simulated flight much like failure events that might take place in actual flight.

Of value to scenario designers is the feedback and ratings from pilots who participated in SHARP-1, including their comments on current and potentially new training events. An objective of Study 1 was to validate the fidelity of the scenario event sets for inducing attentional states of interest and apriori and a posteriori ratings and measures evince the efficacy of the scenario. Therefore, SHARP-2 study, which also employed a confederate pilot, was conducted based on the previous study finding of scenario validity for inducement of attentional states under test. A take-home final questionnaire was not provided to Study 2 pilot participants. The findings of SHARP-1 study are provided in Appendix.

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Appendix: Pilot Responses to SHARP-1 final questionnaire

Pilot responses to the SHARP-1 final questionnaire provided a wealth of data in terms of current LOFT scenario implementation at airline training centers and substantial information for addressing issues of interest to CAST. Thirty-four questions were asked that revealed significant and valuable data for how to enhance LOFT scenario and implementations and potential avenues to explore for further scenario development specific to construction of training for attention management scenario and related constructs (confirmation bias, diverted attention, startle/surprise, channelized attention).

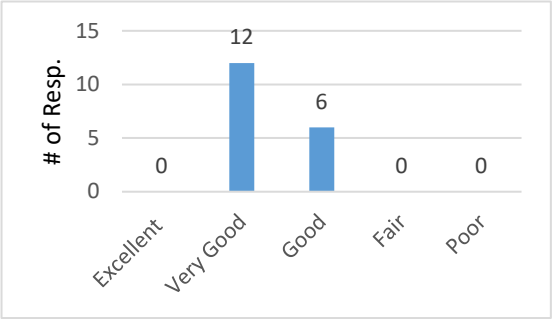
The take-home final questionnaire was given to all pilot participants with instructions to complete the questionnaire package and return via U.S. Mail. There was a 70% return rate achieved. Each question asked is provided below with a corresponding data graph, where appropriate. Some questions asked pilots to provide a comment or further explanation or details and those responses are provided where responses were given.

Questionnaire results:

1. Please rate the effectiveness of each of the following that you have experienced at airline training centers in terms of training **standard operating procedures** for actual line operations.

Question 1a) Simulator Training Scenarios

How effectively are scenarios designed to train standard operating procedures for actual line operations? (Answered on a 5 point rating scale)



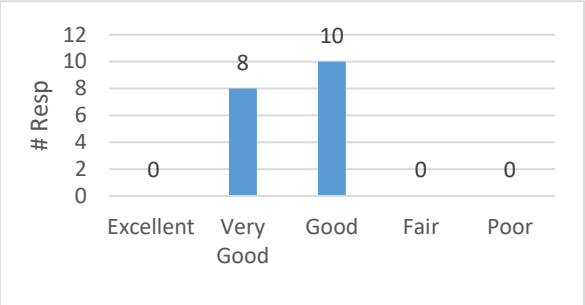
What can be done to improve the effectiveness of scenarios to train standard operating procedures for actual line operations? (Written responses)

- "Not that much. Emergency procedures need to be covered multiple times watch leaves less room for line operations, during initial line qualifications most SOP items are covered."
- "Just continue reinforcing standardization"
- "Rather than save the LOFT until the very end of training, incorporate a standard LOFT during the "normal" portion of training, and then an abnormal LOFT at the end of training."
- "LOFT: If the desire is to not reach MIA-program for an alternate that would be more appropriate in terms of weather and runway availability- (RWY 27 at mem not avail on LOFT) a decision to return to mem was not realistic."
- "My perspective is that standardized training scenarios and practice has just had a very positive seismic shift with the introduction of the B787 to our training department and are still in small group trials."
- "Introduce compound malfunctions; or at least talk about prioritizing tasks"
- "Make sure crews are from the same airline and on the same equipment. Also tailor the scenarios to that specific airline SOP.
- "(1) Trainers do not instruct, they have you do the procedure. If acceptable, you go on. If unacceptable, you do it again. There is no "teaching." Instructors are merely monitors. (2)

Scenarios are set up for all fleets. We'll be going to airports that are illegal for our aircraft –just to get high altitude training or other training."

- "Not so much the procedures, which are very good. My concern is the time between (illegible phrase). Nine months is too long. Six months was much better."
- "More emphasis on manual hand flying pilots are loosing (sic losing) basic flying skills due to automation"
- "Needs more operational inputs e.g., passenger issues route changes, call company, etc".
- "too much is placed into computer based training. Need more live instruction"

Question 1b) Airline Training



How effective is airline training overall to train standard operating procedures for actual line operations? (Poor to Excellent)

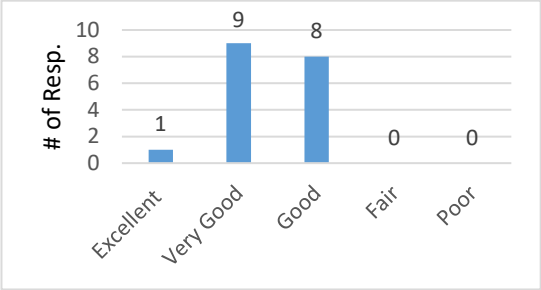
What can be done to improve the effectiveness of airline training to train standard operating procedures for actual line operations?

- "Sufficient fixed based trainers"
- "It's common knowledge/acceptance that operating experience (OE) exposes the holes in training. If training for actual operations were the standard OE would be more of a formality then the high intensity training event it is in reality."
- "Airline training has become more standardized across fleets in terms of checklists and procedures where applicable."
- "One option to enhance would be to add additional time to initial operating experience-possibly based on previous aircraft experience. S80 to B787 needing more time than B777 to B787."
- "B787 IOE program is excellent. Thorough checklist of tasks from normal passenger problems to cargo to aircraft anomalies to ocennic procedure and finally emergency divert."
- "Real-time scenarios are sometimes rushed to complete the event. Always make scenarios real-time."
- "hire "teachers" as sim instructors. Stop cramming 5 hours of training in a 4 hour sim period. Tailor training to specific aircraft type."
- "Again the time between (illegible word) is too long, especially for long-haul pilots who get very little hands on flying."
- "More emphasis on ground school systems review and real world scenario reviews."
- "Airline Z does a good job in realistic LOFT scenarios. Possibly more emphasis on upset recovery and weather avoidance and turbulent flying and exit procedures."
- "Better environmental inputs, ATC radio calls, external issues, schedule pressures, etc.

2. Please rate the effectiveness of the following you have experienced at airline training centers to train **manual handling skills, techniques, and skills** necessary for actual line operations.

Question 2a) Simulator Training Scenarios

How effectively are scenarios designed to train manual handling skills, techniques, and skills necessary for actual line operations?

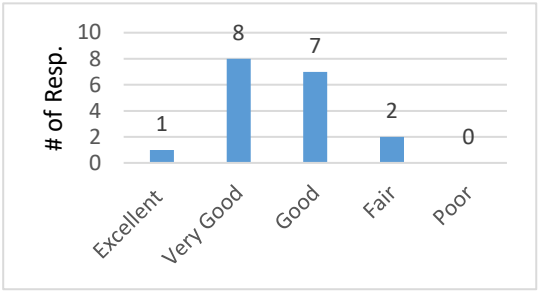


What can be done to improve the effectiveness of scenarios to train manual handling skills, techniques, and skills necessary for actual line operations?

- "More time in the sims would be great. If pilots could jump in sims and just practice various emergencies, as we did in the military."
- "More hand flying required"
- "Incorporate different airports (too often the scenario is simply takeoff from one airport and immediately return for landing), to include SIDs and STARs. There is no need for the enroute portion; it could be a takeoff, fly the STAR (find few points to clean up at least) then pre-position to the SID and culminate in landing at a different airport."
- "Good and getting better at Airline Y – more emphasis put on hand flying over last 2 9 month training cycles. Sometimes instructor and (illegible word) has to fail A/P on demand manual control, but with same outcome."
- "By AOP standards we are required to complete certain parts of scenarios flying by hand. We could increase that requirement to force higher proficiency."
- "More (illegible word) (A/P off) (illegible word) would be helpful for proficiency…except there is a (illegible word) of "negative training" when an actual EO (illegible word). History has shown that pilots will kickoff automation-because that's what they trained."
- "Airlines should emphasize more visual approach training and manual handling skills and automation training"
- "Try to emphasize the need to practice more hands-on time especially during VFR weather."
- "More stick and throttle training. More technique instruction."
- "Increase number of scenarios"
- "Just more of it! Turbulence procedures, weather procedures etc"
- "More visual approach training"

Question 2b) Airline Training

How effective is airline training overall to train manual handling skills, techniques, and skills necessary for actual line operations?



What can be done to improve the effectiveness of airline training to train manual handling skills, techniques, and skills necessary for actual line operations?

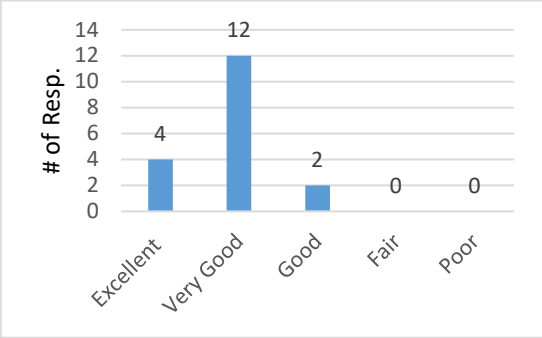
- "More hand flying otherwise I think Airline Y does a great job with procedures, standardization and schema training."
- "Incorporate SIDs, STARs and actual weather conditions (brief weather conditions if changed for scenario), rather than takeoff with weather at 5 miles visibility and 5000 overcast, and then set the weather to ½ miles visibility and 200 overcast at same airport for immediate landing."
- "We have to balance then (sic the) needs and comforts of our passengers during actual flights. Training is much more conservative in nature than simulators due to inherent real time risks. Possible use of roll play/what if scenarios during low cockpit demand (cruise)."
- "Occasionally manual fly the aircraft to/below 18,000'. But brief it-because it requires extra attention from everyone in the cockpit."
- "More manual handling training time."
- "Increase allocated time while in recurrent trainings, 4 days vs 3days minimum"
- "To (sic too) much automation, we are loosing (sic losing) hand flying skills"
- "Aircraft training without passengers would enhance handling skills"

3. Please rate the effectiveness of the following you have experienced at airline training centers to train **skills to handle emergencies and safety-related events** necessary for actual line operations.

Question 3a) Simulator Training Scenarios

How effectively are scenarios designed to train skills to handle emergencies and safety-related events necessary for actual line operations?

What can be done to improve the effectiveness of scenarios to train skills to handle emergencies and safety-related events necessary for actual line operations?

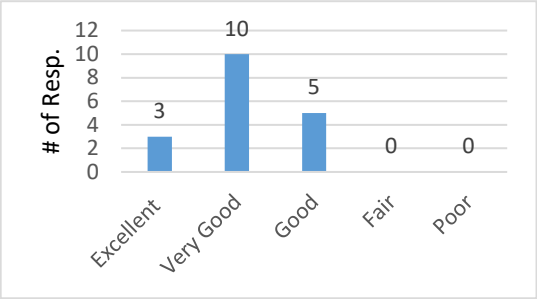


- "Nothing other than time to practice emergencies-but money constraints preclude companies from offering additional time in the sim."
- "They do a great job"
- "I think the emergencies/safety related events training is very good and can think of nothing to improve it significantly."
- "Achilles heel is checklist construction/readability/checklist directions/index, etc- scenarios (illegible word) OVE non-normal at a time and rarely with carry-over implications if another non-normal is introduced."
- "A majority of our qualification training scenarios are devoted to emergency, non-normal procedure. Our new training philosophy lends towards a more effective preparation by the crews as they know in advance what curriculum specifics will be taught on any given period."
- "Simulators are built EP training, Brief or demonstrate multiple/compounded emergencies (like what (illegible character) non within military)."
- "Operational realism is important"

- "Keep it as close to real-time as possible. Take an extra day to cover the events if need be. Try not to cram too much into one time period."
- "Manuals are very good at helping pilots learn to make time when they can. Again, this is mostly self- taught as sim instructors are very poor at teaching skills and they are overwhelmed by the amount of scenarios they have to fit into a short period of time. With no jeopardy it would be great to have compound emergencies to allow crews to really learn the interaction of systems."
- "Increase number of scenarios presented"
- "More upset recovery procedures and actions required, more WX avoidance and exit procedures"
- "Too much emphasis on engine failures. More problems drawn from actual emergencies should be trained."
- "If there was a way to startle pilots, that would be good. The problem is that pilots talk about their simulator training scenarios, so the startle will be less effective a few weeks after it is introduced"

Question 3b) Airline Training

How effective is airline training overall to train skills to handle emergencies and safety-related events necessary for actual line operations?



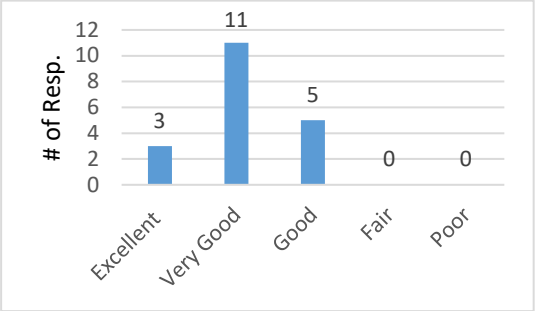
What can be done to improve the effectiveness of airline training to train skills to handle emergencies and safety-related events necessary for actual line operations?

