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Evaluation of X-38 Crew Return Vehicle Input Control Devices in a Microgravity Environment

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Longview, Texas

December 2000

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December 2000

Acknowledgments

This report was created by students from Longview High School, Longview, Texas. Longview High School was selected from a group of Texas high schools to participate in the 1999 Texas Fly High Program. This program gives Texas high school students a chance to work with NASA engineers to design and fly a real-world experiment aboard the KC-135 during zero-g parabolas. Jeffrey Fox's role was to provide a concept for the experiment and to mentor the students in its design and testing. The students were responsible for executing all phases of the project.

Information contained in this report reflects data collected by the students, and the conclusions presented here were formulated by the students' team.

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Contents

Acronyms

CRV	crew return vehicle
ICD	input control device
ISS	International Space Station

Human Interface Demonstration

Flight Dates:	Tuesday, April 20 and Wednesday, April 21	
Investigators:	Longview High School Team	
	Flight Crew:	Amanda Grubbs Jason Mayes Bryan Lawson Kirsten Welge
	Ground Crew:	Don Robinett Ruth Ann Pope Alicia Moore Suzette Shivers Rachel Beene Michel Zoutendam
	Aided by:	Sponsor Cherry Moore (Flight) Sponsor Jessie Roberts (Ground) Mentor Jeff Fox Mentor Harold Robertson

Abstract

The X-38 Project Office at the Lyndon B. Johnson Space Center Johnson Space is designing a crew return vehicle (CRV) to be docked at the International Space Station for crew rescue in an emergency. Vehicle controls will be almost completely automated, but a few functions will be manually controlled. Four crew input control devices were selected for evaluation by Longview High School students as part of the 1999 Texas Fly High program. These were (1) Logitech Trackman Marble (optical trackball), (2) Smart Cat Touchpad, (3) Microsoft SideWinder 3D-Pro Joystick, and (4) Microsoft SideWinder Gamepad. In two flight tests in the KC-135 aircraft and a series of ground tests, the devices were evaluated for ability to maneuver an on-screen cursor, level of accuracy, ease of handling blind operations, and level of user comfort in microgravity. The tests results led to recommendation of further tests with the Joystick and the Trackman by astronauts and actual space station residents.

Purpose

The purpose of this paper is to (1) explain the research techniques used in the experiment, (2) document the results and data collected through the course of the experiment, and (3) discuss possible conclusions obtained from the data and possible sources of error.

Introduction

The X-38 Project Office at the Lyndon B. Johnson Space Center is current creating a crew return vehicle (CRV the X-38. The CRV is being designed as a rescue vehicle that will be docked at the International Space Station (ISS) and will be used in the event of an emergency. The Longview High School branch of the Texas Fly High Class of '99 helped to select the input control devices (ICDs) to be tested for use in the CRV. The CRV will be almost completely automated with a few crew control functions and selected manual backup functions. As part of the ICD selection process, the Longview Fly High Class of '99 NASA team conducted two flight evaluations and a series of ground evaluations of selected ICDs.

Experimental Equipment and Task

The experiment slated to the Longview team was to evaluate different ICDs for possible use in the CRV currently undergoing construction. After much consideration, the team selected four ICDs to analyze: the (1) Logitech Trackman Marble (Optical Trackball), (2) Smart Cat Touchpad, (3) Microsoft SideWinder 3D-Pro Joystick, and (4) Microsoft SideWinder Gamepad. Major criteria for selecting the most efficient ICD were an ability to maneuver the cursor using the ICDs, the level of ICD accuracy, how easily they handled blind operations, and the level of comfort in microgravity.

In their comparison of these ICDs, the Longview team was fortunate to have a computer programming major from nearby Letourneau University create a program for this specific use. This program, which was based on the Antiballistic Missile Game, tested each ICD's maneuverability and response. Subjects had to target a "missile" as it appeared at the top of the screen and click on the target to eliminate it before the dot reached the bottom of the screen.

Percentages were first calculated by the ratio of "missiles" hit to the number of shots fired. They were then recalculated as the ratio of "missiles" hit to the total number of target missiles. Each test conductor tested an ICD for 10 rounds.

To accurately simulate the X-38 environment, a committee of Longview High School team members designed a bracket that would hold a computer monitor above the test conductor, who was reclined on a seat with a 60-degree back angle. (See appendices for picture and diagram of setup.) During the experiment, an ICD was attached with Velcro to the armrest—also designed by Longview High School team members—which was positioned to the right of the test conductor.

Students on the Longview team were tested as were various NASA personnel. A mentor from the X-38 Project, a sponsor, or a journalist stood nearby and evaluated the tests. Another student acted as a test monitor and helped with different functions, setups, and performances.

Review of Flights and Ground Control Experiments in Remote Cockpit Van

Tuesday, April 20, 1999

Flight: The first flight in the KC-135 occurred on Tuesday, April 20, 1999. The flight crew was composed of Amanda Grubbs, Jason Mayes, Cherry Moore (sponsor), and Jeff Fox (mentor). This crew tested the Smart Cat Touchpad and the Microsoft SideWinder 3D-Pro Joystick. Grubbs succumbed to motion sickness after completing six rounds of the program on the touchpad. Mayes was unaffected by Nausea and completed all 10 rounds of the experiment on both the touchpad and the joystick. Most of the data from this flight has been drawn from Mayes' percentiles. The data from Grubbs' rounds has been factored only into the first six rounds of the touchpad data.

In addition, the testing procedure was slightly altered for the next flight to ameliorate the dilemma of getting a test conductor into the apparatus. For this flight, the ICDs were exchanged instead of switching test conductors. This lessened the chances of motion sickness.

Ground Control: Students on the ground crew alternated between testing the other two ICDs (the Logitech Trackman Marble (Optical Trackball) and the Microsoft SideWinder Gamepad) using the same seating/bracket apparatus as the one on the KC-135. The team was fortunate to have astronauts who were willing to participate in the experiment stop by. The astronaut data and that of other personnel who volunteered their time and percentages in the experiment were not factored into the primary source (student) data when the percentage averages were calculated.

Wednesday, April 21, 1999

Flight: The second flight day for the ICD experiment took place on Wednesday, April 21, 1999. The crew for this flight was composed of Kirsten Welge, Bryan Lawson, Harold Robertson (mentor), and Patrick McKenna (a NASA co-op student who aided in building the bracket). This flight was conducted to test the Logitech Trackman Marble (Optical Trackball) and the Microsoft SideWinder Gamepad. Welge, who was the first test conductor, finished all procedures for both the optical trackball and the gamepad successfully. However, Lawson, who was adversely affected by motion sickness, was unable to carry out the experiment at all. To salvage the remaining 20 parabolas and gather some comparison data, Welge and McKenna petitioned both of the Fly High '99 NASA program directors and a reporter to test the program. Fortunately, one of the directors logged 10 rounds of the program on the gamepad, which meant that comparable data for analysis was provided. Therefore, the data from rounds played on the trackball were collected only from Welge's percentages. The data from the gamepad are an average of Welge's and the director's percentages.

Ground Control: Once again, the ground crew tested the other two ICDs (i.e., the Smart Cat Touchpad and the Microsoft SideWinder 3D-Pro Joystick) in the same seating/bracket apparatus as the one used on the KC-135. A few more astronauts and pilots volunteered to participate in the experiment for a few minutes. Their data and that of other personnel who volunteered their time and percentages in the experiment were not factored into the primary source (student) data when the percentage averages were calculated.

Discussion and Conclusions

For data analysis, we classified the data into two sections: subjective and objective. The objective segment data were obtained through the scores received by test subjects in the program. The subjective portion was collected by means of questionnaires filled out by ground and air test subjects.

Objective Conclusions

Ratio of missiles hit to number of shots fired: The majority of objective data from both the remote cockpit van and the flights aboard the KC-135 confirmed that the Logitech Trackman Marble surpassed the other three ICDs with respect to accuracy and maneuverability. It is interesting to note that this result differed slightly from those of earlier experiments performed by the X-38 Office. These previous tests concluded that the optical trackball was "sluggish" in response time and did not function well in zero g since the trackball itself tended to float up. However, we believe this different result was obtained due to our use of Velcro and an armrest to secure the ICD. In the previous experiment the optical trackball had not been adequately secured.

Ratio of missiles hit to total number of target missiles: Oddly enough, these ratios for flight data showed that the joystick was superior to the trackball, especially in early rounds of the program. As the rounds progressed in difficulty, however, the trackball surpassed the joystick four times out of the last five rounds. The margin between the two ranged from 0.5 point to about 20 points, suggesting that a larger testing pool may be required for flight segments of the experiment in future. It is impossible to determine whether the margin is due only to a subject's greater ability on one of the ICDs or to a serious difference in handling. Data from the remote cockpit van were more evenly distributed. Here every ICD except the touchpad surpassed the others in at least three rounds. This distribution also supports the suggestion that a larger testing pool for the flight segment is required, since varying levels of ability would tend to cancel each other out. It could also indicate that there are no significant differences among the four ICDs, since the range of percentages for 4 of the 10 rounds was less than 8 points. If so, other factors might be used to determine the final choice of ICD; e.g., cost, applications, or even results obtained from a testing pool consisting wholly of possible pilots of the CRV (astronauts, mission specialists, etc.).

