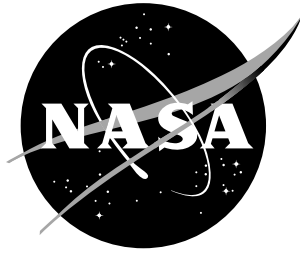


NASA / CR-2000-210306



# Pilot Comments for High Speed Research Cycle 3 Simulation Study (LaRC.1)

*Melvin L. Bailey, Editor  
Lockheed Martin Engineering and Sciences Company  
Hampton, Virginia*

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July 2000

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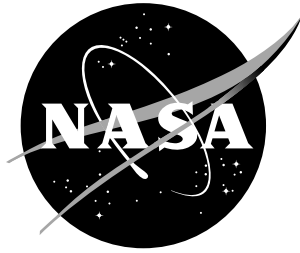
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# Pilot Comments for High Speed Research Cycle 3 Simulation Study (LaRC.1)

*Melvin L. Bailey, Editor  
Lockheed Martin Engineering and Sciences Company  
Hampton, Virginia*

National Aeronautics and  
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Langley Research Center  
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**Table of Contents by Task Number:**

<u>Task Number</u>	<u>Page Number</u>
Abstract	iv
1050 Refused Takeoff	1
1052 Refused T/O - 35 kt	3
2010 Standard Acoustic T/O	5
2011 Standard Acoustic T/O	9
2030 PLR Takeoff	13
3020 Climb Trans. to Lvl Flt - Xsonic	16
3022 Climb Trans. to Lvl Flt - Supersonic	18
3030 Profile Climb	20
3040 Lvl Flt Trans. to Climb	21
3050 Profile Descent	23
3060 Trans. to Supersonic Descent	25
3062 Trans. to Xsonic Descent	28
3070 Transonic Accel	30
3072 Supersonic Accel	32
3074 Transonic Decel	34
3076 Subsonic Decel	36
3080 Heading Change - Xsonic climb	39
3082 Heading Change - Initial climb	42
3084 Heading Change - Final Cruise	46
3086 Hdg Change - Xsonic Descent	48
3088 Heading Change - TCA Descent	50
4020 Nominal Approach and Landing	52

4050 Nominal Approach and Landing with Ground Effects	61
4069 IAG (TIFS) Approach	62
4085 Go Around at 30' AGL TS OFF	69
4085 Go Around at 30' AGL TS ON	72
4086 Go Around at 50' AGL	76
4093 Crosswind Ldg - 25 kt (Procedure A)	80
4093 Crosswind Ldg - 25 kt (Procedure B)	86
4095 Crosswind Ldg - 35 kt	91
4110 App. & Ldg - Jammed Stab.	95
4140 VFR Circling Approach.	97
4220 Decelerating Approach	101
4225 Decelerating Approach/Manual Throttles	104
5010 Stall at Idle Power	107
5020 Stall at Max Power	110
5040 Turning Stall - Idle Power	113
5050 Turning Stall - T. F. L. F.	115
5060 Diving Pullout	117
5070 Emergency Descent	120
6050 Inadvertent Speed Increase	123
6060 Two-axis Upset Recovery	126
7030 VMCG demonstration	129
7035 Takeoff - one engine out	130
7036 Takeoff - one engine out - 35 kt x-wind	133
7040 Dynamic VMCA	137
7050 Dynamic VMCL-2	140
7060 Engine Unstart	142

7070 Stall - one engine out	145
7080 Turning stall - one engine out	147
7095 Manual Throttle Landing	150
7100 Unaugmented Landing	156
7211 Flaperon Hardover during takeoff	160
7212 Elevator Hardover (TE down) during takeoff	162
7252 Elevator Hardover (TE down) during landing	165
7253 Rudder Hardover during landing	169
7254 Rudder Hardover during landing rollout	172
7261 Elevator Hardover (TE up) during 2-axis upset	174
7262 Flaperon Hardover during 2-axis upset	176
7286 Go-around with Autoflap failure	178
7291 Loss of 75% Roll Control landing w/X-wind	182
7292 Flaperon Hardover during landing w/X-wind	185
Takeoff Rollout Pilot Questionnaire	189
Takeoff Rotation Pilot Questionnaire	195
Stall/Turning Pilot Questionnaire	207
Climb/Cruise/Descent Pilot Questionnaire	216
Approach and Landing Questionnaire	239
Go-around Questionnaire	281