- "I can't think of anything to significantly improve emergencies/safety related events training."
- "Good except to the extent that too much content is introduced in a 4 hour period and retention of learning becomes negative."
- "Repetitive exposure/work. I only see this happening if the mainline crews adopt the training philosophy of "training like you fly". Many do, some don't until there is a pending evaluation/check ride."
- "*Airline Z* is adopting green/yellow/red TEM threat error management. Along with "gates" to be stable"
- "Need to repeat training as much as possible"
- "Every 5 years or so crews should be brought in for 4 or 5 days to requal in all of the emergencies that were taught during initial training."
- "Ensure live crews paired together. In the lsat 12 years, I haven't been paired with the proper crewmember in the other seat. Usually, it is another crew member in the same seat as me (Capt with Capt) or a seat (illegible word) instructor. CRM is significantly degraded with this crewing."
- "More exposure and real world examples"
- "Lots of training controls around crew response management. Equal emphasis needs to be made for own state awareness."

4. Please rate the effectiveness of the following you have experienced at airline training centers to train **proper pilot response (including standard operating procedures)** to flight deck alerts.

Question 4a) Simulator Training Scenarios

How effectively are scenarios designed to train optimal pilot response (including standard operating procedures) to flight deck alerts?

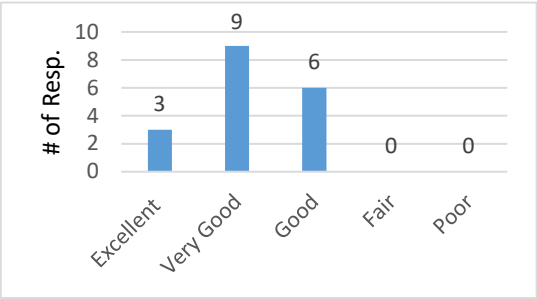


What can be done to improve the effectiveness of scenarios to train optimal pilot response (including standard operating procedures) to flight deck alerts?

- "More sim time. Practice makes perfect"
- "I can't think of anything to improve optimal pilot response training."
- "More exercises to create awareness of distractions, deficiencies, and other human factors that affect the monitoring process. These exercises could be briefed and accomplished in the briefing room prior to the simulator event."
- "A few growing pains with new procedures. –reinforce "exact" call outs and stifle short cuts, omissions, previous aircraft-isms."
- "Most of the instructors are pro-active/aggressive on checklist /procedure verbal responses and action."
- most of this is straightforward."
- "Can get rushed trying to complete the scenario-As more critical items come up due to the complexity of the aircraft. More time in the simulator would help. We hop from one shortened scenario to the next."
- "increased emphasis one standardization closer verbatim red box item responses"
- "I think training is adequate"

Question 4b) Airline Training

How effective is airline training overall to train optimal pilot response (including standard operating procedures) to flight deck alerts?



What can be done to improve the effectiveness of airline training to train optimal pilot response (including standard operating procedures) to flight deck alerts?

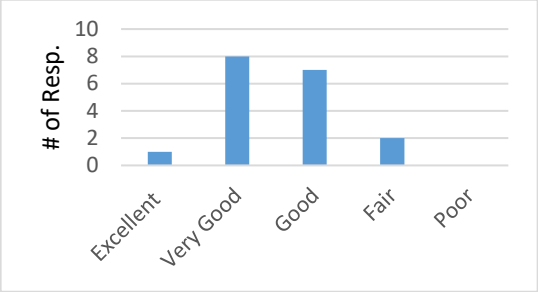
- "I can't think of anything to improve optimal pilot response training."
- "Build on the pre sim exercises by focusing cockpit activities on monitoring for abnormals. A SPOT designed solely for this purpose could feed into a LOFT scenario. Typically the human factors issues associated with monitoring skius is seldom addressed."
- "Reinforce standardization, correct procedures, i.e. verbalizing "1000 for 2000 vs 1 to go" on altitude call outs automation while helpful can lead to a false sense of security. Loss of Nav

Inertials in the 787 will cause all automated call outs to stop functioning. It's a requirement for the PF/PM to pick up as appropriate."

- "Old/bad habits creep in…so imperative I or probably trainer pilots to mention/speak up on new call-outs"
- "Come up with standard procedures for all airplanes in fleet. Try to keep those procedures without making subtle changes especially to fleets that only fly a few legs per month (long-haul flying) much harder to remember the new procedures with fewer legs for repetition. IE what is the difference between throttle or thrust levers. Why make it mandatory to call them thrust levers when any pilot would respond to either name."
- "increase exposure"

5. Please rate the effectiveness of the following you have experienced at airline training centers to train **pilot automation monitoring skills**.

Question 5a) Simulator Training Scenarios

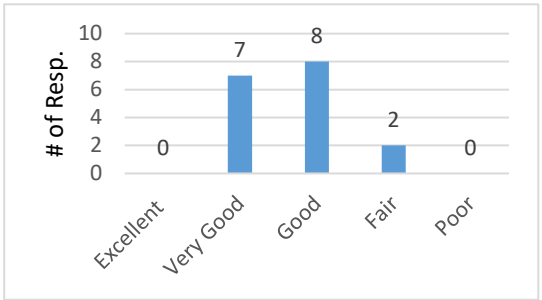


How effectively are scenarios designed to train pilot monitoring skills for actual line operations?

What can be done to improve the effectiveness of scenarios to train pilot automation monitoring skills for actual line operations?

- "By giving multiple emergencies, continues scans of instruments are required, but there isn't any actual training for the scans
- "Maybe display anomalies to help increase awareness as the NASA scenario-"
- "In cases where pilot monitoring should see/notice an anomaly, but doesn't, the display should highlight or flash the information which has been missed."
- "Fail the automatic systems to reinforce positive habit patterns. Time, money and training constraints dictate more important procedures are emphasized."
- "Like the pretest, possible show a video with (illegible word) in real time, to enhance scan pattern."
- "Have minor or major instrumentation flags pop up to see if pilots react appropriately."
- "Monitoring is not stressed, except when it can be identified as the causal factor in a substandard performance on any scenario."
- "More emphasis and time allocation"

Question 5b) Airline Training



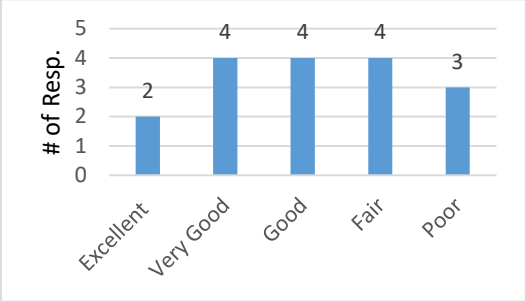
How effective is airline training overall to train pilot automation monitoring skills for actual line operations?

What can be done to improve the effectiveness of airline training to train pilot automation monitoring skills for actual line operations?

- "In cases where the pilot monitoring should see/notice an anomaly, but doesn't, the display should highlight/flash the information which has been missed."
- "Reinforce cockpit procedures to back up automation."
- "Have complete crew change briefing on long-hand flying information automation (illegible character) intentions are often left out when new pilot gets in the seat."
- "Calling out changes to FMA, course change is exceptionally important for monitoring pilot".
- "Very little training in this area"
- "The subject is just now being introduced in discussions. This is an underserved area. It should be covered more in our recurrent training."
- "Increase LOE requirements with respect to minimum time with a check airman"

6. Please rate the effectiveness of the following for training of **optimal instrument scan**.

Question 6a) Simulator Training Scenarios



How effectively are scenarios designed to train pilot optimal instrument scan?

What can be done to improve the effectiveness of scenarios to train pilot optimal instrument scan?

- Optimal instrument scan isn't something trained. The assumption, and I think is a good one, is pilots at the airline level should already have the ability to effectively scan instruments or they should fail in training."
- "Can't remember when any emphasis was put on honing an instrument scan. The joystick/mouse multi-tasking exercise would be an effective tool to stress the need for an efficient instrument."
- "Optimal scanning isn't a regular topic in the "training trenches" Perception that; -issues are usually rooted out earlier in careers. –one-off's are addressed on a case by case basis."
- "Scan patterns are rarely talked about. Usually it OJT on the sim, trying to survive from or maneuver to the next. Pre-brief with pointer to the mock-up would be helpful"
- "Spend more time with training of new procedures."
- "As new procedures are implemented make sure adequate training on it is provided."
- "More emphasis on scan procedures, currently nothing in training manuals about this."
- "Scenarios are cut and dried. See a problem, fix the problem, next scenario. It is tough to do, as the aircraft are built to be self-alerting. Probably more hand flying in the sim during recurrent."
- "No emphasis is placed on reviewing scan"
- "Really do not train scan techniques, rely mostly on experience"
- "Introducing anomalies such as airspeed differences are difficult to incorporate in scenarios but important"
- "Basic scan examples would be beneficial"

Question 6b) Airline Training

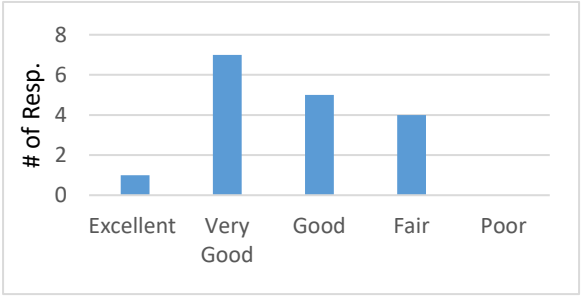
How effective is airline training overall to train pilot optimal instrument scan?

What can be done to improve the effectiveness of airline training to train pilot optimal instrument scan?

- "I'm not sure if there is an optimal scan."
- "Program in more anomalies"
- "Optimal scan isn't something trained nor do I think should be. Each pilot is a little different and what is "optimal" for one may not be for another."
- "Optimal scanning isn't a regular topic in the "training trenches" Perception that scan stagnation usually occurs due to target fixation on a problem, as a result of fatigue, lack of attention/distraction, boredom, hunger, stress, illness, altitude…… LARC sim eye tracking hardware/software could be used to detect fixation and create an alert similar to altitude excursions."
- "Running individual mental drills keeps the dust off. Another way is to rotate between seats (i.e. FO-FB/CA-RC) gets a whole new perspective."
- "Nonexistent"
- "Training focuses on CRM. Instrument skills not addressed."
- "Not addressed during training"
- "Experience is sufficient for optimal scan"
- "Modern PFDs make for poor scan and hard to diagnose."

7. Please rate the effectiveness of the following for training of **attention management for commercial airline flight operations**.

Question 7a) Simulator Training Scenarios



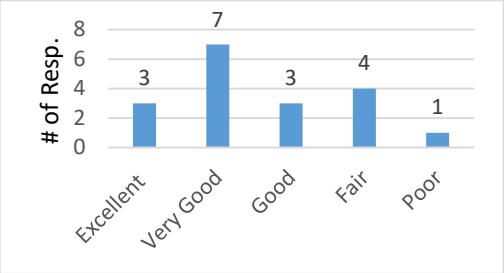
How effectively are scenarios designed to train pilot attention management for commercial airline flight operations?

What can be done to improve the effectiveness of scenarios to train pilot attention management for commercial airline flight operations?

- "Normally attention management isn't part of simulation training because of the high intensity, one –after-another emergencies, but incorporating a normal LOFT into the training program at the midpoint rather than the end would help.
- "Attention management is incumbent during SPOT(s) and LOFT(s), Pilots known something will happen so the degree of attention paid in the sum is much higher than normal line flying."

- "Reinforce; Good cross check procedures EICAS clearing procedures after abnormal is completed- "clean slate" CRM and cockpit management
- "Turnkey: (illegible word) pre-brief, sim; (illegible word), to post-brief."
- "Hard to reproduce cockpit environment in the sim. We know something is going to go wrong. In real world, rarely does something go wrong. Hardest LOFT I ever did was one where nothing went wrong-I was exhausted at the end of it because I was looking everywhere for an anomaly."
- "Increase emphasis on AM during recurring training"
- "Good briefing prior to sim session so pilots know what to expect"
- "Scenarios need to create channelized attention and pilots need to be made aware of when the have channelized attention."

Question 7b) Airline Training

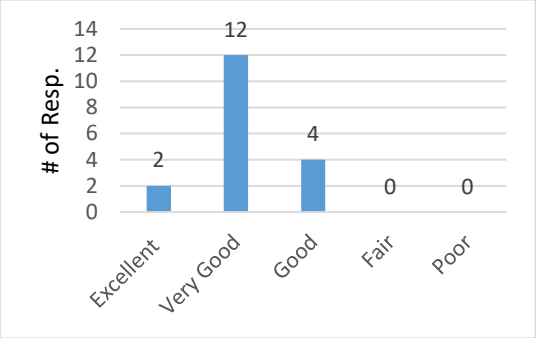


How effective is airline training overall to train pilot attention management for commercial airline flight operations?

What can be done to improve the effectiveness of airline training to train pilot attention management for commercial airline flight operations?