Subjective Conclusions

Subjective data suggest another ICD was the best selection. The questionnaire responses lean in the direction of the joystick. This disagrees with the first set of ratios and concurs with the second set of ratios. This is a reasonable result when the many games and flight simulators that use joysticks are taken into account. Tests conducted in the remote cockpit van by the ground crew, off-duty flyers, and NASA personnel test subjects indicated that the joystick was more comfortable, exerted less stress on the hand, and even maneuvered better than the other ICDs, despite data gathered from the first set of ratios. According to the second set of ratios, these reactions to the joystick seem confirmed by the performance of the joystick.

Discussion

The joystick certainly has its advantages. The pilots who likely will be flying the CRV will have much more training with a joystick than with a trackball. In addition, a few subjects (mainly astronauts and pilots) stated that, although the trackball was more "intuitive," they nevertheless preferred the joystick. However, the first set of ratios points to the optical trackball as being the best ICD for the task presented. There are some gray areas, due to the second set of ratios, which favor the joystick, then the trackball in zero g and indicate that the ICDs are basically on an equal footing in a large testing pool on the ground. It might be beneficial to discover why. Perhaps the joystick is better for simple maneuvering and quick, precise movements with lots of distraction We also must take into account possible disadvantages of the trackball. The person selected to guide the CRV to Earth will, in all probability be under a great deal of stress, and stress often manifests itself through trembling hands. This could be a severe detriment to this ICD, since the trackball registers all hand movements as "commands." In addition, the proper ICD may vary depending upon the task selected for the CRV pilot. If the task is to control the movement, descent, yaw, etc. (to actually "fly" the vehicle), the best ICD for the task may differ from the ICD best suited to a computer-guided descent, which requires only information and assent from the pilot. Our testing pool was also rather small, especially in the air where half of our crew suffered from severe motion sickness. Personal differences in experience and ability on different ICDs in a flight crew could account for some of the gap between performances of the ICDs. It would be worthwhile to explore this ideas as well.

Conclusions

If we were to use assumptions derived from the first set of ratios alone, we might conclude that the trackball is indeed the most capable ICD. However, after viewing the second set of ratios and the questionnaire responses, the data in fact indicate that the joystick is probably the best overall ICD. There is also a discrepancy between the flight data and ground data of the second set of ratios. Flight data certainly favor the joystick as well as the trackball in later rounds; yet the ground data show a much closer distribution among the four controllers. Our recommendation is that the joystick and trackball be further tested in a large testing pool composed of astronauts and other residents of the ISS, who might have to "fly" the CRV to Earth in the event of emergency. Such testing should show more clearly which of the two ICDs is better suited to be used in a guided descent of the CRV.

Appendix 1 – Graphs of Rounds vs. Percentages

Numerical Data and Graphs of Refigured Percentages

Scores for player A with controller 2:

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	4	1	9	44.44
2	6	4	10	60.00
3	4	12	12	33.33
4	4	16	12	33.33
5	0	24	0	0.00
6	9	28	12	75.00

Totals:
Missiles hit: 27
Missiles missed: 85
Shots fired: 55
Accuracy: 49.09%

Scores for player B with controller 2:

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	3	2	7	42.86
2	6	6	16	37.50
3	9	10	18	50.00
4	10	18	16	62.50
5	12	23	21	57.14
6	10	25	17	58.82
7	12	37	19	63.16
8	9	48	20	45.00
9	11	49	22	50.00
10	5	64	23	21.74

Totals:
Missiles hit: 114
Missiles missed: 367
Shots fired: 234
Accuracy: 48.72%

Scores for player C with controller 3:

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	12	0	19	63.16
2	12	0	21	57.14
3	14	6	21	66.67
4	12	13	24	50.00
5	21	16	27	77.78
6	16	25	24	66.67
7	18	32	33	54.55
8	20	44	32	62.50
9	0	65	1	0.00
10	16	64	31	51.61

Totals:
Missiles hit: 255
Missiles missed: 632
Shots fired: 467
Accuracy: 54.60%

Grndda.txt

Scores for player A with controller 1: (DR)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	11	0	11	100.00
2	10	8	14	71.43
3	14	12	18	77.78
4	13	18	17	76.47
5	17	28	19	89.47
6	11	37	13	84.62
7	9	35	16	56.25
8	12	51	19	63.16
9	6	59	15	40.00
10	11	69	15	73.33

Totals:
Missiles hit: 114
Missiles missed: 317
Shots fired: 157
Accuracy: 72.61%

Scores for player A with controller 4: (DR)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	10	0	14	71.43
2	11	3	14	78.57
3	8	19	18	44.44
4	14	18	15	93.33
5	13	22	16	81.25
6	11	32	17	64.71
7	15	37	20	75.00
8	18	48	22	81.82
9	15	62	27	55.56
10	11	77	24	45.83

Totals:
Missiles hit: 240
Missiles missed: 635
Shots fired: 344
Accuracy: 69.77%

Grndda.txt

Scores for player B with controller 1: (MZ)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	5	3	16	31.25
2	7	7	16	43.75
3	11	10	15	73.33
4	9	18	16	56.25
5	18	20	24	75.00
6	12	33	20	60.00
7	11	39	19	57.89
8	12	60	21	57.14
9	8	63	22	36.36
10	6	72	17	35.29

Totals:
Missiles hit: 99
Missiles missed: 325
Shots fired: 186
Accuracy: 53.23%

Scores for player B with controller 4: (MZ)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	9	1	12	75.00
2	9	5	18	50.00
3	11	9	16	68.75
4	12	13	13	92.31
5	9	22	14	64.29
6	13	26	17	76.47
7	7	35	13	53.85
8	10	43	13	76.92
9	10	47	20	50.00
10	10	63	14	71.43

Totals:
Missiles hit: 199
Missiles missed: 589
Shots fired: 336
Accuracy: 59.23%

Grndda.txt

Scores for player A with controller 1: (SA)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	8	1	16	50.00
2	9	5	16	56.25

Totals:
Missiles hit: 17
Missiles missed: 6
Shots fired: 32
Accuracy: 53.13%

Scores for player A with controller 3: (SA)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	3	2	16	18.75
2	5	5	18	27.78

Totals:
Missiles hit: 25
Missiles missed: 13
Shots fired: 66
Accuracy: 37.88%

Scores for player A with controller 4: (SA)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	7	1	14	50.00
2	7	4	18	38.89

Totals:
Missiles hit: 39
Missiles missed: 18
Shots fired: 98
Accuracy: 39.80%

Grndda.txt

Scores for player F with controller 4: (SS)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	6	1	7	85.71
2	7	4	9	77.78
3	10	6	16	62.50
4	10	11	13	76.92
5	4	22	13	30.77
6	8	23	18	44.44
7	11	34	20	55.00
8	4	45	16	25.00
9	7	58	19	36.84
10	6	63	20	30.00

Totals:
Missiles hit: 73
Missiles missed: 267
Shots fired: 151
Accuracy: 48.34%

Scores for player E with controller 4: (RAP)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	5	1	7	71.43
2	5	6	9	55.56
3	3	14	8	37.50
4	5	12	8	62.50
5	5	25	14	35.71
6	1	34	5	20.00
7	3	40	7	42.86
8	4	47	8	50.00
9	3	62	9	33.33

Totals:
Missiles hit: 107
Missiles missed: 508
Shots fired: 226
Accuracy: 47.35%

Scores for player E with controller 1: (RAP)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	5	3	10	50.00
2	5	7	14	35.71
3	10	9	11	90.91
4	10	20	12	83.33
5	9	25	15	60.00
6	7	30	12	58.33
7	9	40	11	81.82
8	5	44	15	33.33
9	8	62	15	53.33

Totals:
Missiles hit: 175
Missiles missed: 748
Shots fired: 341
Accuracy: 51.32%

Scores for player F with controller 1: (SS)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	6	2	12	50.00
2	11	5	19	57.89
3	7	11	16	43.75
4	10	22	24	41.67
5	8	26	17	47.06
6	12	31	21	57.14
7	12	30	18	66.67
8	11	45	18	61.11
9	10	61	15	66.67

Totals:
Missiles hit: 87
Missiles missed: 233
Shots fired: 160
Accuracy: 54.38%

Grndda.txt

Scores for player B with controller 1: (AM)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	0	0	0	0.00

Totals:
Missiles hit: 0
Missiles missed: 0
Shots fired: 0
Accuracy: 0.00%

Scores for player B with controller 1: (AM)

Round	Hit	Missed	Shots Fired	Accuracy (%)
1	9	2	12	75.00
2	11	2	18	61.11
3	15	6	18	83.33
4	15	8	21	71.43
5	19	18	24	79.17
6	16	29	26	61.54