## **Abstract**

This is a compilation of pilot comments from the Boeing High Speed Research Aircraft, Cycle 3, simulation study conducted from January to March 1997 at NASA Langley Research Center, known as LaRC.1. This simulation study was conducted using the Visual Motion Simulator. The comments are from direct tape transcriptions and have been edited for spelling only. These comments were made on tape following the completion of each flight card, immediately after the pilot was satisfied with his practice and data recording runs. Six pilots were used in the evaluation and they are identified as pilots A through F.



## **Task 1050 Refused Takeoff**

Pilot A

Task 1050 Refused Takeoff 13 Jan 97; Runs 17-19

Cooper Harper rating, I guess you're just rating the directional on this one, right, that would be a 2, I'd say, pretty good. The only thing that might be better would be thrust asymmetry compensation would give you anticipation of a directional problem. But it was not a problem, at such a high airspeed, I think there's plenty of rudder control. We're using about, maybe, 20, 30 percent of the rudder, and using some brake there to help keep it straight.

Pilot B

Task 1050 Refused Takeoff 06 Jan 97; Runs 22-24

Just some general notes on this...you might want to consider for future runs, alternating the engine, putting the engine [failure] at random on either side, and interspersing these with other takeoff runs so the pilot doesn't always know they are going to occur. I think that might effect what the data looks like. In any case we did the card as per the instructions and was able to maintain runway centerline deviation within 10 ft each time and got within 5 ft on the last one. So, lateral directional CHR -it's controllable, adequate, and satisfactory, improvements not required, minimum pilot compensation for desired performance HQR3. That's just a necessity to fight for control a little bit to keep it centered. I'm working a little bit to keep it within 10 ft. That concludes my comments.

Pilot C

Task 1050 Refused Takeoff 15 Jan 97; Runs 45-47

For the tracking, satisfactory without improvement, sure, and that's as good as it's going to get, very little special technique on that, so, I'd say a 2 for the lateral-directional, it was good. I might of got one overshoot after the failure went to the right, and then I came back to the left, I might of overshoot the heading just a little bit and came back, but it's certainly not a problem, and getting off centerline and getting back to it, was very controllable prior to the engine failure too, so overall, really nice.

Pilot D

Task 1050 Refused Takeoff 21 Jan 97; Runs 52-54

Number four engine cut at a 170 knots. We made one practice and three data runs, and obviously going down a learning curve, which I think is a little bit unfair. I was adequate 15.9 ft on my first data run, I think it's probably more typical, I'm going to kind of rate it based on that one. The task is not too bad, a couple problems, have a hard time getting my feet up on the rudders, correction, up on the brakes, off the rudders. Also, had a hard time getting all four throttles back at the same time, because of the very wide spacing on the throttle. I'm going to give it a pilot rating of a 5, because I think under realistic conditions you'll probably be busting that 10 ft pretty regular.