- "Operating Experience (OE) exposes the holes in sim training. If those holes could be plugged, with additional LOFTs in training, the OE could be used to train more of attention management principles because the student won't be consumed with learning line operations information which could be learned in the LOFTs."
- "Little if any focused training on attention management. Establish an ongoing program (quarterly training with sim supplemental SPOTs every 9 months) *Airline Y* has done this with CRM and Threat and error management."
- "Continued reinforcement of standardized procedures for phase of flight. Hazard analysis and regularly addressing "what if" scenarios. Example-we are rolling out a Depressurization Guide that formalizes strong techniques which will help with proper attention focus. Experience > Review > Compare > Reinforce Change, repeat"
- "Given the difficulty mentioned above, It is okay."
- "No AM is addressed during training-should be addressed"
- "Sim training helps to reinforce good pilot skills"
- "Focus needs to be on awareness of channelized attention"

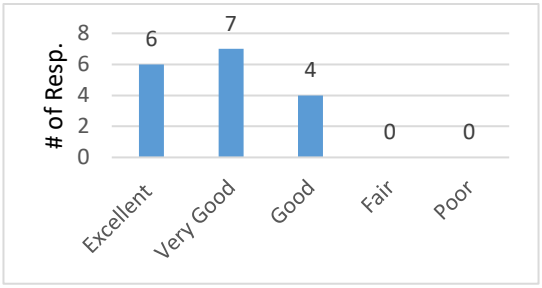
Question 8. Please rate the **average quality of the line-oriented flight training (LOFT) scenarios you have experienced** at airline training centers.



Please provide a comment/reason for the rating above and how airline training center LOFTs can be improved (i.e., what can be done that would result in a higher rating than the one you provided)

- Good, but most of a LOFT is just flying as if we are out on the line. So not very difficult"
- "I think Airline Y does a great job with their LOFTs. It is very easy to overload a pilot to the point of negative training. Airline Y does a great job in balancing this."
- "The LOFT scenarios I've experienced have been very realistic, no failures of every system simultaneously. One thing which could help improve them would be to replicate scenarios which resulted in actual no-so-great outcomes, e.g. B-777 hitting the seawall in SFO on landing, t see how actual conditions (late vectors "slam-dunk" approaches and other actual events experienced on the line) can be experienced and handled with greater (illegible word). Also, adding in a degree of ATC stress would also help, i.e. controlled saying "unable…" or crews being asked to make rapid turns, descents, etc."
- "For the most part LOFT(s) are realistic and allow great latitude in decision making with regard to diverting us continue to destination altitude and route decisions, time needed to complete procedures. Debriefing is a key especially in terms of establishing standardization – *airline x* instructors are very good briefers however debriefing is an art/skill that needs work at the departmental level."
- "This is a work in progress and getting better. Simulation is rapidly evolving (with the addition of Google Earth visuals, new electric actuation platforms, simulator software that mimics or is the same as actual aircraft systems software) adding greater realism. This enables courseware development to become multi-faceted in presentation. Although currently we do not train with multiple complex scenarios the systems will allow for that potential. Increasing complexity as a training tool may be the next logical step."
- "(illegible word) LOFT with multiple malfunctions that creep up."
- "Good training but sometimes not done in real-time"
- "It is the only event you do in the sim that you start and end at the gate. So there is no other training in pre/post flight ops. There are only 8 scenarios. You know you won't get the same one as last year. From the city pairs, you can narrow the potential scenario down to 3 events. It is way too canned, but since our license is on the line, pilots want it that way."
- "Probably good, since they are extended profiles and procedures we only practice in the sim-engine out or depressurization all the way to landing."
- "Longer scenarios with more pitfalls to address, but not multiple current issues"
- "Try to compress time to optimize training some LOFTs have too drone time"
- "More realistic external inputs like ACARs messages, cabin com issues, weather issues"

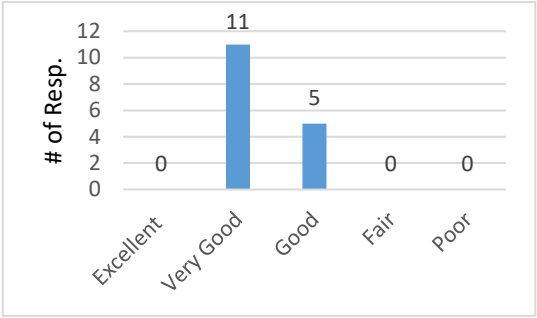
Question 9. Please rate the **realism of the line-oriented flight training (LOFT) scenarios you have experienced** at airline training centers, compared to actual line operations.



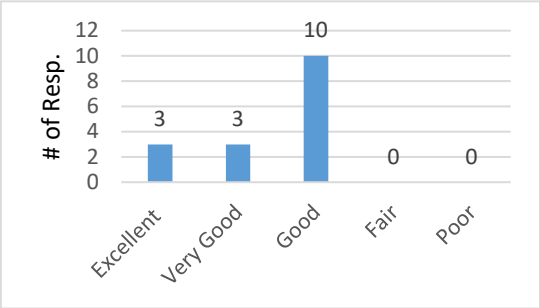
Please provide a comment/reason for the rating above and how airline training center LOFTs can be improved to increase the "realism" of the LOFT scenarios (i.e., what can be done that would result in a higher rating than the one you provided)

- "It's just like flying the line only you have one or two minor emergencies."
- "I believe all the LOFTs are very realistic as they have already happened on the line at one time or another."
- "No complaints about realism-actually a strong suit because of the capabilities of the simulator."
- "This is a work in progress as well. The initial qualification training process has traditionally focused on emergency scenarios with the LOFT tagged on at the end and almost becoming anti-climactic. The shift is not to make the training periods fell (sic feel) more like line flying with preflights, taxi in/out, flying SID's/STARs and running real time (as is practical) thus adding to the realism."
- "Many times- actual divert have little to do with aircraft malfunctions and are more human driven: medical emergency, security threat, ATC shutdown"
- "Sometimes the actual scenario is flown with an instructor wearing too many hats to simulate an actual scenario."
- "Scenario is realistic. Problem is that it is canned and you have a good idea of what is coming. Plus most scenarios are fairly simple."
- "Scenarios are realistic but Longer scenarios with more pitfalls to address, but not multiple current issues"
- "They accomplish the task however way not optimize training with less drone time"

Question 10a) Please rate the **typical level of mental workload/effort needed to successfully perform the line-oriented flight training (LOFT) scenarios you have experienced** at airline training centers (compared to what you think it should be for training).



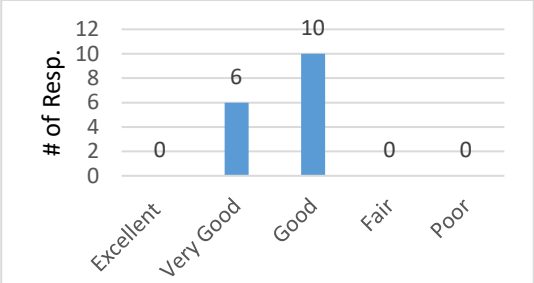
*Question 10b) Please rate the **typical level of mental workload/effort needed during actual line operations** (for comparison to above response)*



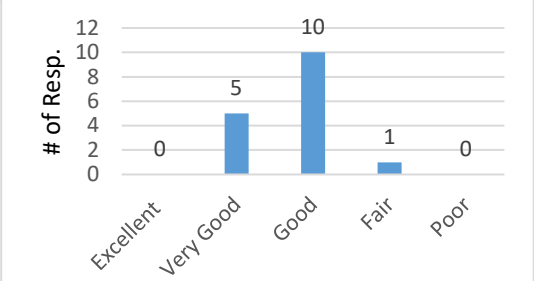
Please provide a comment/reason for the rating above

- "You are expecting something to go wrong during a LOFT where as on the line things run smoothly 99% of the time."
- "LOFT scenarios I've experienced are pretty straight forward and have little for (illegible word). Flight crews are basically allowed to fly the profile with little interruption and, in the event of emergencies/abnormals, are pretty much given whatever is requested as far as clearance, vectors, speeds, runways, etc."
- "Sim training prepares one well for line flights in terms of workload and what one can expect during an abnormal – Have had 2 engine out events on organic crossings –both became non-events in terms of workload, expectations, flight characteristics, etc. – speaks to how realistic the flight characteristics are of the sims."
- "Simulator sessions are fast paced with frequent stops, starts, new scenarios, repeats, emergencies given, resolved, and then on to the next approach with multiple events trained in any given 4-6 hour period. It is a constant evolution of Threat and Error Management requiring a high level of constant focus. Actual flight operations tend to be a bit more benign. While a high level of attention is required it isn't loaded with multiple training simulations and scenarios. The work loads ebb and flow depending on the stage of flight. Example, high alert=taxi, runway incursion issues, takeoffs and landings lower level alert=cruise."
- "LOFT scenarios, (illegible word) last 15-20 years, have been standard, (illegible word), tried and true. While actual diverts have ranges from piece of cake to O.M.G. – 2 alternate airports shutting down in tropical storm, and 2 hours to the 3rd one, low on fuel, of course."
- "More time to form your CRM team in real-time event."
- "The comparison is mixing apples and oranges-primarily because you know something is going to happen in the simulator. In the sim you are constantly scanning all instruments. In actual line ops you are talking, eating, perusing RFBs, etc... the system scan rate is significantly less than in the simulator, but, in line ops things rarely go wrong. And when they do, they are usually accompanied by a noise, red/amber flab, etc…) to alert the crew."
- "As with any flight, these are only moments of high workload. Takeoff, approach, landing phases. Fortunately, as a 787 international pilot, there are fewer high workload moments-that is offset by the fatigue at 14-16 hour flight"
- "LOFT can be more challenging to address training aspect more ten evaluation"
- "Its (sic it's) fairly accurate to optimize training more action should be introduced into LOFT"
- "Never enough realistic inputs like MEL issues, time pressures, ACARS, cabin issues, weather"
- "Both do not require maximum brain effort because usually nothing happens during a flight. Through even when I've lost an engine during a flight it still does not require full mental capacity to handle all that is happening. I find that I still have time to contemplate other decisions, talk on the radio and inform the passengers."

Question 11a) Please rate the **typical level of attention management needed to successfully perform the line-oriented flight training (LOFT) scenarios you have experienced** at airline training centers (compared to what you think it should be for training).



*Question 11b) Please rate the **typical level of attention management needed during actual commercial airline line operations** (for comparison to above response).*



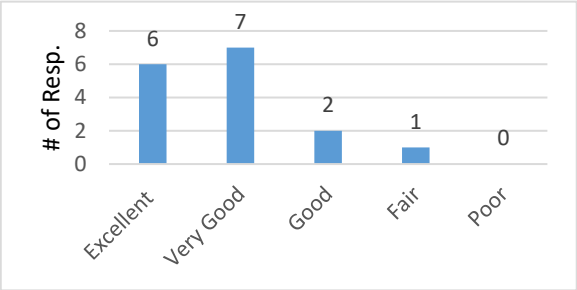
Please provide a comment/reason for the rating above

- "LOFTs tend to be a bit more demanding of attention than actual line ops. However, it is feast or famine on the line. When things do change or get interrupted on the line, it is far more challenging on attention management than your typical LOFT."
- "Both scenarios create a commensurate (illegible word) of attention-in the sim you know something is coming and you just wait for it. In the A/C you typically do not expect it but are energized by the chance of focus and extra attention required to solve the problem."
- "They are similar in intensity for different reasons. Simulation demands constant attention due to the training scenarios and ultimate a rating ride. Flights have their own level of stress with meeting scheduling constraints, maintenance issues, weather…"
- "TNG, regulations, procedure, daily (illegible word) have directly contributed to high rate of attention management."
- "More time to sort thru the problems as well as in long-haul OPS, there are a total of 4 pilots to work thru problem"
- "Specifically decided by the pilots involved. If one is proactive during the flight, the workload can be constantly higher-WX, alternates, etc. on international flights, much of the attention spent analysis escape routes, WX, available airports, etc. Domestic-sometimes filtering (illegible word) the distractions inflight-ATC, diversion airports, delays for weather, etc. Can be overwhelming sometimes."
- "LOFT can be more complex to address/increase level of AM required to accomplish task"
- "More attention required during line ops, traffic, WX, cabin issues, etc"
- "Time limitations never all for the boredom of very long flights"

Please rate the **quality of the <u>NASA LOFT scenario</u> overall**.

Question 12a) Please rate the overall quality of the NASA LOFT scenario you experienced at NASA Langley Research Center.

Question 12b) What can be done to improve the quality of the NASA LOFT scenario overall?