Totals:
Missiles hit: 85
Missiles missed: 65
Shots fired: 119
Accuracy: 71.43%

Numerical Data and Graphs of Recalculated Percentages

Refigured percentages – ICD performance, flight data days 1 & 2

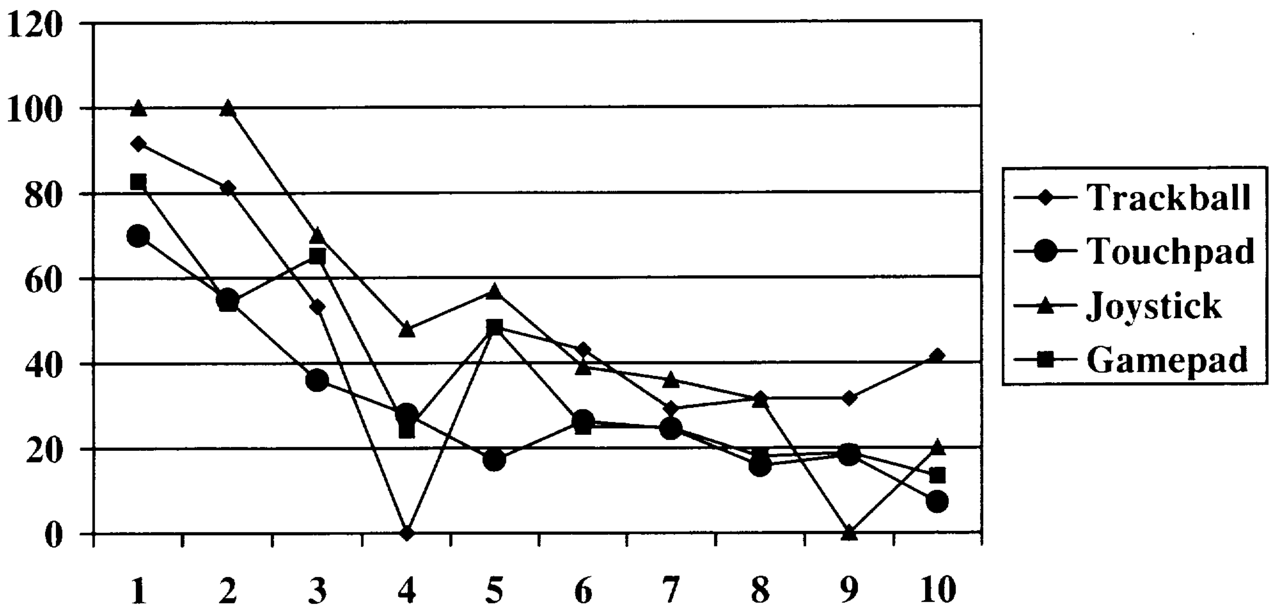
Round no.	Trackball	Touchpad	Joystick	Gamepad
1	91.67	70	100	82.87
2	81.25	55	100	54.16
3	53.33	36	70	65.15
4	0 (null)	27.85	48	24.30
5	48.48	17.15	56.8	48.49
6	43.18	26.3	39	25
7	29.16	24.5	36	24.83
8	31.5	15.8	31.25	18.01
9	31.5	18.3	0 (null)	18.85
10	41.5	7.2	20	13.43

Refigured percentages – ICD performance, ground data days 1 & 2

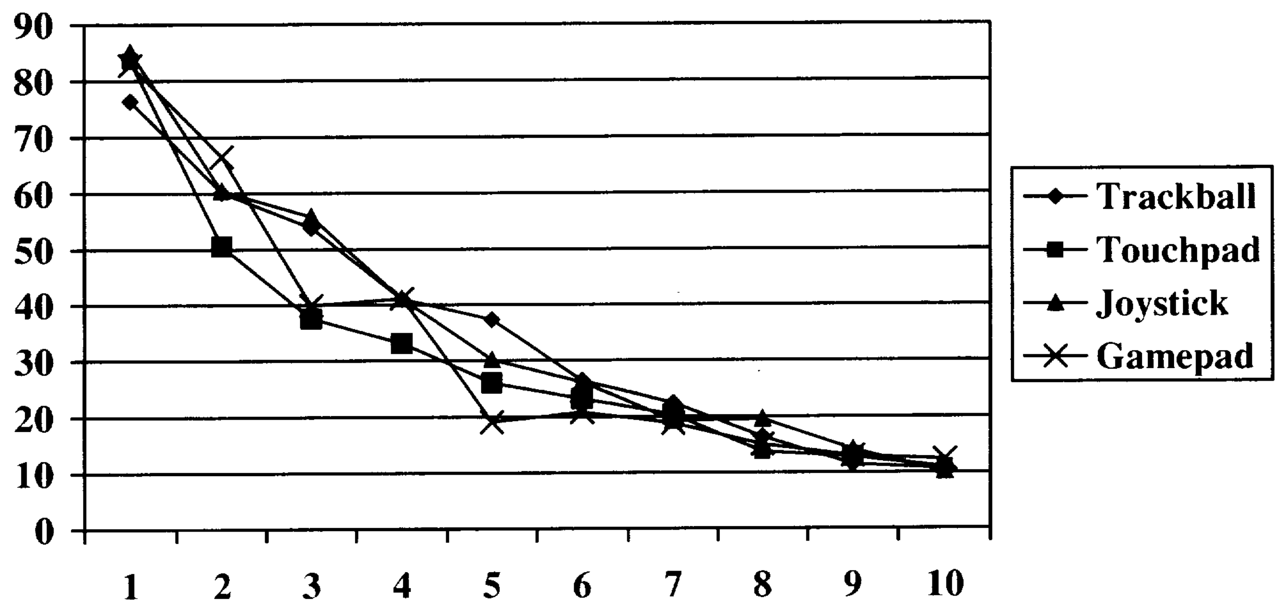
Round no.	Trackball	Touchpad	Joystick	Gamepad
1	76.364	83.57	85.138	82.756
2	60.12	50.552	60.412	66.515
3	53.836	37.533	55.818	39.882
4	41.016	33.042	41.062	41.067
5	37.3	26.003	30.097	19.098
6	26.396	23.158	26.08	20.752
7	22.348	20.338	19.263	18.817
8	16.39	13.735	19.552	15.072
9	11.503	12.867	14.133	13.042
10	10.72	10.983	10.148	12.403

*Note: The rounds with a score of zero under the flight data do not reflect ICD performance. An error by the tester prevented data being collected during that specific round.

Flight Data Days 1 & 2



Ground Data Days 1 & 2



Appendix 2 – Pictures of Bracket/Monitor Setup (KC-135 and Remote Cockpit Van)