Pilot E

Task 1050 Refused Takeoff 07 Jan 97; Runs 43-45

There is only one rating, that is lateral directional. Center line tracking. The abort is right at V1. The only comment I'll make is that obviously I know from the get-go this is going to be an abort so I am keyed and ready to do it, and if I wasn't, my lateral performance and anything else probably wouldn't be as good because I am all spun up here ready to maintain tight center line tracking and do an abort. So a suggestion might be if you ever needed more data on these is to maybe have a failure somewhere sprinkled along into the other tasks, which would be a little bit non-controlled or non-scientific and that there would be briefed for one card and maybe do another one, but it certainly is a big difference between being all keyed up for an abort and being anticipating a takeoff. Anyway, with that in mind I will rate this thing controllable? Yes, adequate, yes, satisfactory, yes, Cooper Harper of 3. I did maintain well within the desired criteria, but I did take a lot of very... it's a high gain task, you've really got to work hard on the rudders and the differential braking to keep your tracking on the centerline. Obviously, not so hard you can't do it well, but it is a lot of work load. It would be a 3. I didn't have any tendency to overcontrol to any degree and I had good ability to compensate for the lost... for the failed engine, so certainly we're well within our controlled airspeed regime as far as there is no problems with the VMCG or the like and basically it is a pretty tight criteria for something like that and if you are able to maintain it within that, but it looks like it's a pretty easy task for the aircraft.

Pilot F

Task 1050 Refused Takeoff 23 Jan 97

Not performed by this pilot.

## **Task 1052 Refused Takeoff - 35 kt x-wind**

Pilot A

Task 1052 Refused Takeoff - 35 kt x-wind 13 Jan 97; Runs 20-22

The abort with the crosswinds, I'd give it a 2 on the directional Cooper Harper, it's easily controllable, because you're so far above VMC, it probably contributes to it. Might be a better simulation if you randomized the engine failures left and right, because after a while you kind of learn to anticipate...directionally. It didn't seem to be a big problem with the crosswind. I didn't notice...did not notice any particular problems with the lateral directional as far as wings coming up, and that sort of thing, that was how much of a crosswind, 35 knots, that's not bad, okay.

Pilot B

Task 1052 Refused Takeoff - 35 kt x-wind 06 Jan 97; Runs 26-28

35 KTS cross/wind task 1052 accomplished as per the card. Basically kept it within the desired performance the entire way. Again, I think I am anticipating the abort so the performance is reflecting that. Not really a problem to get desired performance. Its controllable, adequate, satisfactory, although I am working a little bit, improvements not required mildly unpleasant deficiencies, minimum pilot compensation required HQR3. And that's just the requirements to work a little bit with the brakes to maintain the centerline. That concludes the comments.

Pilot C

Task 1052 Refused Takeoff - 35 kt x-wind 15 Jan 97; Runs 48-50

lat-dir for the 35 kt crosswind and that's still very easy, definitely more work load than the other one, and a very good 3 would do that one, I think, and no new comments other than, with this much crosswind, notice the length of the airplane, because when there's a angle off a little bit, and I bring it back, just the change of the heading seems to displace me off a little bit, with this much crosswind you're beginning to see the heading indicator to the right of the centerline, and of course that puts you a little bit to the right of the centerline, so, the image is a little bit different, but it's still, certainly no problem.

Pilot D

Task 1052 Refused Takeoff - 35 kt x-wind 21 Jan 97; Runs 56-58

So, this is about the tenth run that I've done in a row that's essentially the same task, and it's really getting to be like the trained monkey, so, I think it's pretty unfair from an operational standpoint, as Lou points out, if we're trying to figure out whether we can do RTO's for certification, that's a whole other thing. I'm looking at it from an operational standpoint. My performance on these were all well within desired, and I was getting better and better, and I'm at 2.8 ft on the last one. So, I'm still going to give it a pilot rating of 5, which is really tough to give, and I'm not sure what the heck I'm doing there, but to me that's extrapolating this situation to real life. I think if I hadn't seen one of these things, even though I practiced in the simulator, if I hadn't seen one for 6 months, which is possible, I think I would have a tough time keeping it within 10 ft.