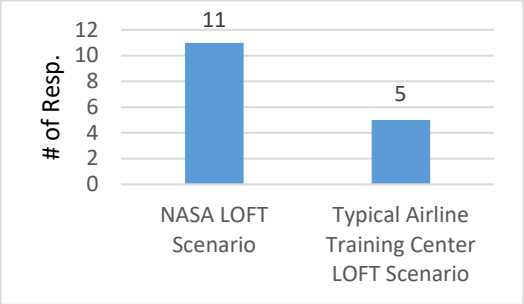


- "Probably using an A/C that we are familiar with would help since some of the instruments were not exactly like our A/C it made our scans different than they usually would be."
- "Have a simulation that is more exact to the airplane that we actually fly. This will give the results much more accuracy."
- "I thought the addition of an actual Air Traffic Controller was outstanding. Such an addition would be very useful in airline training LOFTs. I've experienced the actual ATC scenarios before, on a military program and can say with absolute certainty it makes a world of difference."
- "The scenario with regard to the abnormal was appropriate: the inability to divert to a more suitable airport was not I understand the limitation presented by the sim data base in terms of airports however a solution would have been to improve weather and/or winds or provide a runway 27 approach which would have been more appropriate with a wet runway winds 270/20+kts, and a HYD failure. ATC comm was not optimum. Typically ATC is prompt and very helpful with requests made by emergency aircraft-not the case with this LOFT"
- "Excellent overall, sim hydraulic platform had its' (sic its) limitation with roll capabilities. Complex/compound EP was a nice challenge with some "shock and awe" with go-around and AP failure. Automated ATC calls presented some timing challenges. On some, I would have completed calls more rapidly (forced us to play the game). Also correct controller instruction for ILS vs Non-ILS intercepts so as to not (sic not) jam the approach or intercept a course or proceed to a fix to intercept as appropriate. (I understand the challenges of not having a real controller)."
- "For me, the only item would be more manual flying to feel the stick pressure. Otherwise, briefing and sim orientation was excellent."
- "scenario was fine but we had major problems with sim visual."
- "Scenario was great learning event. We never see multiple failures in airline training. This causes/allows us to use our system knowledge regarding the interaction of systems. However, given LOFT scenarios are jeopardy events at airline training. Pilots would balk at receiving (illegible word) training unless changed to a "non-jeopardy" event. Also, all the bio measuring devices were a hindrance in optimally performing adequate response to scenario. Weight, wires everywhere and constant concern about dislodging devices hindered training."
- "Very good, very intense and compact."
- "Increase number and complexity of scenarios, more challenging."
- "Good level of task orientation requirement"
- "The study could have benefited better from having pilots experienced in the actual aircraft they fly. Using a simulator that has features of Airbus and Boeing made the scenario more difficult than perhaps may have been, but not impossible. "

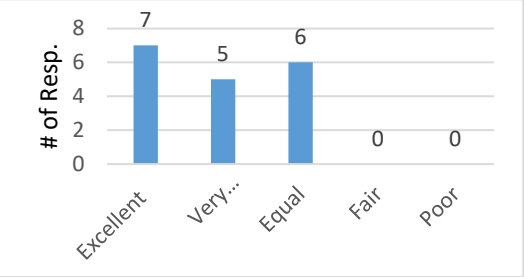
Question 13a) Please rate **which of the following scenarios you think is of higher quality in terms of implementation**.

_____ NASA LOFT Scenario

_____ Typical Airline Training Center LOFT Scenario



Question 13b) Please rate the quality of the NASA line-oriented flight training (LOFT) scenario compared to the typical LOFT scenarios you have experienced at airline training center(s).

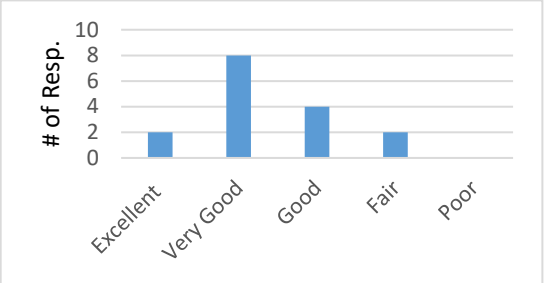


Question 13c) What can be done to improve the quality of the NASA LOFT scenario in terms of how airline training centers may do it differently or better?

- "Again most airline lofts are a check ride for your ticket so we would rather they not be to difficult. After we complete the LOFT we then have 2 hours worth of multiple emergencies. So it's not that your LOFT was worse, it's that during airline lofts we don't want the so hard we get lots of failures."
- "Give more resources to the Pilots; i.e. dispatcher, controller aid, etc."
- "Instead of taking off immediately behind a heavy aircraft, because that cues the pilots to what is coming, have the heavy aircraft take off on a parallel runway with the winds set up to cause a wake vortex encounter. Other ideas would be aircraft/aircraft system specific and not realistic given the variety of pilots tested and unique features of the NASA simulator."
- "While NASA has much to teach airlines in terms of technology and methods, I think airline training department have much to teach NASA in terms of building effective and relevant scenarios. Also, the compactness of the sim environment at an airline sim where the instructor is in the cab controlling events is a major advantage when compared to the set-up and coordination of parte/planes at NASA."
- "Simulation was very good, increasing complexity is a plus but could have it (sic its) limitations depending on the tenure of pilot/crew, i.e., transition versus seasoned. Airlines tend to not run complex failures. NASA hybrid cockpit (stick vs yoke) was a neat choice…."
- Regarding just simulator flying, the scripted events, radio chatter, and multiple malfunction is one notch above airline LOFT"
- "Do those type LOFT scenarios as "non-jeopardy". Eliminate bio measuring devices."
- "Our LOFT events are heavily scripted, and known to all pilots after the first few times flown. Here at NASA it is more like the old days, more flying, less imanaging (sic imagining). Our LOFTs may have one system failure and the majority of the time working on crew coordination and managing the ATC/Dispatch/Crew/PAX"

- "maybe add weather issues"
- "Pilots typically will want the LOFT to be easier than line because it is evaluated and already stressed so will not perform as well as they normally do day-to-day."

Question 14a) Please rate the **overall realism of the <u>NASA LOFT</u> scenario** compared to actual commercial airline flight operations.



Question 14b) What can be done to improve the quality of the NASA LOFT scenario in terms of "realism" of the NASA LOFT compared to actual line operations (in terms of both normal line operations and also the specific NASA LOFT events)?

- "Your LOFT was good it gave multiple problems and time to work on and complete those problems. But in actual airline operations we hope not to have many problems at all, and usually don't."
- "I thought the NASA LOFT had way too many events built into it which had a tendency to overload the Pilots. To make the scenario more realistic you need to make the company dispatcher available to the pilots as one of the tools to help with decision making. We don't operate in a vacuum in the cockpit and it is always wise to pool resources."
- "Dealt with improvements toward realism with NASA LOFT in question 12"
- "I like the compound/progressing scenarios. It can be challenging as the PF to fly and monitor. Gate to gate operations adds realism especially with incursions. We current (sic currently) employ a scenario of a runway change, SID change while on the taxi out. Nav Inertial Sys Failure airborne can be an eye opener due to the multiple systems degradation/failure. It requires team work and hand flying. I believe successful Line Ops are dependent on good CRM and TEM. Effective communication is a must."
- "Realism- well planes are getting much, much better-so the realism of a jammed, multiple flap problem is probably less likely than say a volcanic ash storm. Human problems, even (illegible word) from the back cabin, or poor regulations, etc. are much more of concern/add header to simulate. Luckily, line pilots deal with this every day."
- "It may be hard for NASA to do since it does not have resources to make sims specific to each airline in the LOFT"
- "Some LOFT events were unrealistic due to simulator technology (e.g. trying to stall the aircraft by cranking up SAT). But most were very good. They challenged your aviation skills. Probably the biggest detractor in the NASA sim was that it wasn't the aircraft we fly. Would have loved to do these scenarios at FAA 737 sim. Then we could also use our systems knowledge to better respond to the event."
- "About as real as you can get, given your resources. Remind crews that they should use their own airlines normal checklists. Perhaps they can print out their normals to review during the scenario? We found ourselves a bit off balance. We have a rhythm and a litany that puts us in the proper state of mind. The checklists and specific call outs as much as (illegible word). But remind them that the limitations of the sim and the many different airlines that participate requires their participation in making it real."

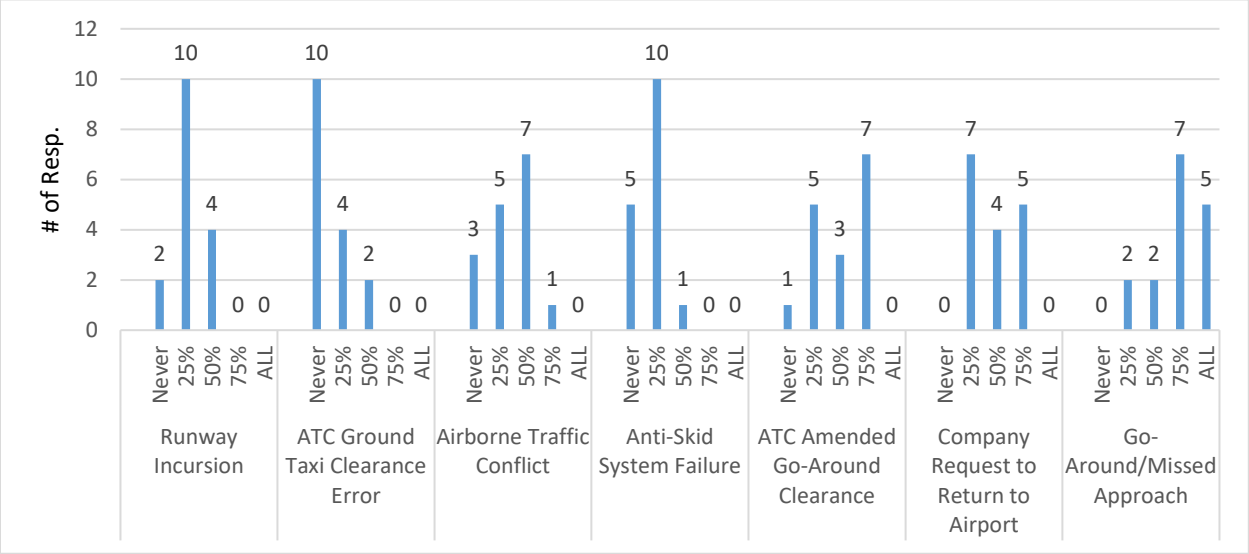
- "Increase number and complexity change airports during multiple LOFTs for more exposure to procedures"
- "Weather cabin issues. Possible diverts"
- "Company calls and ACARS inputs. Cabin crew interactions. Other distractors. More ATC traffic."
- "The LOFT was well-designed"

Question 15) Please estimate the **overall frequency of each of the following LOFT events that are included in LOFTs you may have experienced** at airline training center(s).

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please estimate the frequency that you estimate your airline training center uses each of the following events for LOFT training and scenarios.

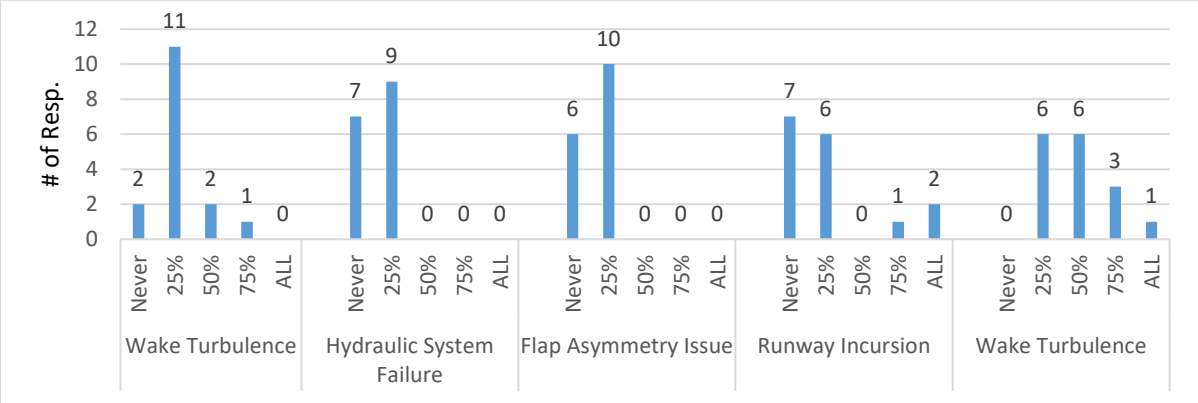
|---------- | ---------- | ---------- | ---------- |
Never 25% 50% 75% ALL

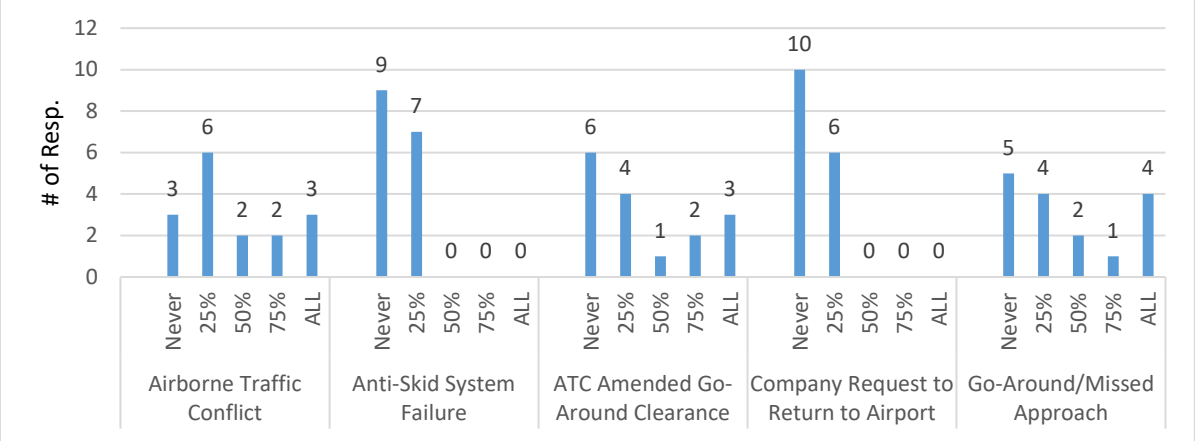


Question 16) Please **estimate the likelihood of frequency of each of the following events** during actual commercial airline flight operations.

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please estimate each of the following events in terms of how likely an airline pilot would experience each of these events in actual line operations during career.