Figures

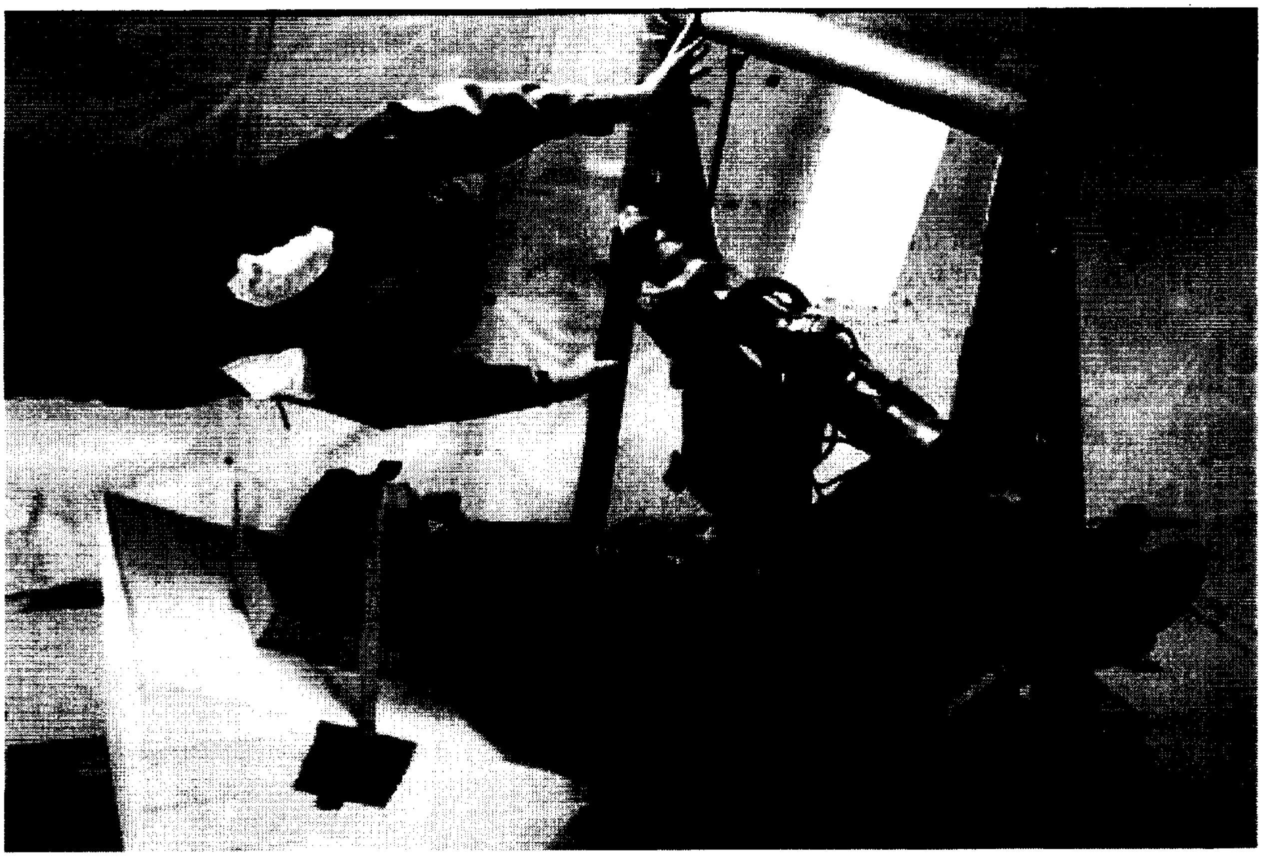


Figure 1 Side view of KC-135 setup

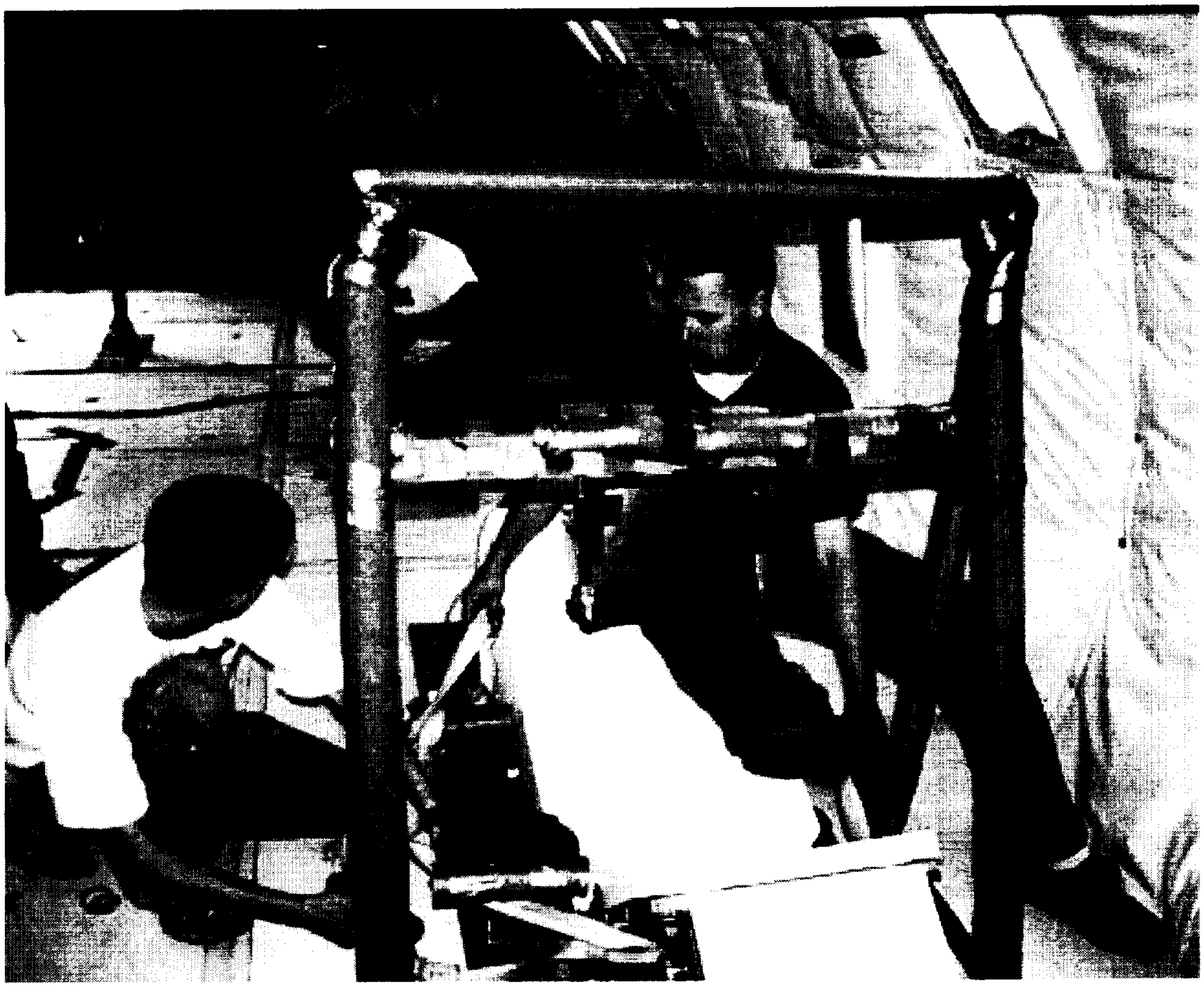


Figure 2 Front view of KC-135 setup

Figure 3   Remote cockpit van, exterior view

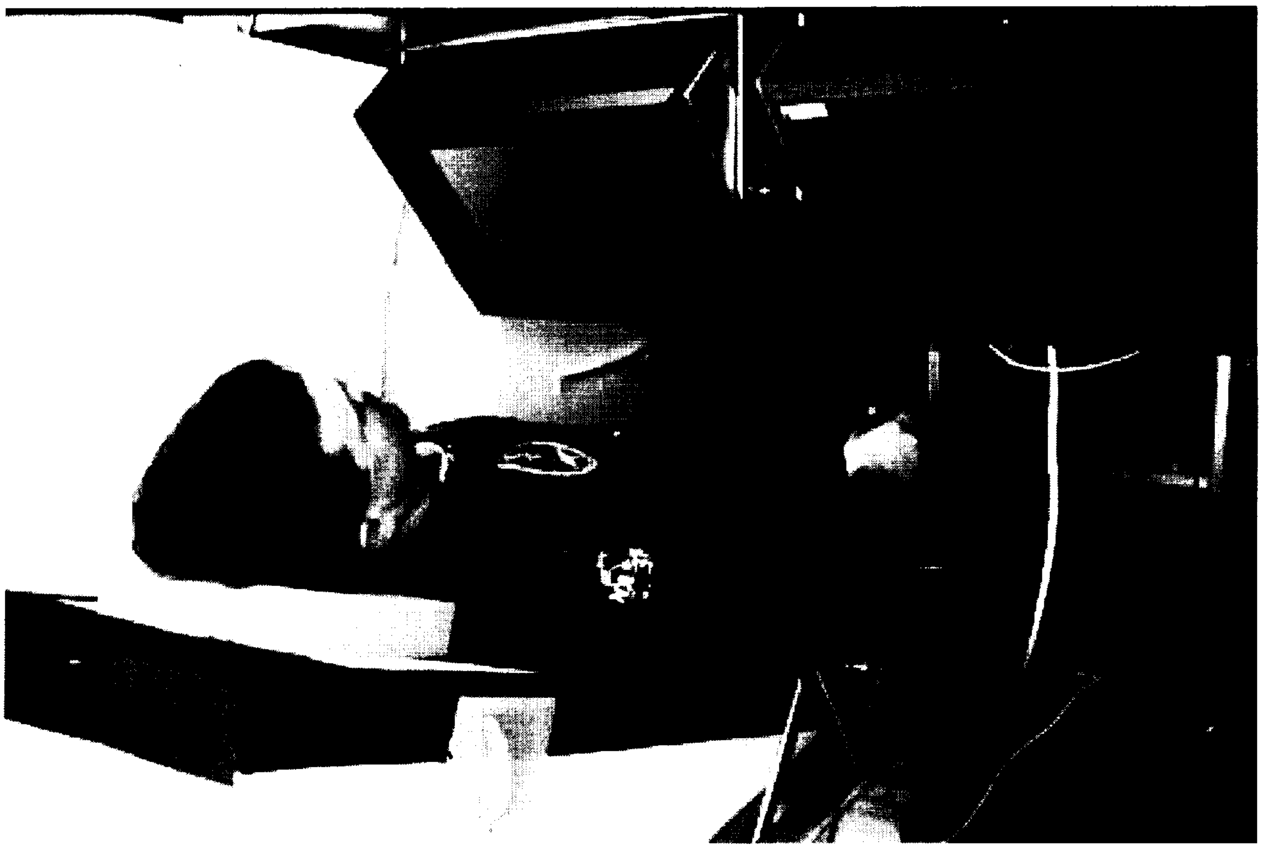


Figure 4 Front view of interior setup of remote cockpit van

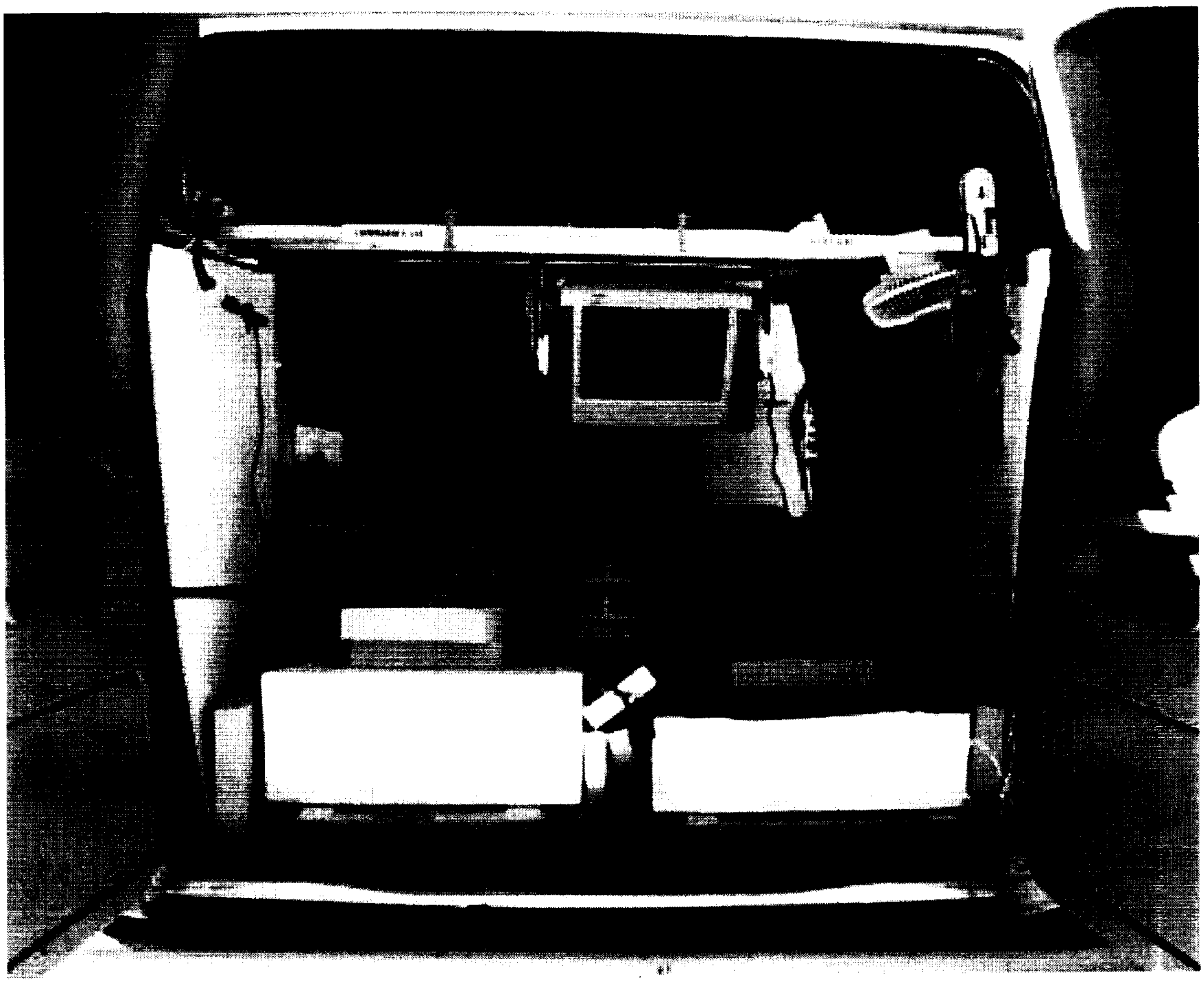


Figure 5 Back view of interior setup of remote cockpit van

Appendix 3 – Designs of Bracket/Armrest and Setup

Figures

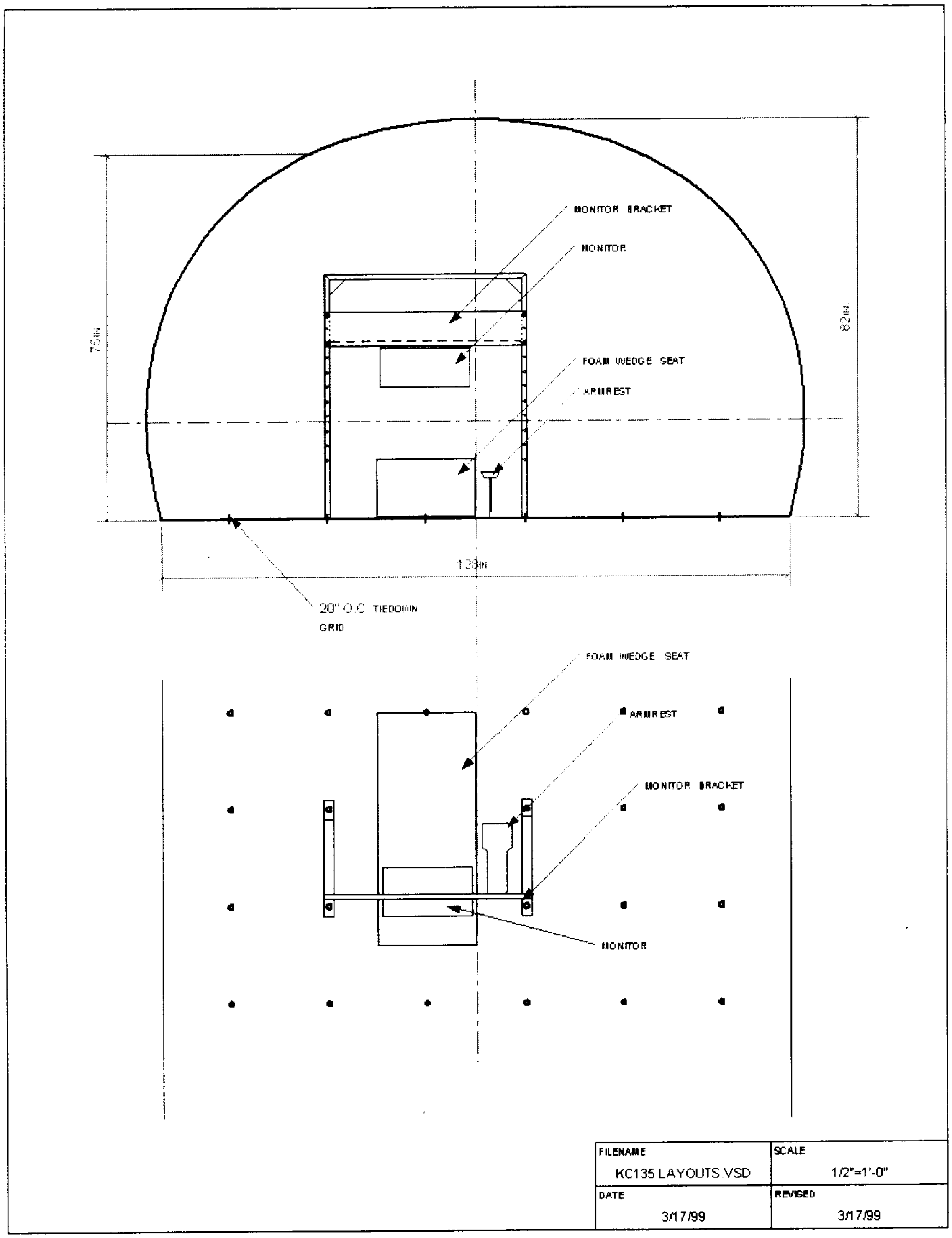


Figure 1 KC-135 layout

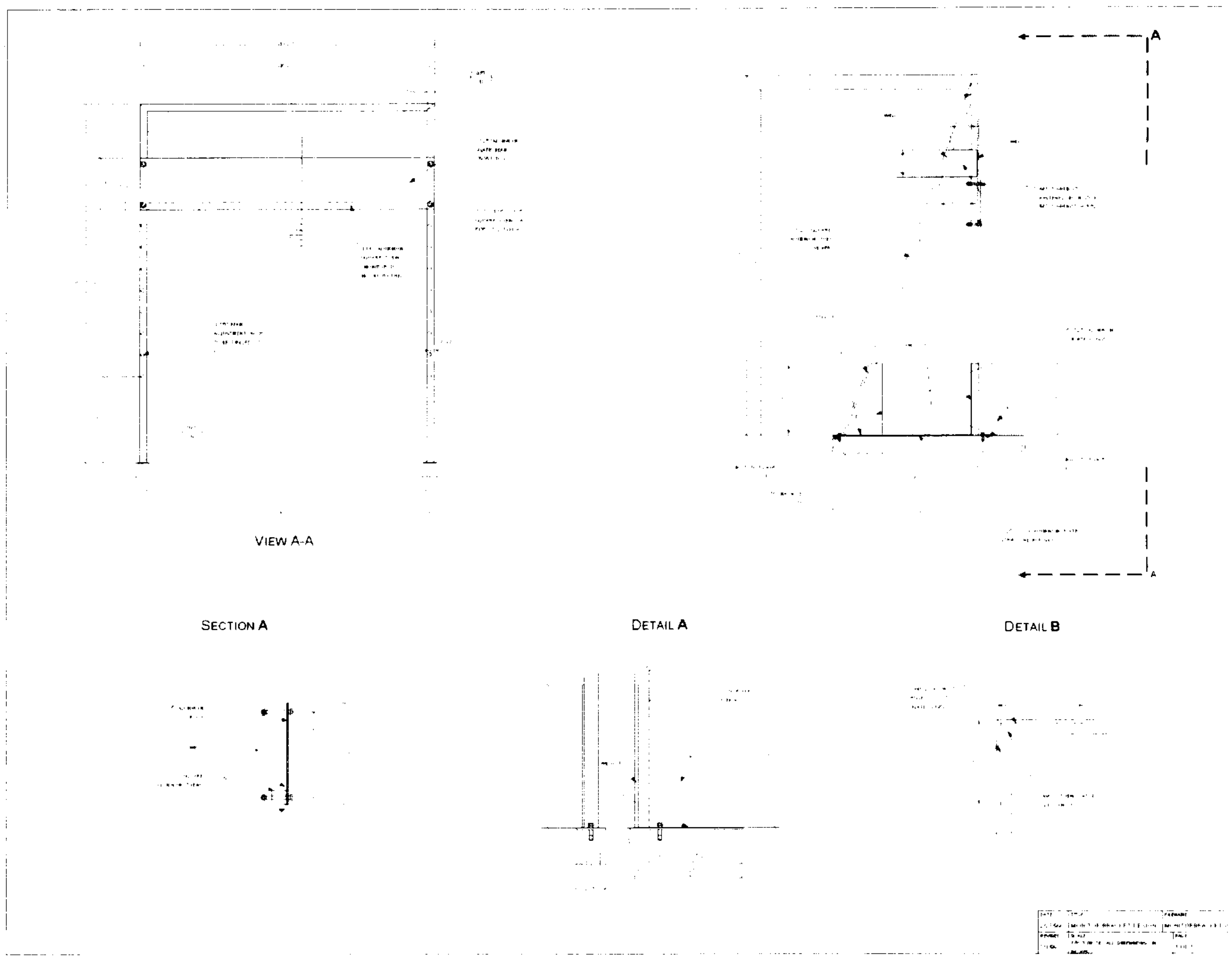


Figure 2 Monitor bracket design

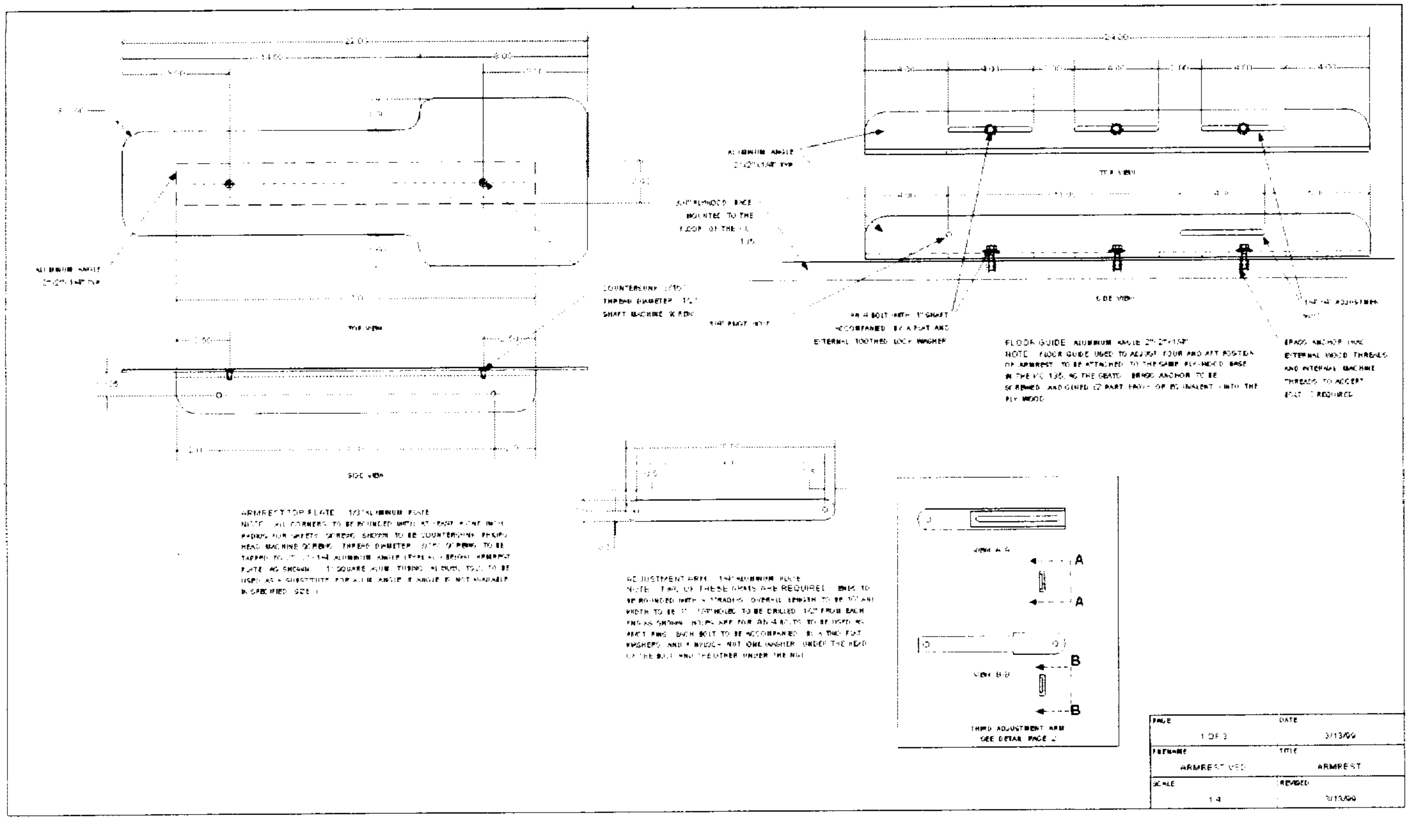


Figure 3 Armrest

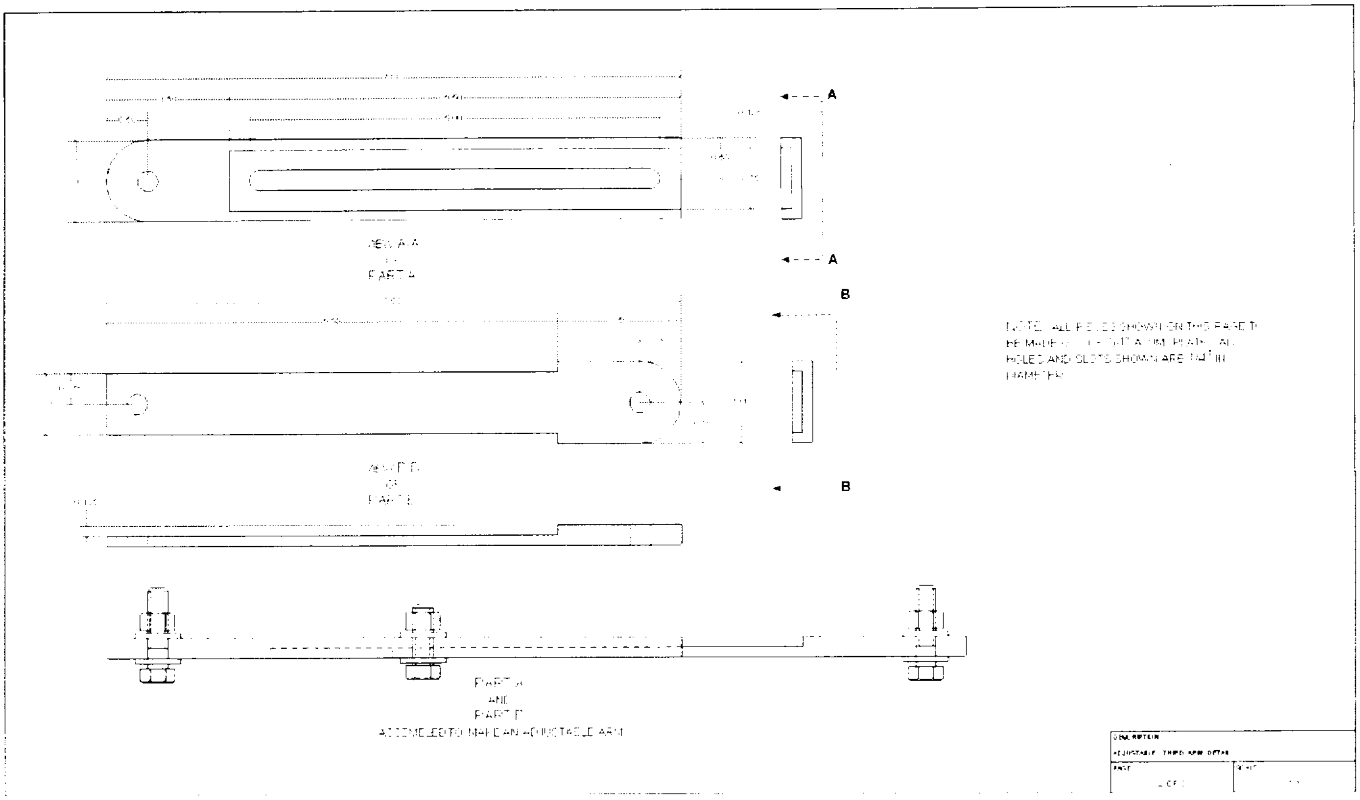


Figure 4 Adjustable third arm detail

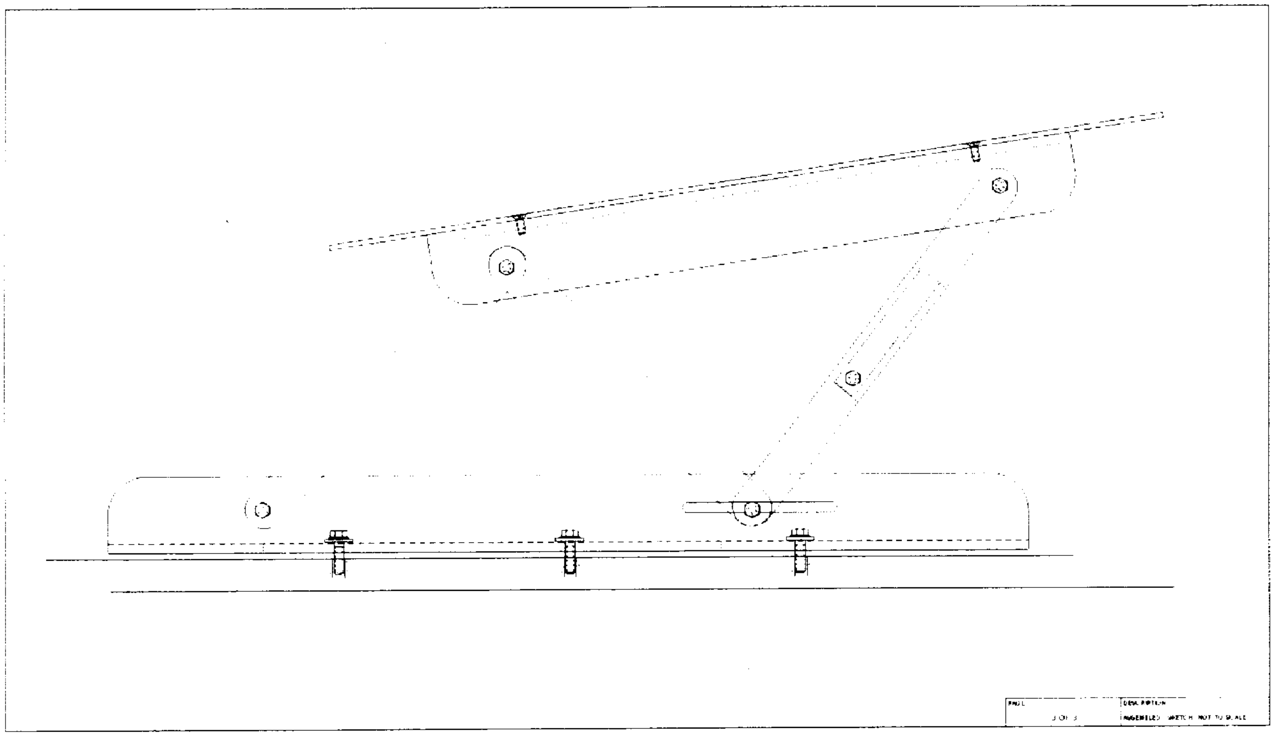


Figure 5 Armrest bracket design

Appendix 4 – Sample Flight and Ground Questionnaires

Sample Flight Questionnaires

Name: Kirsten Welse   Test Date: 4/21/99

Male or **Female** (circle)   Height: 5'7

Left or **Right** handed (circle)   Weight: 156 lb.

Do you have any flight experience? If so how many hours?

YES	NO	HOURS
	✓	

Do you have any computer programming experience? If so how many years?

YES	NO	YEARS
✓		1

How many hours on average do you spend on a computer each week? How many of these hours are spent playing games?

WORKING	PLAYING
4	1

INPUT CONTROL DEVICES

CONTROLLER IDENTIFICATION:

optical trackball ICD #1

game pad ICD #2

Directions: Insert check in the appropriate box, 1 = least/poorest/hard and 10 = greatest/best/easy. Please add any comments to the right of the question to which you are referring.

1. How much experience have you had with the ICD's?

ICD	1	2	3	4	5	6	7	8	9	10
1							✓			
2				✓						

2. How easy was it to reach each ICD?

ICD	1	2	3	4	5	6	7	8	9	10
1										✓
2										✓

3. How comfortable was each ICD to use?

ICD	1	2	3	4	5	6	7	8	9	10
1						✓				
2								✓		

4. How well did the ICD perform the necessary tasks?