## Pilot E

### Task 1052 Refused Takeoff - 35 kt Crosswind 07 Jan 97; Runs 46-48

The comments for the attempt remain about the same, basically my performance improved on every single run so there is some learning curve as far as how to play the rudders. The only really thing I noticed about the cross wind was that it tended to lift the upwind wing, so I had to get into the lateral loop of the aileron of the lateral control loop to keep the wings level, the... with the engine failure I may have had to put a little bit more... if you look at the strip charts, you might see a little bit more initial or differential braking to keep it from... the nose swinging into the wind, but basically after that one initial kind of higher amount of differential braking the task was just as easy as no wind so the cross wind really wasn't a factor as far as performance, work load was a little bit higher, but I think my learning curve is also improving so my performance is getting better, but basically, certainly all desired. Cooper Harper for this task, for the lateral directional for the refused takeoff with a 35 knot cross wind; it was controllable, adequate performance was attained with satisfactory improvement? Yes, for 3, it certainly is a little bit of a work load, but you have the ability, without extensive compensation, to make the desired criteria.

## Pilot F

### Task 1052 Refused Takeoff - 35 kt Crosswind

Not performed by this pilot.

## **Task 2010 Standard acoustic takeoff**

Pilot A

Task 2010 Standard acoustic takeoff

Not rated.

Pilot B

Task 2010 Standard acoustic takeoff 06 Jan 97; Runs 9-11

[The] card was accomplished pretty much as per the instructions on it. I got one comment I made, was that the way the metrics are read out--you are penalized right after liftoff where the command guidance is up at 14% and the velocity vector course is somewhat near the horizon ramping up, and during that period of time while you're zeroing the error out you are penalized both in terms of max and min error and in terms of percentage, because 2 miles happened so quickly that any error there is percentage wise is magnified. So I'm not going to really penalize it for that in terms of desired inadequate performance. Lets look at performance standards: pitch attitude---I think controlling flight path or pitch attitude within a half degree is relatively easy. So I was able to get desired there. Deviation from climb speed is N/A. Bank angle control I was able to keep it within desire pretty well. Same thing with runway heading deviation . Load factor is not really something I'm tracking. That's kind of N/A also. I'll list it because I kinda got a feel between the practice runs and the data runs for what 1.2-1.3 g's looked like. For climb out flight path angle that was also relatively easily controlled plus or minus a half degree. So that was desired. Longitudinal CHR --controllable, adequate, and I think its satisfactory. See this is where I can really stand to give a 1/2 rating. Minimum pilot compensation required. I'm going to say minimum for desired performance cause you can't say it's not a factor and force it under -an HQR3 for longitudinal , for lateral directional its controllable , adequate, it is satisfactory. This time it is a solid 3. Minimum pilot compensation . You're just fighting the turbulence and bank angle control. Okay, for the EPR cutback evaluation segment. Maintain climb airspeed....no I'm not doing that .....desired flight path....I am doing that. And runway heading with minimum rolling...no PIO's occurred. Deviation from climb airspeed is N/A. Bank angle control was able to keep it within desired. Runway heading deviation within desired. Load factor ...predominately within desired.....we had some spikes there, but again I'm not really controlling that so I'm not going to penalize it for it. Climb out flight path angle plus or minus 1/2 degree .. again fairly easy. Again though, I can't say that compensation was not a factor. You're working but you're not really working all that hard, its fairly clearly level 1. Okay, for longitudinal--it controllable, adequate, satisfactory, improvement not required, minimum pilot compensation, HQR3 . Lateral directional.....and that on the high side of 3.. in other words closer to a 2. Again, not being able to give 1/2 ratings, I'll put it at a 3, but its fairly pleasant. Lateral directional...controllable, adequate, satisfactory, improvement not required. This time its a solid 3 again. Mildly unpleasant, deficiencies minimum pilot compensation required for desired performance. Again that was due primarily to the turbulence. And lets see...that concludes my comments.

Pilot C

Task 2010 Standard acoustic takeoff 15 Jan 97; Runs 32-34

Not rated.