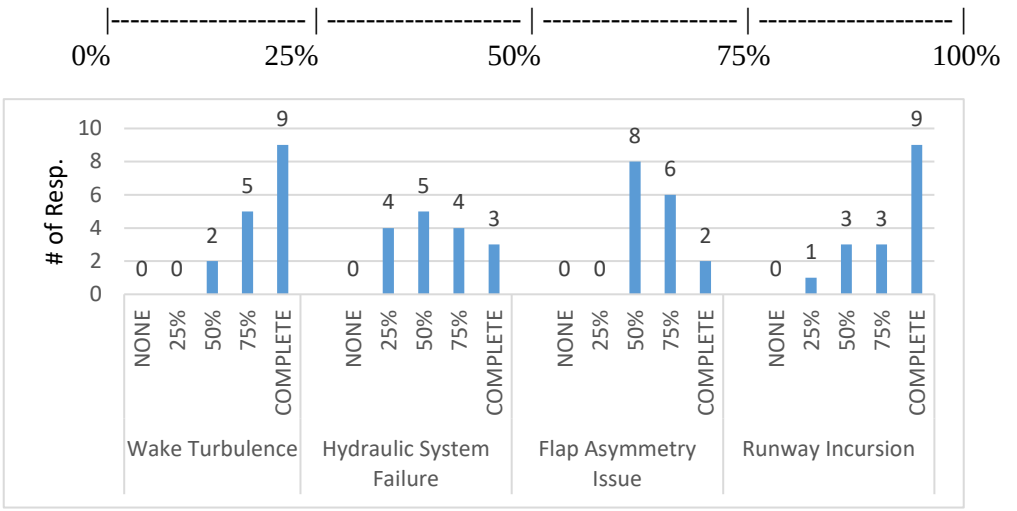


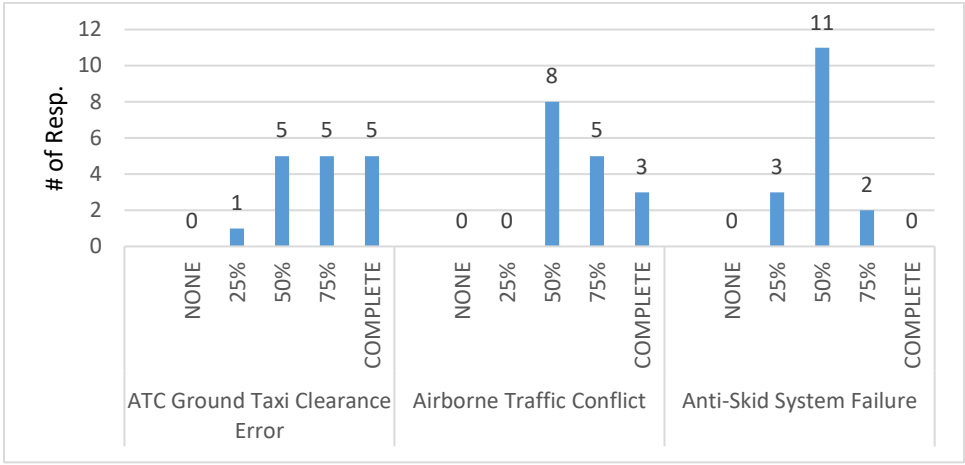


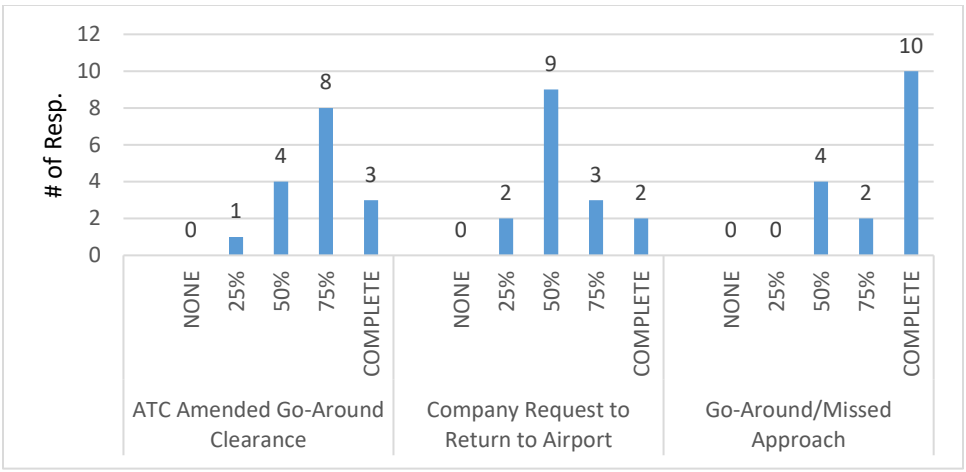
Question 17) For each of the following NASA LOFT events, please **indicate the level of representativeness of the event compared to the same event type if experienced in actual airline flight operations**.

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please rate how well each of the following LOFT events were implemented and presented during the <u>NASA LOFT</u> compared to the same type of event if experienced during actual line operations.







Question 18) Please indicate the **level of <u>channelized attention</u> you estimate you experienced** as a result of each of the following NASA LOFT events.

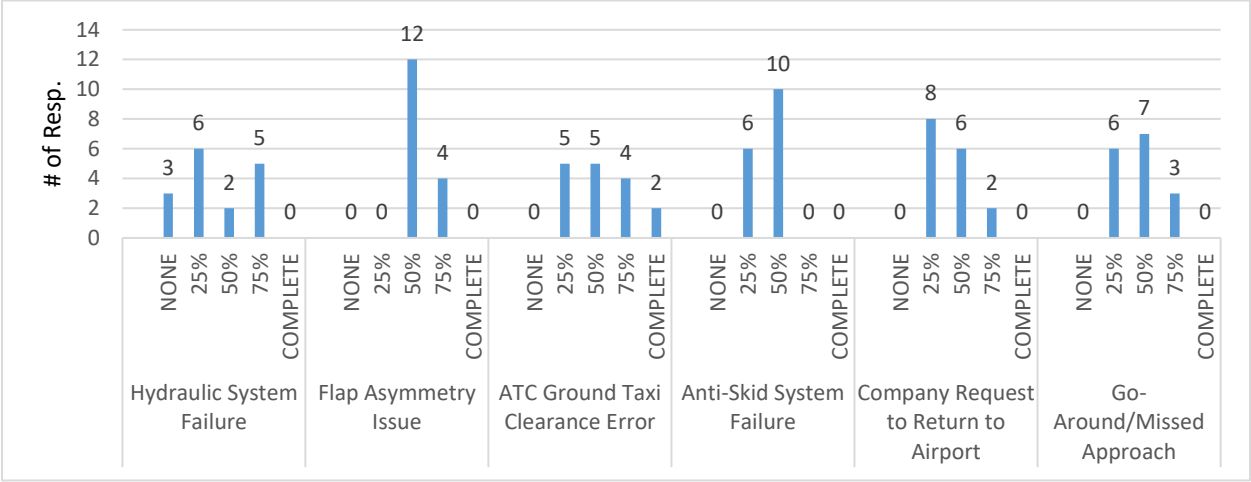
Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please provide an estimate in terms of % of channelized attention with 0% indicating no experience of a channelized attention state at all to 100% being fully channelized attention state.

Channelized attention is defined here as, ***"to be focused on one instrument or one response to the exclusion of all other relevant inputs, comments, or alerts; the 'Tuning out' of any information that may have led to fully understand the problem faced."***

---------- | ---------- | ---------- | ---------- |

0% 25% 50% 75% 100%



Please provide a comment / reason for the rating.

Hydraulic System Failure

- "It did require focusing to be sure proper procedures were being used."
- "Running check list"

- "HYD sys failure procedures follow a straightforward procedure –allow the PM to perform while PF flies not much analysis required"
- "Failed and checklist complete, didn't worry about it anymore"
- "2 man cockpit leaves task to pilot monitoring. R hyd in 757 not a bid deal"
- "Still had scan and SA of flying ops"

Flap Asymmetry Issue

- "Due to the asymmetry it requires more attention to make sure the correct check list is used as well as flying."
- "Running check list"
- "More analysis required, procedure options based on analysis"
- "Let pilot monitoring handle problem while I flew and talked on radios"
- "checklist complete, didn't worry about it anymore, though had to remember not to do move flap handle. In aircraft technique is to put coffee cup over it."
- "That additional failure upped the focus-higher approach speed, strong crosswind"
- "Had SA of flying ops"

ATC Ground Taxi Clearance Error

- "This requires extra time to look at the taxi chart to assure which way to taxi"
- "Not a big deal"
- "unfamiliar airport and signage"
- (illegible word) at an unfamiliar airport to figure out it was incorrect. Afterwards, wary about further instructions."
- "Completely missed it as I was processing the runway incursion"
- "Communication always a problem, keep SA to be safe"

Anti Skid System Failure

- Not a very big deal, so little attention required."
- "landing distance"
- "procedure based, no analysis except landing distance"
- "Focused on it until aircraft is stopped"
- "First failure-thought it was a sim error"

Company Request to Return to Airport

- "Again same time to sit up and coordinate to return, but not much attention required."
- "Proper coordination"
- "Abnormal request, high workload, checklists, etc."
- "more company reports/chatter"
- "received, press on to assigned destination."
- "we decided on our own to return"
- "Low importance, safety of flying"

ATC Amended Go-Around Clearance

- "This one was more difficult since it took extra attention to change settings (altitude, heading, etc.)"
- "Executing proper (illegible word) and procedure"
- "Most of this 75% score was due to the CAPT and I reaching for Flight Director/Autopilot controls at the same time. As the pilot flying, the CAPT should not have been doing this."

- "Simply follow instructions-publishes missed approaches are seldom executed so amended instructions are expected."
- "Go-around was briefed before approach so it was no issue when it happened"
- "Just follow instructions."
- "Given faster/slower than my experience in real life"
- "Safety of flight"

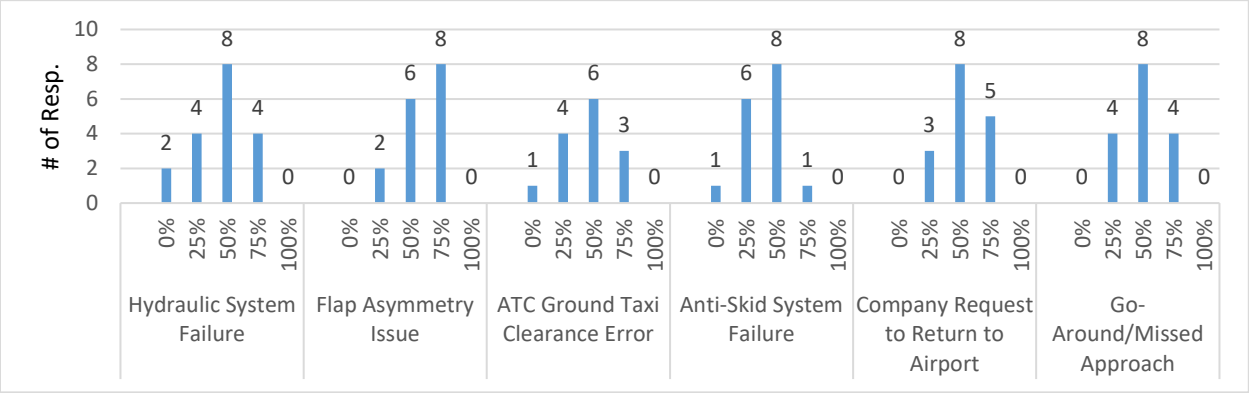
Question 19) Please comment on **how the NASA LOFT events could have been improved to better induce the channelized attention state**.

- "The go around with changes was very good. A flap asymmetry with a subsequent hydraulic failure would compound the one problem and cause further focusing of attention. Probably any multiple event type emergencies all in the same common view of aircraft systems would make the pilot channelize more of their attention on one area of instruments."
- "They did plenty. It is very easy to overload a pilot."
- "Actually, the greatest channelized attention state (and not asked about on the previous question) was the fuel leak and resulting fuel imbalance. Keep that event in the LOFT and ask about it in earlier questions on this survey."
- "introduce more ATC comm work to add workload-force PM on Pilot communicating to either (illegible word) with increased workload on (illegible word) an emergency to reduce ATC distractions. ATC missed approach toward a heading pattern with weather to avoid"
- "Increase the anomaly complexity with system degradation, instrument failure… Have PM respond slowly/and or inaccurately."
- "Malfunction the kicks off A/P (even Brce/ly) would cause fixation or add external party/resonance. Mx request through a carts that fuel probe is degraded. Any "liquid" leaking would cause focus."
- "Perhaps an instrument that fails intermittently. It would cause the pilots to focus more attention to it."
- "Bring traffic conflict at LE000 to an RA (Radar Altimeter) requiring action. Reduce the braking action to where is at runway limit. Set the scenario by possibly saying no alternates are available and mem is the best they have. Wx in surrounding areas has diversions at all airports."
- "increase complexity of event more subtle, more issues"
- "multiple system problems, in most cases aircrew are fatigued late night, early morning flights, airline schedules are an ongoing problem, not sure how we could simulate fatigue other actually show up for sim session on little rest" (no coffee lol!) Overall, NASA LOFT is real accurate. Not often or likely for multiple system issues unless they are related, i.e. hydraulic"
- "Return to airport; have crew contact company on H2 radio while ATC keeps interrupting"
- "The NASA LOFT event was well-designed but could have been improved if the simulator was not hybrid but a standard type"

Question 20) Please indicate the **likelihood each event would induce <u>channelized attention state</u> during an airline training center LOFT training scenario**.