ICD	1	2	3	4	5	6	7	8	9	10
1							✓			
2					✓					

5. How easy was it to handle and control blind operations?

ICD	1	2	3	4	5	6	7	8	9	10
1								✓		
2							✓			

6. Would it have been helpful to have different textures on~~e~~ the buttons in order to feel them?

ICD	YES	NO
1	✓	
2	✓	

MOCKUP

BRACKET:

13. How stable did the bracket seem?

1	2	3	4	5	6	7	8	9	10
									✓

14. How well was the monitor angled so you were able to see everything? If not, how could you fix it?

1	2	3	4	5	6	7	8	9	10
									✓

15. How well was the bracket positioned at a correct height holding the monitor so you were able to see, without straining your neck?

1	2	3	4	5	6	7	8	9	10
									✓

16. Did the bracket have any dangerous parts, such as sharp points or rough edges?

1	2	3	4	5	6	7	8	9	10

ARMREST:

Not Applicable → 17. How maneuverable was the armrest?

1	2	3	4	5	6	7	8	9	10

18. How well were you able to put the armrest in the position you needed it to be?

1	2	3	4	5	6	7	8	9	10
									✓

19. How comfortable was the armrest?

1	2	3	4	5	6	7	8	9	10
									✓

20. Was the length of the armrest a good length for your arm?

1	2	3	4	5	6	7	8	9	10
									✓

21. How easy was it for you to keep your arm on it at all times? (during zero-g in the KC-135 especially)

1	2	3	4	5	6	7	8	9	10
								✓	

22. How well did the armrest work with the ICD's?

1	2	3	4	5	6	7	8	9	10
									✓

23. Did their positions compliment each other?

1	2	3	4	5	6	7	8	9	10
									✓

MONITOR:

24. Was the monitor a good distance from your face?

1	2	3	4	5	6	7	8	9	10
								✓	

Repeat

~~25. Was the monitor a good distance from your face?~~

1	2	3	4	5	6	7	8	9	10

26. Were you able to~~o~~ see the screen clearly? Meaning, was there a glare or something else that got in the way?

1	2	3	4	5	6	7	8	9	10
									✓

27. Was the monitor a good size?

1	2	3	4	5	6	7	8	9	10
									✓

28. How easy was the test to start?

1	2	3	4	5	6	7	8	9	10
									✓

29. How easy was it to load?