## Pilot D

Task 2010 Standard acoustic takeoff 21 Jan 97; Runs 18-20

Okay, pilot comments on task 2010. The initial rotation rate seems fairly high, in fact I would just lower VR so you could rotate at a slower rate, and then it's pretty tough to tell where 10 degrees is, and I'm concerned about tailstrike, so I tend to stop there, and have to wait until you get the flight path to know you're off the ground, and then after we get off the ground I'm tending to over G the airplane getting up to my 14 percent climb gradient, and I think that's a little bit artificial here on the simulator, because we don't have the G cue, that would be a lot easier to do in real life. I've given you my comments already, we're going to go into the pilot ratings now, and let's look at the initial rotation and climb. We had adequate performance, we were not quite always making the desired initial pitch attitude and we were usually over G'ing on... after, because I tended to pause to 10 degrees to avoid a tailstrike and then slightly over aggressive on the rotation backup up to the 14 percent climb gradient. So, we're just making adequate performance on these two parameters, pitch and G, they give it a 5, it's taken quite a bit of compensation in that little area there. Laterally, it's 3, minor tendency to PIO. cutback, we're getting, really we could call it desired performance. It's a fairly easy task, you just pitch down very, very slowly and let go at 2 1/2 degrees. Apparently on the first one, the actual gamma did overshoot a little bit, it must of been due to a gust, and I'm going to give it longitudinally a pilot rating of 4, and laterally 3.

## Pilot E

Task 2010 Standard acoustic takeoff 07 Jan 97; Runs 35-36

There looks like there are two different segments to rate. The overall task, this particular task is allowed almost... step-by-step numbers you have to hit, that don't really fully relate to flying the aircraft as opposed to trying to hit targets on the HUD to capture certain things. I didn't notice any PIO, I felt I had to be a little bit more aggressive on the rotation to reach the desired criteria established with task that I would normally would have liked to been, I would preferred a smoother rotation, but that's just my own technique, and does not considered the fact that this aircraft may have a requirement to necessitate that. I thought that pretty much that I met the desired criteria on all parts of both segments, I didn't notice any potential problems, it was all very straight forward but it was a little too much by the numbers for me to really come up with a good handling qualities feeling for it. But everything worked out fine. Okay for the evaluation segment take off roll rotation as you climb out the acoustic profile, for longitudinal Cooper Harper, basically if I can find the Cooper Harper sheet. For longitudinal up to the cut back. Is it controllable? Yes it was. Is adequate performance attainable? Yes it was. Is it satisfactory without improvement? I'd say no, giving it a level two. Cooper Harper of 4, minor but annoying deficiencies, desired performance requires moderate pilot compensation. In order to make the score card's desired parameters, I felt like I had to work too hard to get those numbers, harder than what the control law really required. I think it is a better airplane than what this rating is showing, but in order to meet the criteria I ended up having to work harder at it. The lateral direction Cooper Harper; controllable? Yes, adequate? yes, satisfactory? Yes, I would rate that Cooper Harper of 3, basically minimum pilot compensation, it looks like we have light turbulence and that required me staying in the loop laterally to keep it tracking in the lateral guidance. For the EPR cutback in the continued climb out, longitudinally controllable? Yes, adequate? Yes, satisfactory, Yes, I'll rate that a Cooper Harper of 3, basically the pushover at the cutback was no real problem. I don't really... I guess I really can't see in the HUDs, because

the HUDs so big, I can't really see the G-Tape up there, in fact I just now noticed it, so perhaps if I looked at that I could of kept it more at plus or minus .2, so I think that should not be a factor. I just... the HUD is kind of big and my seating height to line up the balls the G line is not in my view, so I didn't even realize it was up there. For the lateral direction Cooper Harper, controllable? yes, adequate? yes, satisfactory? yes. I will rate that a Cooper Harper of 3 also. again the light turbulence required minimum compensation to maintain the velocity vector on the guidance dot.