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please rate the likelihood of the following LOFT events in terms of whether it would/could induce channelized attention if used as part of an airline training center LOFT.



Please provide a comment for the reason for your rating.

Hydraulic System Failure

- "Again, making sure correct check list is used."
- "Temporary until cockpit tasking assigned"
- "Certainly, dual failure"
- "Most airline pilots are experienced enough not to become channelized on these issues. Tasks would be divided among crew onboard."
- "it required hand flying aircraft"
- "We practice this a lot- depends on phase of flight"
- "Usually multiple problems associated with this system"

Flap Asymmetry Issue

- "The bigger the flap asymmetry the more channelized"
- "Once aircraft is stabilized and checklist done, not much else to channelize attention."
- "Situational-poor runway conditions and high approach speed"

ATC Ground Taxi Clearance Error-

- "LOFTS are usually at familiar airports."
- "Training is pretty good to get us to just stop-until directions cleared."
- "In hotspots, yes."
- "Good SA will keep you out of trouble"

Anti Skid System Failure

- "Over-saturated"
- "Not a major concern or requirement for dispatch."
- "Phase of flight dependent-runway conditions"
- "Not a big issue unless RCR is poor"

Company Request to Return to Airport

- "This is currently a common sim technique to get pilots to go to the airport the training requires."
- "Depending on nature of recall"
- "Rare"

ATC Amended Go-Around Clearance

- "Same as previous page"
- "Channelized attention generally results from confusion or unfamiliarity. LOFTs at airline training centers are done on aircraft the pilot is/has been trained on. Therefore, the scores above reflect familiarity and higher level of system understanding."
- "If complex, very easy to channelize attention"
- "At the point of highest workload-a-go-around"
- "Safety of flight not a common occurrence"

Question 21) Please comment on **other events that you think may be useful LOFT events** to include in airline training center LOFTs **to induce channelized attention**.

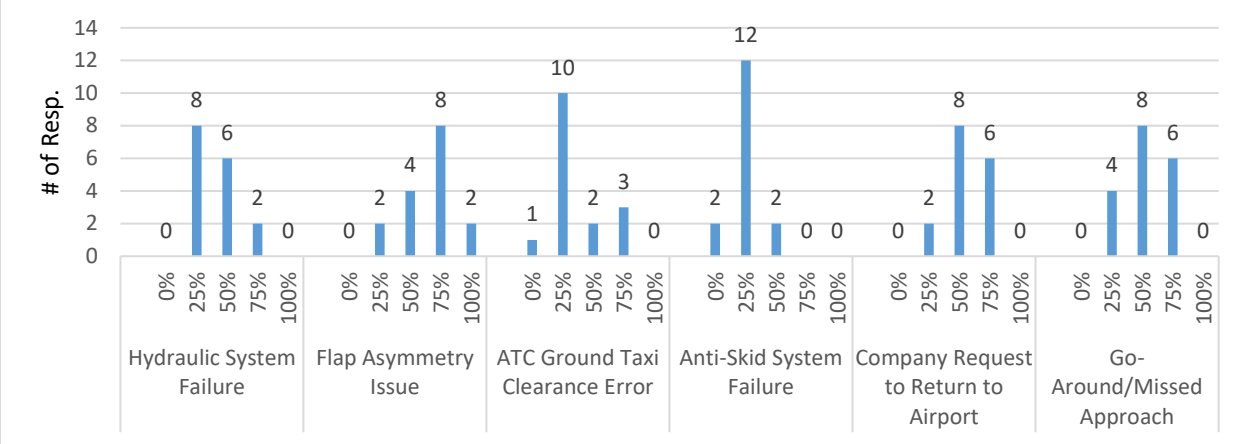
- "As stated earlier multiple events all in the same common area of an aircraft system would make the pilot focus more on that same area. But with two pilots working on problems (one flying, one running check lists) usually helps minimize the channelization. Of course by having the aircrafts autopilot not work makes the pilot tend to focus more on instruments and they could miss other distractions or instructions due to the additional workload of flying a partially disabled aircraft."
- "Any emergency that involves a lengthy checklist and coordination with a time constraint; i.e. smoke and fumes, fire"
- "Degraded flight or handling characteristics. For example, trim jammed (elevator, rudder, and/or (illegible word), one landing gear not down and locked/real or indication problem, like the L-1011 in the Everglades), or other which require abnormally high levels of effort to "keep the blue side up" or high concentration to diagnose the problem. The fuel imbalance in the LOFT was a great example."
- "Emergency descent due to a pressurization over terrain with o2 mask on morphing in to an additional system failure (loss of display, EFIS Control Panel failure, Nav Inertial…that should induce channelized attention.) These represent those "other" scenarios we discuss but rarely train to. Fire, engine and hydraulic failures are the common core of what typical training encompasses."
- "Crews rely on checklist. Instructor should/could have generic paper checklist for crews (handed at time of emergency or crew must ask for checklist) not (illegible word) with EFB. EFB convers/hides a lot of human mistakes. (illegible phrase) and EP, LOL!"
- "Training has moved away from compound failures for a couple reasons-First, a LOFT is already a high-pressure checkride. Secondly, experience has shown that except in remote occurrences. Most failures are not compound. Create a LOFT scenario as ANSA has and stress that it is a no-fault training scenario. There really is a limitation on time and assets. They barely make the minimum requirements as is. Of course, a LOFT ride on which your continued employment is determined is fairly stressful and leads to channelized attention."
- "Wind shear events clogged (illegible word) static systems"

- "Weather or turbulence related issues. Happens often in line ops. It can consume a lot of attention when dealing with exiting"
- "Intermittent faults that distract attention. Approach changes after initial clearance"
- "Channelized attention is usually caused by overloading or new and unusual situations. These are difficult to create. Perhaps more unusual problems could create channelized attention."

Question 22) Please indicate the **likelihood each event would induce <u>channelized attention state</u> during actual line operations**.

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please rate the likelihood of each following LOFT events in terms of whether it would/could induce channelized attention if used as part of an airline training center LOFT.



Please provide a comment / reason for the rating.

Hydraulic System Failure

- "Just make sure proper checklists are utilized."
- Airborne, you rarely know why a hyd system failed, concern about cause could drive channelized attention"
- "Same, but this is real!"
- "Not time critical"
- "Multiple problems could occur with this system"

Flap Asymmetry Issue

- "This just requires time to complete the checklist and ATC will do what you ask."
- "Once aircraft stabilized and (illegible word) completely not much to it. Make it at end of flight on go-around and how fuel state-then attention could channelize."
- "Situational dependent"
- "during critical phase of flight"

ATC Ground Taxi Clearance Error

- "This would not be a major factor since we just stop and sort out the error with ATC."
- "We just stop and figure it out. Ask for progressive taxi"
- "time critical"

- "Abrupt timing"
- "Keep SA and confirm will keep you out of trouble"

Anti Skid System Failure- 0%

- "Not a lot happens with this."
- "Not a big deal"
- "detected by warning system"
- "usually not a problem unless poor braking action"

Company Request to Return to Airport

- "Slightly more than the LOFT because other information has to be passed to the company, flight attendants, and passengers."
- "Common in sim training"
- "not time compressed, methodical"
- "who cares! Lol!, low priority"

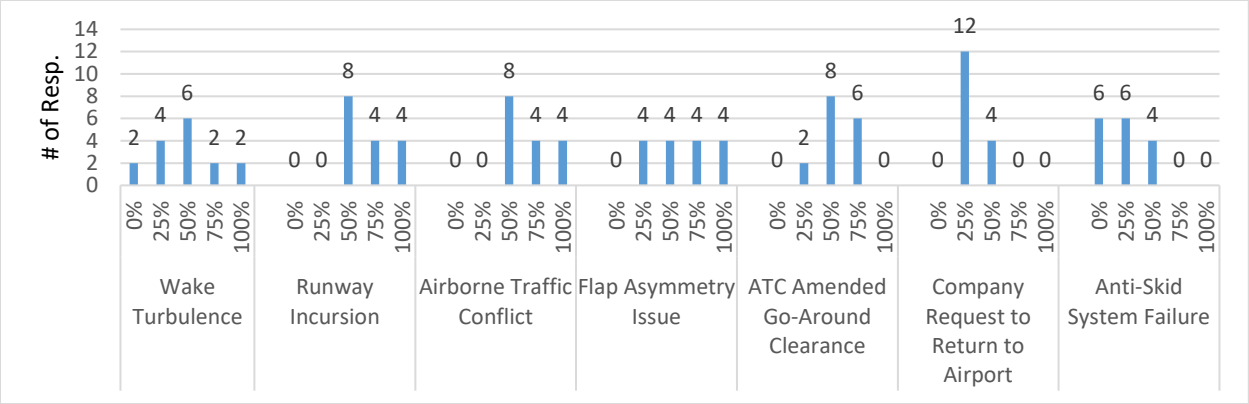
ATC Amended Go-Around Clearance

- "As stated before many things going on at once (go-around-changing altitude and headings)".
- "All scores under 50% due to pilot familiarity with aircraft and aircraft systems. Unfamiliarity with ATC, procedures, and aircraft bang the scores only slightly higher."
- "Add in mountainous terrain, language barriers (South America), and darkness and this could be significant."
- "Abrupt change during critical phase"
- "compressed procedure could cause missed communication or SOP's"

Question 23) Please indicate the **level of <u>startle/surprise</u> you estimate you experienced** as a result of each of the following NASA LOFT events.

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please provide an estimate in terms of % of startle/surprise with 0% representing not startled or surprised at all and 100% being fully startled and/or surprised when it occurred. Startle is defined here as, ***"The startle reflex occurs in response to intense and abrupt auditory, visual or tactile stimuli."*** *Surprise is defined here as,* ***"a pre-emotional response caused by a violation of expectancy which, if sufficiently intense, can trigger the fight-or- flight response."***



Wake Turbulence

- "Knew it was coming with heavy in front of us."
- "very short term"
- "Very abrupt (illegible word) should have been adequate"

Runway Incursion

- "Didn't expect it, but knew we would miss."
- "More anger that ATC screwed up-since we were almost stopped."
- "Saw A/C from afar"

Airborne Traffic Conflict-

- "Saw this coming due to TCAS."
- "Usually can see them coming."
- "can see it develop on TCAS"

Flap Asymmetry

- "Not really surprising –already expecting emergencies- in the sim."
- "Not a big deal"
- "Slow to develop no adverse control issues"

ATC Initiated Go-Around

- Comments: "Again when in the sim always expecting a go- around."
- "We practice these a lot"
- "Stabilized approach, always anticipated"

Company Request to Return to Airport

- "Just something different not startled."
- "Common in sim training"
- "Methodical no hurry"

Anti Skid System Failure

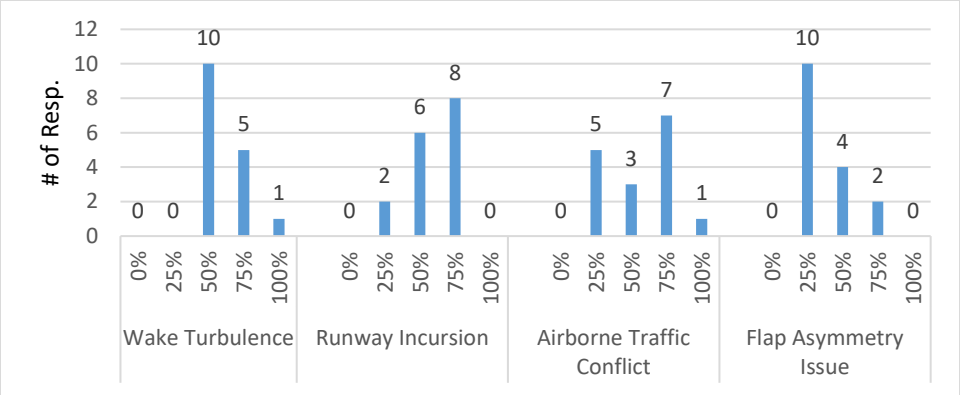
- "Again not startled."
- "Not a big deal"
- "usually distracted with fault light"

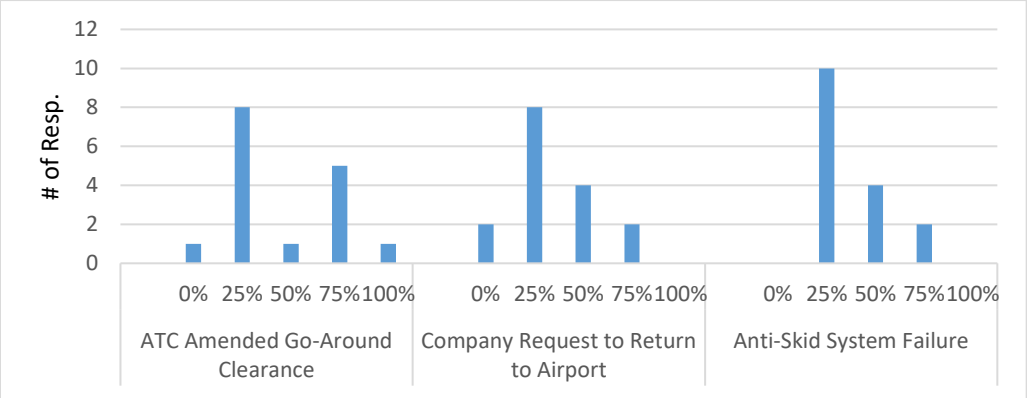
Question 24) Please provide a comment / reason for the rating.