1	2	3	4	5	6	7	8	9	10
									✓

30. How easy was it to switch the ICD's between tests?

1	2	3	4	5	6	7	8	9	10
									✓

31. How easy was the program?

1	2	3	4	5	6	7	8	9	10
					✓				

32. How close a demonstration do you think the test was to how you think the ICD will perform?

1	2	3	4	5	6	7	8	9	10
							✓		

33. How easy was it to maneuver the ICD in zero-g? → trackball: 6 (kind of sluggish sometimes); game pad: 7

1	2	3	4	5	6	7	8	9	10

34. How comfortable was the ICD in zero gravity? → trackball: 8; game pad: 8

1	2	3	4	5	6	7	8	9	10

35. Did the test work with the time allowed?

1	2	3	4	5	6	7	8	9	10
									✓

OTHER

36. Did you get sick? Why? During what phase of the flight?

YES	NO
	✓

37. Did the mockup make you feel claustrophobic? If so, what was it that made you feel so cramped? No!

1	2	3	4	5	6	7	8	9	10

38. How comfortable was the overall mockup?

1	2	3	4	5	6	7	8	9	10
								✓	

39. Were you able to get everything done that was planned? If not, what, and why not?

YES	NO
	✓

→ unable to get down hard copies of data – Bryan was sick from p. 13 →, ~~and~~ I lost my pen, & didn't know how to document ~~the~~ Berke, Don & the Ch. 11 reporter on our charted pgs – might want to have them less structured next time.

40. How well did you adjust to micro-gravity?

1	2	3	4	5	6	7	8	9	10
									✓

41. How well did you adjust to high-g?

1	2	3	4	5	6	7	8	9	10
									✓

42. Did the micro-gravity environment affect your ability to maneuver and use the ICD's? If any ICD in particular was affected, please note that here.

1	2	3	4	5	6	7	8	9	10
✓									

→ not really – the trackball was rather sluggish on a few rounds, but still worked fairly well.

43. How comfortable was the armrest?

1	2	3	4	5	6	7	8	9	10
									✓

44. How well was the seat positioned to compute the tasks of the test?

1	2	3	4	5	6	7	8	9	10
								✓	

45. How well did the bracket work in aiding your completion of the test?

1	2	3	4	5	6	7	8	9	10
									✓