Pilot F

Task 2010 Standard acoustic takeoff 22 Jan 97; Runs 111-113

Let's see basic comments, first of all, the rotation rate, let's see, judging the initial rotation rate in order to lift off at 10 degrees, plus or minus .5 is kind of difficult, it's just really a guesstimation and there's nothing really for me to control... close loop on. So basically, it's just kind of a... I think this is about right, and then the second comment that I have is for capturing the flight path after you have rotated the airplane, and are on the initial climb out capturing the flight path, 14 degree climb gradient, at least from my perception is, is that I'm stopping the command flight path vector exactly on the line or very close to it, but we're getting overshoots. On the last data run, which we shortened, I tried reducing the rate at which I approached that, 14 percent climb gradient line, which is about 8 degrees, and we still got the overshoot. It looked to me, like the overshoot occurred after I had stopped the command vector on the line, some decrement of time after that, and at that point and time the... my perception is, is that the actual and the command flight path vectors were not split in my display, but after I had stopped at some decrement of time later, the actual flight path vector ghosted up, went above the line, and then came back down. So anyway, that's something to look at in the data tapes to see what's going on there. Basically, for the... on the last run we did, we did get off at 9.6 degrees of pitch at liftoff, which is desired. I think the other two previous runs, we miss that by one or two tenths, and so, yeah, generally we're more in the adequate range, than the desired range for pitch at liftoff, and then also for all the captures of the 14 percent climb gradient, which is at 8 degrees, we overshoot, and I think they were all in the... overshooting the pitch, in other words, taking the flight path vector too high, and that was adequate, and I think we had one that was actually outside the adequate range there too. So, coming into the matrix or into the Cooper Harper rating scale, it's obviously controllable. We're getting adequate performance with a tolerable work load, is it satisfactory without improvement? And for this task, I'd have to answer no, although again, I'm not so sure what compensation I could use really to make the rotation, the pitch at... liftoff any better, except for just experience, I could get a rate down, I'm sure I could learn it better. But, and then the other factor of capturing the 14 percent climb gradient with a flight path vector, I'm not sure what I could do about that. I would probably have to ratchet and set the flight path vector maybe a degree below, and so, hopefully it would balloon up and try to catch it, but, I'm not really sure what kind of compensation I could use that would be reasonable for that. So anyway, it's not satisfactory without improvement, we did not get desired performance, so we're probably in the five (5) range. Adequate performance requires considerable pilot compensation. The problem that I have with this is, is to get adequate performance it really doesn't require considerable pilot compensation. Like I said, I'm not really sure how I could work harder, or what kind of compensation I could work that I would consistently get desired performance with. So, this is kind of a quandary between and a 4 and a 5, and most people don't really like to give 4 1/2's, although some people think that's an acceptable rating. Anyway, we're not doing half ratings here, so, since we only got adequate performance, I'm going to go with a 5. Although, I would make the comment that I'm not so sure that, that's really indicative of... for the pitch at liftoff, I'm not really sure that,