- "As I had said in the debrief after the heavy takeoff on a parallel runway then cruse (sic cruise) our runway so we would not see it takeoff. Make the go around closer to the ground or have to A/C taxi across the bend of the runway as we approach to touchdown and then let the pilots see and avoid on a go-around. Mke the taxi error be that ground (illegible word) you taxi into a taxi way with a A/C taxing towards you're A/C."
- "You always expect the unexpected during a training event."
- "Make several point of calls to pilots of traffic which cause no conflict, before one actually generates a TCAS TA/RA. Have ATC initially say "Fly published missed" and then shortly there after change the instruction. Have wake vortex generating aircraft takeoff on parallel or intersecting runways. Also have the wake encounter caused by a heavy aircraft ahead, which is flying above the glideslope while trying to configure for landing and then descends rapidly (the scenarios which resulted in the actual crash of a business jet following a B-757 in Billings, Montana in the early 90s I believe). Have the flap asymmetry occur on takeoff/clean-up rather than on landing (every asymmetry I've experienced in LOFTs have been on landing."
- "Surprise and startle are a hard thing to induce in the sim. By nature "we" expect the "wheels to come off the wagon." Increasing complexity will surprise as we don't typically train to multiple events (except check airman giving check rides to other check airman). Surprise event (1) Dual Engine event-bird strike, 1 engine rolls back/fails while the other alerts Fire but still produces thrust. (2) Complete hydraulic loss with RAT failure *(DC10 in Iowa) aircraft pitch, roll and AS controlled by throttles. An eye opening event….."
- "Delay landing clearance due to aircraft traffic; then give LND CLR, on short final, followed by vehicle that crosses runway. (it happens)."
- "Maybe simulating an explosion or jolt would have more of a startle/surprise effect than a graduate decrease in a system failure. More lights and horns to add to the confusion."
- "make braking action at airport worse than reported so we still had significant stopping distance when we first saw crossing acft. Keep acft in wake turbulence longer or put in a series of intermittent wake turbulence events"
- "Bring the traffic conflict up to an RA"
- "more events"
- "I think a lot has to do with overall experience in line ops flying and the pilots background, i.e. type ratings, military experience, international flying"
- "Traffic conflict that turns into a RA"
- "The two events that startled me were very startling"
- "Having the wake encounter happen later in the LOFT maybe during landing instead of takeoff may increase startle/surprise because we expect the event in LOFTs during takeoff but do not get it often during landing (usually get wind shear instead)"

Question 25) Please indicate the **likelihood each event would induce <u>startle/surprise state</u> during a LOFT training scenario.**

Please rate the likelihood of each following LOFT events in terms of whether it would/could induce startle/surprise if used as part of an airline training center LOFT.





Please provide a comment / reason for the rating.

Wake Turbulence
- "But short duration"
- "No advance indication"

Runway Incursion
- "If aircraft in position when breakout at 100' on CAT II"
- "Abrupt"
- "Safety related"

Airborne Traffic Conflict- High to 25%
- "Do in UMC with failed TCAS, Aircraft just appears and causes evasive action."
- "TCAS warnings in advance"
- "Happens frequently especially in the tracon"

Flap Asymmetry
- "Slow to develop"

ATC Initiated Go-Around
- "Night, mountains, foreign language, multiple instructions"
- "Abrupt change during critical flight phase"
- "Safety related"

Company Request to Return to Airport
- "Too routine. Nothing surprising."
- "No pressure, methodical"

Anti Skid System Failure

- "Not a major event"
- "not during critical phase"

Question 26) Please comment on **how the LOFT events could have been improved to better induce the startle/surprise state** in the NASA LOFT you experienced.

- "(1) Runway incursion in the flare. (2) Traffic conflict on take off (drift over from parallel runway, acft on the go?? Or low vis approach (PRM) close in drift over. (3) Flap asymmetry with controllability issues related to AS"
- "Erroneous or untimely calls/messages from cabin or external parties/assets"
- "Increase number of scenarios"
- "I feel it's experience"
- "Airline LOFT scenarios need to be survivable, the NASA LOFT runway incursion wasn't"

Question 27a) Please comment on **what other LOFT event types you think would be good candidates** for use in LOFT scenarios **to induce startle/surprise**.

- "Loss of all electric for a few minutes which could cause an unusual attitude. Just the standy (sic standby) attitude indicator (failure of all instruments)."
- "Door opening on T/o, V1 cut"
- "Fuel leak, impending fuel imbalance, loss of pressurization (not slow leak, not explosive), landing gear partial extension, can be actual or (illegible word) problem."
- "Wind shear, rejected T/O, Rejected landing, Engine fire"
- "Sudden Air Speed drop, loss of display, Nav inertial sys, airspeed unreliable at rotation (possible system anomalies, alerts can cause counter intuitive responses), predictive wind shear, RNAV RNP approaches with failures, brake failure on rollout with NIL braking on runway, asymmetric (sic asymmetric) thrust issues, I liked the rapid fuel loss…good one!"
- "Any intermittent systems problems finally goes away, but the focus is still there. "set up".
- "Failures that can be fatal and result in significant loss-of-control of aircraft are more likely to cause startle/surprise"
- "Catastrophic failures would get more of a startle/surprise effect and increase stress of event"
- "other pilot incapacitation (heart attack), unexpected weather-sever turbulence, loss of all generators"
- "Engine failure critical phase of flight. Turbulence on approach. Dual FMC failure."
- "Wind shear"
- "Low level wind shear on approach, runway incursions, rejected landing, lightning strikes, heavy icing"
- "TCAS"
- "Runway Incursion"
- "Wind shear, flight control malfunction resulting in uncommanded pitch or roll"
- "loss of electrical power"

Question 27b) Do you think a loss-of-control due to icing conditions event type would be a good candidate? Why or why not?

- "Yes if it happens so you don't realize it's going to occur."
- "Yes, maybe not loss of control but definitely losing you're A/S (ALS?) and altimeter due to Pilot static icing. Requires relying on throttle position and other engine instruments.
- "Yes, I believe it would test the pilot's abilities to determine they are in icing conditions, take the appropriate action to get out of icing and for employ proper anti-ice/de-ice equipment, don't extend the flaps and shut off the autopilot (this last one will almost never happen). We keep having these icing related crashes with the crew taking no action or the wrong actions. We need to train to this until it stops."
- "If associated with Pitot static icing and instrument failure or unreliability"
- "Excellent choice. We are studying JAL's problem and just releasing new procedure to handle."
- "Maybe, but modern A/C have so many systems of alert (&/9) anti/de ice. But good exercise to find stable WX"
- "TCAS would be a good event. Yes, it is not normally trained"
- "Yes, it would force you to think outside the box. What if this happens and you have no checklist or never have trained for this. A good example is the DC-10 accident that landed with no HYD or the landing on the Hudson river."
- "Not sure. Event is usually slow and insidious"
- "Recoverable? Phase of flight? Complicated to brief without giving away? Frustration with crews not able to use their company procedures?"
- "Good scenario but slow developing, minimal startle"
- "Absolutely, it requires immediate response which may or may not accomplish complete recovery of the aircraft"
- "Yes, not normally trained"
- "No, to slow on-set"
- "Yes, icing building can be insidious"
- "Yes"

Question 27c) Do you think a bounced landing event type would be a good candidate to induce startle/surprise? Why or why not?

- "Yes, but we see what is happening on landing, so it (illegible word) not be that much of a surprise."
- "No…Negative training"
- "No. Some pilots bounce landings, all the time on the line ☺. Seriously though, the stability of the approach should already be an indicator of whether the landing will be a bouncer, so there should be little startle/surprise. Also the unfamiliarity with the sim will no doubt leave pilots to blame the scan rather than take the bounce as a startle event.
- "Yes, getting a pilot to induce it would be unrealistic however a wind/gust event would work in the flare"
- "Absolutely a great idea (or rejected landing after touchdown (no reverse thrust applied)). Enable good discussion on relationship between Vref and Vr, simple exercise that can cause surprise and can lead to runway excursions on contaminated runways, early rotation problems…"
- "Difficult to set-up. (Short (illegible word/illegible word) carrier LND) also happens every day on long rwy"

- "Potentially if done without inducing negative training"
- "Yes, that is something we don't expect or practice."
- "When these happen, you know they are coming. Perhaps a sudden wind shear while in the flare could case startle/surprise"
- "Yes-we never practice a (illegible phrases) this type"
- "Yes, critical phase of flight, at low energy state, end of flight (illegible words)."
- "Sure requires quick response"
- "No. How do you induct it without negative training?
- "Yes, real world, unexpected"
- "Yes, but not sure how you would induce the bounce"
- "Yes, but it has to be set-up so we do not see it developing on landing"

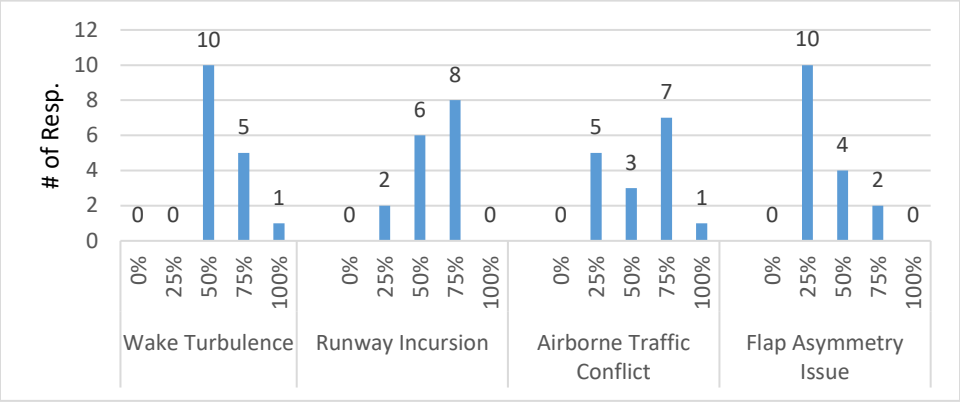
Question 27d) Do you think automation event types are good candidates to induce startle/surprise? Why or why not? If so, which automation type events would you recommend? Please provide a comment on reasons for recommendation.

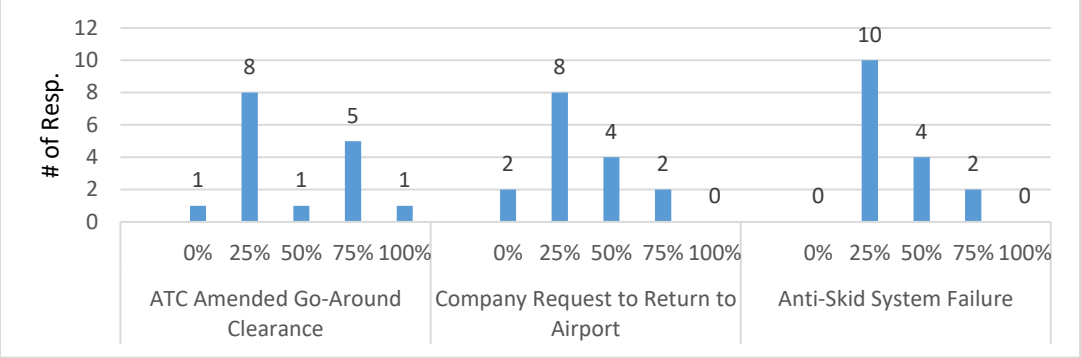
- "Somewhere some of automation kicks off (L NAV or VNAV) not sure what others."
- "Yes…Increases awareness, autopilot disconnecting without a warning"
- "Yes. The best indication of startle/surprise I think is the phase (sic phrase) "What the ----?" which comes when automation is turned off or does something unexpected. Good events would be the disconnect of the autopilot as the aircraft encounters too much ice and begins to stall (Buffalo, Detroit, and Roselawn accidents), or disconnects because of unreliable sensor inputs (A330 over the Atlantic accident)."
- "Symbol generator failure, auto throttle loss, autoland abnormality forcing a missing approach/go around"
- "Runway Stab Trim at rotation will cause startle, CAT III Autoland AP failure in flare/touchdown, very low RVRm we typically train to failure prior to TD or after landing has occurred with LOC tracking issues."
- "Absolutely. Automation or lack thereof, is the new killer. SFO/B777"
- "If unexpected and done when complacent"
- "No, reverting to flying the way we always were taught would be easy to do."
- "Runway nose trim is usually surprising"
- "There is enough dissimilarities in the generic sim from our type fleet aircraft. So it won't take much to create more startle/surprise."
- "Minimal startle, minimal loss of control, easy to recover from"
- "Low weather/vis approaches, where autopilot falls would require high amount of attention"
- "Unexpected disconnects and creating situations that lead to overreliance on the automation"
- "Yes, Real world, unexpected"
- "No, if pilots have good awareness of automation mode, they should never be startled"
- "Create automation confusion but having partial automation failure or revert to partial manual control where LNAV or VNAV is unannunciated."

Question 28) Please indicate the likelihood each event would induce <u>startle/surprise state</u> during actual line operations.

Note: A list of LOFT events were presented in the questionnaire that are not duplicated here

Please rate the likelihood of each following LOFT events in terms of whether it would/could induce startle/surprise if used as part of an airline training center LOFT.