– it didn't collapse, if that's what you mean :)

46. Were there any glitches, and if so, what were they?

YES	NO
✓	

just 1 — during the 4th(?) trackball test parabola, the clicking/maneuvering got really sluggish & wouldn't answer so readily then the clicks caught up w/ themselves (I guess) & clicked thru the next two screens to start the next parabola's game
(it could've been due to my finger shaking & an inadvertant double-click, but...)

Sample Ground Questionnaires

Name: Suzette Shivers Test Date: 4/20/99 G

Male or **Female** (circle) Height: 5' 3"

Left or **Right** handed (circle) Weight: 130 lbs

Do you have any flight experience? If so how many hours?

YES	NO	HOURS
	✓	

Do you have any computer programming experience? If so how many years?

YES	NO	YEARS
	✓	

How many hours on average do you spend on a computer each week? How many of these hours are spent playing games?

WORKING	PLAYING
3	30 mins

ICD QUESTIONS

ICD tested: gamepad

Directions: Insert check in the appropriate box, 1 = least/poorest/hard and 10 = greatest/best/easy. Please add any comments to the right of the question to which you are referring.

1. How much experience have you had with the ICD?

1	2	3	4	5	6	7	8	9	10
✓									

2. How comfortable was the ICD to use?

1	2	3	4	5	6	7	8	9	10
								✓	

3. How well did the ICD perform the necessary tasks?

1	2	3	4	5	6	7	8	9	10
								✓	

4. How easy was it to handle and control blind operations?

1	2	3	4	5	6	7	8	9	10
									✓

5. Would it have been helpful to have different textures one the buttons in order to feel them?

YES	NO
✓	

6. How much stress did controller cause on your hands?

1	2	3	4	5	6	7	8	9	10
✓									

7. How cramped did ICD make your hand feel?

1	2	3	4	5	6	7	8	9	10
✓									

8. How well did your body size fit with the ICD position?

1	2	3	4	5	6	7	8	9	10
									✓

T

Name: DONALD ROBINETT   Test Date: 4-20-99

Male or **Female** (circle)   Height: 6'-0"

Left or **Right** handed (circle)   Weight: 160 lbs.