that's indicative of a control problem. My intuition is, is that the capture of 8 degrees climb path with the gamma, and the 14 percent climb gradient, I think that... my intuition says that that might be a flight control problem, or some issue of flight control. One other thing that I didn't mention is the G, with the display that we have here, it's not real apparent what the G is, and if I was doing this, let me rephrase that. The G is up in the corner of the HUD, and it's there, and I can read it, but it's not real noticeable to me what the G is. On the last data run that we did, we did stay within the desired performance of .2, and the way that we did that was, on the initial climbout, I had a high... an acceptable rotation rate, because we got desired performance for 10 degrees at liftoff, and then after we had lifted off, I reduced the rotation rate, and slowly captured, an attempt to slowly capture the 14 percent climb gradient. The point here being, is that it appears, and again you can go back and look at the traces, but that we were getting the 1.3 G strike after we were off the ground during that capture task, and I'm not so... I didn't perceive that I commanded an increase in rotation rate after we lifted off. Again, I... that might be something to look at the traces and see what the pilot commanded input was versus what the aircraft response was and see if there is something going on with the flight controls there. So, we'll give it a 5 for both lateral and longitudinal, although, actually all the problems we saw were longitudinal. Again, I don't really like splitting Cooper Harper tasks, but I guess I would go with a... maybe this appropriate to do that. Why don't we give it a 5 in pitch, and then if I just try to separate the lateral axis out, I guess I would answer yes, to satisfactory without improvement, and again the display issue, the magenta not being real bright, and there being some overwriting of information in the HUD, the same comments as the last run, I'd give it a 3 for lateral, just because, sometimes the cueing is a little bit hard to see. It's more a display issue than really a control issue. Okay, in segment two, I didn't really see any problem with segment two, the cutback maneuver, it seems like you can push over fairly gently for passenger comfort. You wouldn't want to push over too hard, as far as a G goes, that's one thing that we can't really simulate, you don't get the feedback as far as, you know for passenger comfort, the pilot's using the seat of his pants more than he's going to use a G meter. With the pushover, there are some procedures out there, like in Orange county where the pushover is pretty abrupt, I think it was a reasonable pushover that we were using. I thought the airplane was very controllable for putting the cutback phase, so I'd come in, it's controllable, adequate performance is obtainable with a tolerable work load, and for the cutback, although, in the display I would of liked to have been able to read airspeed a little bit better. I think the airspeed stayed pretty in close into the range that we wanted it to. I guess I would go, say yes, it's satisfactory without improvement, again the display issue, I'd like to be able to read the airspeed a little bit better than I can in this display, and to be honest with you, I don't think that this would be an acceptable flight display because of the... even if format was okay, because of the fuzziness of parts of the display, but disregarding that, kind of... I think there are some display issues as far as being able to follow the guidance and overwriting and everything else. I'm going to say it's satisfactory, and I'm going to go into the block, and I'm going to say it's a 3 and a 3 for the cutback phase, and again, I think it's more of a display issue than it is a controllability issue for this phase.



## **Task 2011 Standard acoustic takeoff**

Pilot A

Task 2011 Standard acoustic takeoff 13 Jan 97; Runs 9-11

On the rotation, it's...it would help if you had some kind of aural callout that was synced to the the, I guess you'd call...you'd call it rotation, right, okay, so, there seemed to be a tendency in the pitch axis to wander around this pitch guidance brackets and targets, probably creating more of a PIO in the pitch, than as if you had no...if you have no guidance whatsoever, and made a smooth rotation, it would probably be much smoother, but with that guidance up there it seemed like you're ... I find myself trying to follow it and so on, and dithering around some pitch rate, which seems a little unnatural, other than that, the task seemed to relatively easy, as far as longitudinal Cooper Harper rating, you ought to rate the time up through lift off, is that it, or... I'd have to give it a 2 for longitudinal and a 2 for lateral directional, the flight director guidance seemed to keep everything right in, right where it should be, and for the ... after that, 2 and 2, longitudinal and lateral directional.

Pilot B

Task 2011 Standard acoustic takeoff 06 Jan 97; Runs 13-16

Divided into 3 phases. The initial phase, takeoff roll rotation, initial climbout. Performance standards, centerline deviation ..within 10 ft, and I'll say we met the desired criteria. Pitch rate control..it was tough to get desired. I was inadequate quite a bit of the time so I'll say desired was not achievable for me....adequate was. Velocity vector control airborne well within desired. Lateral control well within desired. Deviation from climb speed within desired...I think. Bank Angle control within desired and heading deviation within desired. So in terms of longitudinal CHR it's, adequate...a controllable and adequate, however , deficiencies warrant improvement . Desired performance requires moderate pilot compensation HQR4. Lateral directional, its controllable, adequate, and satisfactory, improvement not required. Mildly unpleasant deficiencies, minimum pilot compensation required HQR3. I said 3 phases, there's actually only 2 phases. The second phase to...lets see..EPR cutback from the initiation of the cutback to 8 DME. Velocity vector control well within the desired at plus or minus 1 degree. Lateral same thing. Well within desired. Climb airspeed was within desired as was bank angle control and runway heading deviation ...so all within desired. Longitudinal CHR..it's controllable, adequate, satisfactory, no improvement required, mildly unpleasant deficiencies minimum pilot compensation HQR3. same thing as before..that's on the good side of 3. Lateral directional is controllable, adequate, satisfactory, improvement not required. This is a solid 3 due to the turbulence. Minimum pilot compensation required for the desired performance. Mildly unpleasant deficiencies HQR3 . On some note there's some control system anomalies that when encountered in this thing.. in terms of vibrations of the stick and things like that , I don't that affected my rating. I think I allowed for that and it didn't affect my accuracy substantially. Also of note...is that the turbulence is affecting the lateral directional axis considerably more than it is the longitudinal axis. So there's an apparent harmony issue. Also of some note., periodically I'm noting with pitch inputs that I'm inadvertently entering minor roll inputs, so I'm having to compensate for that. Most of the workload is associated with a lateral directional axis..I believe.. And that concludes my comments.