Please provide a comment / reason for the rating.

Wake Turbulence

- "Usually know it's coming."
- "Always a surprise-even when you expect it"
- "It is severe, yes!"

Runway Incursion

- "Knowing where we are we don't expect a runway incursion from another A/C."
- "Should never happen so should be surprising"
- "Safety!"

Airborne Traffic Conflict

- "Have already had a near miss with a VFR A/C so yes it was a surprise, but."
- "Fairly common"
- "RAs for sure"

Flap Asymmetry

- "Don't expect problems like this often."
- "A non-event usually"

ATC Initiated Go-Around

- "Usually see it coming, but occasionally it is out of the blue."
- "Especially if at busy airport (NY, ORD, DFW)"

Company Request to Return to Airport

- "Would be a surprise because it would mean something is very wrong."
- "A non-event"
- "Who cares! Lol!"

Anti Skid System Failure

- "A non-event"
- "Only if braking action is poor"

Question 29) Please comment on **events that you think may be useful LOFT events** to include in airline training center LOFTs **to induce "confirmation bias."**

Confirmation bias is defined here as, ***"Making a decision based on faulty information or incorrect reasoning (sometimes when task-saturated) and the cognitive phenomenon in which decision-making is biased early in the decision-making process in favor of one understanding of events or one course of action at the expense of others."***

- "Again multiple emergencies compounded from one event leading to other events."
- "Multiple emergencies"
- "(Illegible word) blocked (illegible word) sensors during climb, causing false increase in airspeed with increase in altitude, or during descent causing decrease in speed with decrease in altitude. These will cause confusion as the autopilot adjusts pitch and thrust lowers while changing airspeed. This will usually result in the "What the ----?" comment just before the autopilot gives up. Landing gear indicator bulb burn out on taxi out, found and fixed before takeoff and then the same gear does not indicate down and locked following extension. Most pilots will usually assume it's the light again (confirmation bias) and not believe one gear is not actually down and locked. On aircraft like the B-737 where the gear warning and pressurization one the same or similar, introduce a hydraulic failure at the same time as a pressurization leak brings the cabin to the point where the warning sounds. Most pilots will believe the warning horn has nothing to do with the hydraulics and landing gear (confirmation bias) and miss the cabin pressurization problem. (Taken from B-737 flight Cyprus to Greece which crashed when the crew lost consciousness thinking the gear was sounding).
- "Inertial, air data, GPS, HDG, ATT, ALT, Anomalies would all work- each takes analysis of the faulty component and affected instrument-one false guess at analysis on reasoning would be critical –plus instrument/NAV systems are typically the least understood compared to fuel, HYD, (illegible word) and (illegible word)"
- "(1) Rapid decompression due to possible structural issues followed by a NAV Inertial System failure or Display Failures. Emergency Descent has it (sic its) own set of perils especially in terrain critical areas couple with display failure or primary flight instrument failures. (2) Fwd/Aft Cargo Fires that don't extinguish with high ambient temperatures at low altitude and low cabin differential pressure, electronic equipment may fail. (3) No event happens after multiple events…unsettling for the pilot in sim…"
- "Having 2 malfunctions, on opposite ENGs/sides. Either related or unrelated systems."

- "Give conflicting information from multiple sources or indicators to add to the confusion. This would make the individuals try to work through each indicator more methodically to try to isolate the actual problem."
- "False glide slopes, radar altimeter failure, airspeed errors, processing ADI, conflicting instrument readings CAPT vs FO"
- "Tough to do-must create a no-fault LOFT in order to positively accomplish."
- "Pilot static issues, unreliable airspeed"
- "Instrumentation issues are quite mundane and could lead to channelization and poor decision making, if: "everglades crash" on the airbus we say: "What's it doing now"! so good comprehension of system and instrumentation may help mitigate false confirmation and poor decision making."
- "upset recovery"
- "Have multiple events and emergencies so there is significant time pressure and have the pilots trouble-solve on several problems and then use events that can have multiple causes and solutions but give indications that suggest that the easiest solution worked (at first) but really only pushed the problem until later and then when it shows again they think it was already solved and was long time ago and so can not connect up the issue with the original problem. "

Question 30) Please comment on **events that you think may be useful LOFT events** to include in airline training center LOFTs **to induce "diverted attention."**

Diverted attention is defined here as, ***"To be distracted by actions or thought processes associated with a decision."***

- "Emergency combined with anomalies"
- "Late issue of "takeoff number" (bad closeout) while the aircraft is in hotspot areas and/or actively crossing runways to introduce runway incursion possibility. As an F/O on the line, I've actually had to tell Captains, "No, I'm not putting the numbers in until we're across the runway [or out of the hotspot], and each time the Captain was not happy because of the pressure to get the numbers in before getting to the end of the takeoff runway. Have tower controller relay icing report of immediately departing aircraft in low overcast to see if crews focus on icing and forget about wake turbulence. Issue/change clearance to land on parallel or intersecting runway about 5 miles from runway, (illegible word) final aircraft configuration in good weather. See if both pilots go "heads down" to fly the airplane first and still get configured in time for a stabilized approach."
- "Traffic conflict, weather issues, medical event, runway conditions, security issue, VVHF/Data link comm failure, pressurization failures, any of these events causes diverted attention from PF and PM flying requirements"
- "Dual engine issues (different on each) on Takeoff or missed approach low vis. Unreliable AS on Takeoff"
- "Kick off A/P, communication chatter, noise, un-related messages, calls from cabin, DISP, MX, ATC, other planes erroneous noise or warning system going off. (amber lite on bell or door strap hanging outside the plane-making noise) it happens. Normal cabin call that happens at inopportune time. Changing airport runways, unusual WX"
- "Have ATC, company, flight ATT, unexpected weather interfere with tasks trying to be worked thru"
- "Call to cockpit from 3rd party –(F/A, Compant on Comm2, J.S. rider, etc), unusual blinking light, intermittent failure indications, problems with EFB, TCAS traffic on apparent collision course"

- "Staged multiple malfunctions designed to interrupt the analyses/actions of a prior equipment failure. "C" Hydraulic failure-one gear fails to lock extended (down). –forced go-around or.and fly-by (illegible word) tower."
- "Any warning light issue especially audio warnings that can't be silenced"
- "Having system problem in high load operations, i.e. weather, approach phase, multiple communication errors with ATC"
- "Use divert scenarios that have multiple options and require discussion/information gathering"
- "Use ATC amended clearances and significant interruptions and have partyline communications difficult to understand but suggest issues or conflicts possible so they crew has to pay close attention to communications and that diverts attention when an event happens all during a high workload phase of flight (e.g., issues with fuel, poor Wx, congested airport, another aircraft with priority due to medical emergency, etc.).

Question 32) Please provide overall comments on **what you would recommend to improve the quality of current LOFT scenarios** typical in use by airline training centers today.

- "LOFTs are fine the way they are. The multiple emergencies post LOFT period is great to test the pilots skill level also."
- "Introduce anomalies"
- "use research/findings conducted by NASA regarding channelized attention, startle/surprise, diverted attention and confirmation bias to address root causes of why we make mistakes on poor decisions, different mistakes but with a similar root cause"
- "Real time (as sim time/period allows), we use a set of scenarios that occur in multiple divisions (domestic, Atl & Pac) (South AM and Pac have similar terrain issues so SA is omitted.) Events occur at an equal distant point to logical divert bases depending on scenario (engine selection predicated on multiple factors to include suitable vs emergency, weather, fuel…to name a few. This is a new adaptation recently released. I like these options as they force critical thinking on a number of levels. I wouldn't make changes at this time, our new program needs time to mature."
- "Brief, demonstrate, de-brief"
- "Make them non-jeopardy. At that point you can make them less "canned" and more of a learning vice evaluation event."
- "Add more time to create the type of LOFT you all are creating."
- "More instrument anomalies"
- "More weather related scenarios, wake turbulence, lightning strikes, wind shear, heavy icing, poor communication in tracon approach phase of flight"
- "More normal real-world events like cabin crew communications, ATC conflicts, MEL complications"
- "Adding an icing possible loss of control event would be good. But need to overcome the issues of the sim must be survivable"
- "More realism in LOFT that include the types of issues we see on line particularly distractions (e.g., cabin crew, Wx, paperwork, company dispatch changes, etc.)"

Question 33) Please provide overall comments on **what you would recommend to improve the quality of the NASA LOFT scenario** you experienced today.

- "As said earlier it was good. Our on (sic own) A/C type would make us more familiar."

- "It was very well thought out. As stated earlier to make it more realistic to an actual line event there needs to be the same resources available to the pilots."
- "I thought the sim profile was well planned. I would have liked my iPad for a higher level resource (and comfort level). The go around after initial approach with the hydraulic problem caught me a bit off guard forcing a reversion to a lower level of overall automation (including the aspect that the autopilot failed) and forcing a higher level of interaction with my PM. Good one!!!"
- "ATC comms should have natural pause after giving instructions to NASA flight"
- "No hybrid sims. Either all Boeing or Airbus. "
- "The biometric devices were a pain- not just from a point of comfort, but from an inability to go outside and take a mental break"
- "More scenarios"
- "LOFT was well-designed."

Question 34) Please provide overall comments on **anything you would recommend to improve the NASA Experiment** you experienced today.

- "Happy to help and hope the experiment some useful data for improving scans and safety in the airlines."
- "This answer applies to questions 32, 33, and 34: I believe LOFTs should be designed around actual events. This doesn't mean they have to be fatal accidents. In fact, I think more can be gained from near accidents, and events where a series of problems cascade, to see how other crews may have stopped the cascade earlier or even if they allow it to continue further. We should be using the ASAP reports to identify scenarios from which LOFTs can be developed. Part of my reason for saying this is it's become apparent the ASAP reports are being (illegible word) as "get out of jail free cards" and not the safety program it's designed to be. A great deal of information on distraction, surprise, and performance can be gathered if pilots see ASAP reports as protecting them and also being the basis for developing LOFT scenarios where these events can be trained, in the case of normal ops or prevented in the case of accidents or near accidents. There are so many cases of bad results which started off as normal expectations which were mis-handled, missed entirely or compounded by bad decision making. Jets use this information (several examples I've given here) to design LOFTs to show what could happen with different (good or bad, right or wrong) actions at key decision points."
- "I wanted to make you aware that my survey answers may be somewhat skewed relative to my peers due to my recent experiences. My Flight Department has recently (last 30 months) gone through a dynamic shift in training philosophy (*unable to see text because of computer text box covering answer)* merger of ostensibly 3 airline forced an "adopt and go" philosophy using best practice (*unable to see text)* The result was a top to bottom evaluation of how training was being conducted which dictated a revamp/rewrite of training curriculums across all fleets. The airbus and B787 programs led the process. As a B787 initial cadre check airman I've been involved with the development and rollout of these progressive changes. Our new vision statement is "Provide an industry leading, world-class training experience to our pilots" and a flight training department philosophy to "Train the way we fly, fly the way we train." As a result, my perspective of simulator and line oriented training practices has also had a dramatic shift from the old standard to this harmonized "better mouse trap". The evolution of our training department mandates that our programs, training devices, policies, procedures, operating practices, checklists, and manuals mist work together to reflect and promote consistency from the start of ground school through

line operations. To that end; my fleets' training devices are optimized to facilitate the transfer of learning from theory to practice. Our principles of Crew Resource Management (CRM) and threat and Error Management (TEM) are being integrated with knowledge and technical competencies. Our procedures are aligned but structured to avoid the compromising of aircraft operational capabilities for the exclusive purpose of overall fleet standardization. Our training is validated through performance evaluations (trainees and trainers) and improved through feedback. This is a much different airline than the one I started with almost 30 years ago. We are a much safer, better trained and operated airline."

- "Let me ponder that one. Nice Job by all! ☺"
- "NASA did an excellent job in trying to recreate real operations and to try to put pilots into a certain state or show signs of channelized attention or being startled which can be hard to do with highly trained pilots that are expecting something to go wrong"
- "Overall it was an excellent study. Nothing to change other than maybe not flying a hybrid sim."
- "We understand funds are tight, but there was too much stuff covered for 2 days. What we covered would have been better presented over 3 days."
- "Excellent training experience, great self-awareness experience. Call me back if you need me, short notice no problem-great job all around! Thanks."
- "Overall excellent program run by great group of professional scientists, engineers, and technicians! Very interest in returning for more studies, thank you!"
- "More comfortable head probes (fNIRS)"
- "Improve the simulator so there are not so many differences from Boeing and Airbus and resembles one type of aircraft instead of two or three."

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14. ABSTRACT

NASA Langley researchers addressed the Commercial Aviation Safety Team Safety Enhancement 211 through a series of studies to address "Attention-related Human Performance Limiting States" which include channelized attention, diverted attention, startle/surprise, and confirmation bias. The present report focuses on the development of improved training scenarios for operationally realistic Line-Oriented Flight Training scenarios. Areas addressed in the report include: (1) Highlights of events in the LOFT scenario used; (2) Interesting findings with implications for simulator motion; (3) Eye-tracking heat maps in proximity to failure events; (4) Researcher observations of crews as test subjects versus a pilot and a research team co-pilot; and (5) The results of a follow-up questionnaire completed by pilot participants regarding their usual training as well as the scenarios employed in the SHARP studies. These pilot ratings and comments are of value to simulation training developers.

15. SUBJECT TERMS

Crew State Monitoring; Flight Simulation; Pilot Training

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