Do you have any flight experience? If so how many hours?

YES	NO	HOURS
X		100+

Do you have any computer programming experience? If so how many years?

YES	NO	YEARS
X		1

How many hours on average do you spend on a computer each week? How many of these hours are spent playing games?

WORKING	PLAYING
5	6

ICD QUESTIONS

ICD tested: TRACKBALL

Directions: Insert check in the appropriate box, 1 = least/poorest/hard and 10 = greatest/best/easy. Please add any comments to the right of the question to which you are referring.

1. How much experience have you had with the ICD?

1	2	3	4	5	6	7	8	9	10
	X								

2. How comfortable was the ICD to use?

1	2	3	4	5	6	7	8	9	10
						X			

3. How well did the ICD perform the necessary tasks?

1	2	3	4	5	6	7	8	9	10
						X			

4. How easy was it to handle and control blind operations?

1	2	3	4	5	6	7	8	9	10
						X			

5. Would it have been helpful to have different textures one the buttons in order to feel them?

YES	NO
X	

6. How much stress did controller cause on your hands?

1	2	3	4	5	6	7	8	9	10
X									

7. How cramped did ICD make your hand feel?

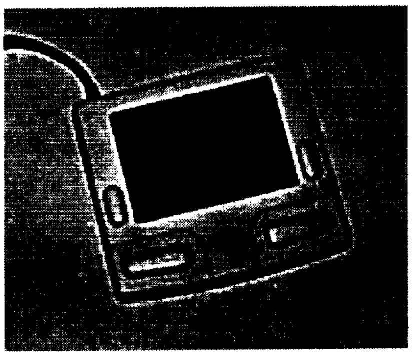
1	2	3	4	5	6	7	8	9	10
X									

8. How well did your body size fit with the ICD position?

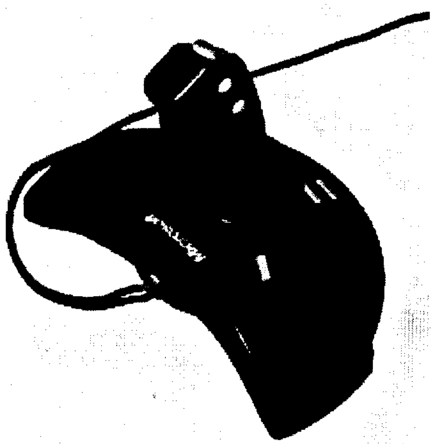
1	2	3	4	5	6	7	8	9	10
									X

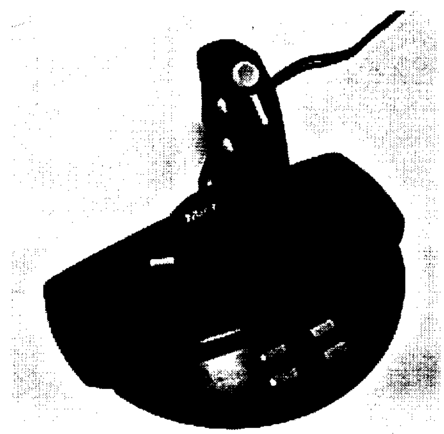
Appendix 5 – Pictures of Input Control Devices

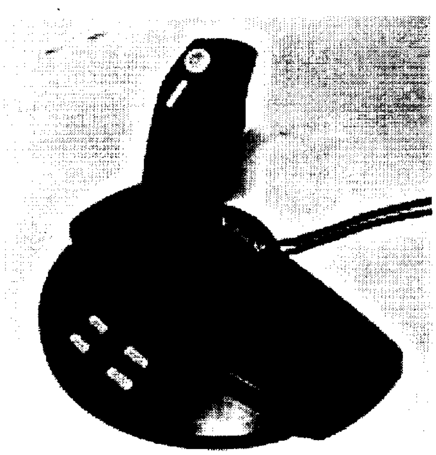
Smart Cat Touchpad



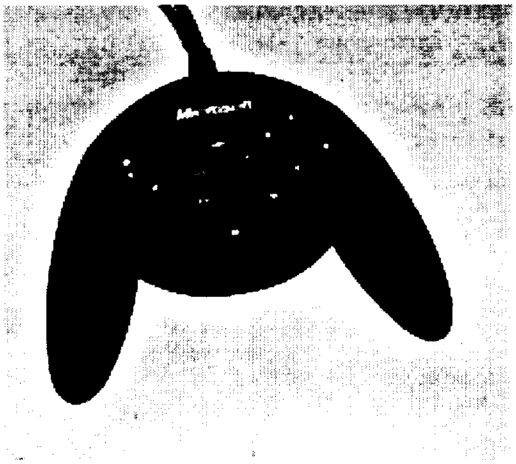
Microsoft Sidewinder 3-D Pro Joystick



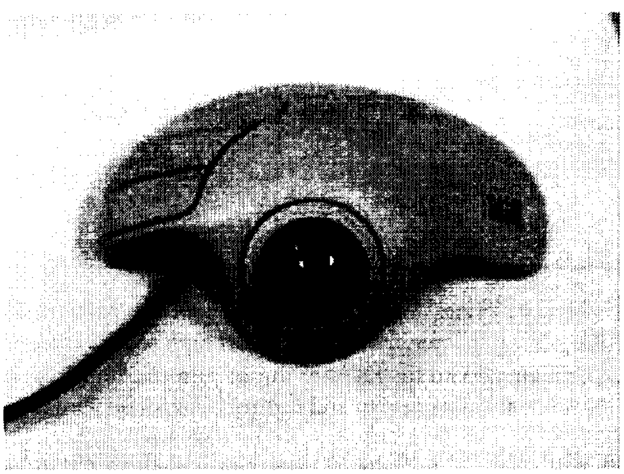


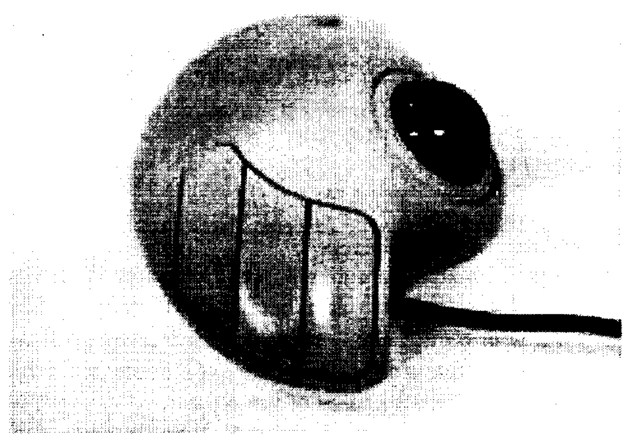


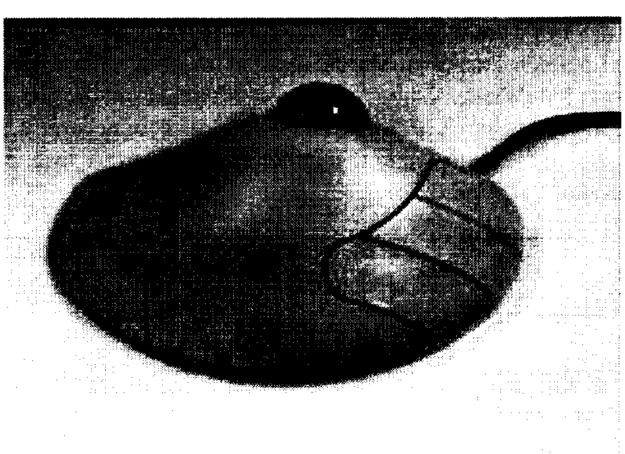
Microsoft SideWinder Gamepad



Logitech Trackman Marble (optical trackball)







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13. ABSTRACT *(Maximum 200 words)*

This report was created by students from Longview High School, Longview, Texas. Longview High School was selected from a group of Texas high schools to participate in the 1999 Texas Fly High Program. This program gives Texas high school students a chance to work with NASA engineers to design and fly a real-world experiment aboard the KC-135 during zero-g parabolas. Jeffrey Fox's role was to provide a concept for the experiment and to mentor the students in its design and testing. The students were responsible for executing all phases of the project.

The X-38 Project Office at the Lyndon B. Johnson Space Center Johnson Space is designing a crew return vehicle (CRV) to be docked at the International Space Station for crew rescue in an emergency. Vehicle controls will be almost completely automated, but a few functions will be manually controlled. Four crew input control devices were selected for evaluation by Longview High School students as part of the 1999 Texas Fly High program. These were (1) Logitech Trackman Marble (optical trackball), (2) Smart Cat Touchpad, (3) Microsoft SideWinder 3D-Pro Joystick, and (4) Microsoft SideWinder Gamepad. In two flight tests in the KC-135 aircraft and a series of ground tests, the devices were evaluated for ability to maneuver an on-screen cursor, level of accuracy, ease of handling blind operations, and level of user comfort in microgravity. The tests results led to recommendation of further tests with the Joystick and the Trackman by astronauts and actual space station residents.

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