Pilot C

#### Task 2011 Standard acoustic takeoff 15 Jan 97; Runs 37-39

Takeoff lat-dir, get that out of the way, that's a 2, that's fine, no complaints for that. Longitudinally, in segment one, satisfactory without improvement, yeah, I'd say so, improvement not required, give that a 3, that's a...that's a fairly good thing, it takes a fair amount of concentration, there's lots of things going on, and it takes a good solid work load to do it, but you can keep it in there, and it looks good, so a 3, a 2 for lat-dir, 3 for longitudinal, second segment, definitely satisfactory without improvement, I'm going to give that both longitudinal and lateral-directional, 2's, pilot compensation is hardly a factor, there's some wandering around that goes in there with turbulence, but there's nothing you can do about that, and what I'm rating now, is my ability to keep the commanded flight path marker within the bounds, and just two quick comments, I think from an experiment design, it would be better to see this one first because this tells me how fast I have to rotate, instead of having to guess it without the guidance, I think it would've...we would've saved a practice run or two, and the other thing is what I mentioned before, this is the first time in the whole test that I've noticed the large breakout in the inceptor, and I know that's not supposed to be the perfect inceptor, but it certainly isn't, and it's...it probably plays a little bit of part in ability to...in performance. The breakout per gradient seems to be larger than I'd prefer. That out to do it.

#### Pilot D

#### Task 2011 Standard acoustic takeoff 21 Jan 97; Runs 10-13

Having just a few problems with the display, you know as I go down the learning curve those will tend to go away. A couple of problems are switching from head down to head up, trying to catch VR, the digital VR on the head up is very hard to see, and the other problem I'm having is switching from tracking with the pitch reference then as... soon as we get off the ground then we have to switch to tracking with the flight path. It's a little bit of learning problem there, and other than that it seemed to work out pretty good. It is a difficult task on the initial climbout, the commanded flight path is moving pretty fast, so, unless you want to really jerk the airplane around, it's pretty hard to get... I never did get it into the desired range. I think we got adequate on the last 3, we're throwing out the first run, which I had inadequate control on those two parts of the task, initial rotation, and the initial climbout, longitudinal. We'll chalk that up to experience. Okay, pilot rating. Do we have a pilot rating scale? Okay, pilot ratings for task 2011. The first segment, the initial rotation in the climb, I'm going to give it a 5, it's because my performance, well, two reasons, one the performance is in the level 2 level, and I think there are some things we could do to tweak the displays to help there, and/or tailor the trajectory. There's quite a bit of... for me... it's taken quite a considerable amount of pilot compensation to try and track that... the two tracking tasks during the rotation and the initial climb. Okay pilot rating for the cutback phase is 4, we were getting desired performance there, but it's still desired performance requires fairly moderate pilot compensation. A little bouncing ball is not real easy to follow. That's correct, my pilot ratings are being degraded to level 2, because of the longitudinal task. The lateral task seems to be relatively easy. Okay, we have the pilot ratings for the longitudinal task. For the initial rotation and climb was 5, cutback was 4. For the lateral directional for both segments, initial rotation, climb, and the cutback, it's relatively easy. It's not perfect though, I have a little bit of a tendency to PIO in roll, we're going to give it a pilot rating of 3 for both of those segments.

#### Pilot E

## Task 2011 Standard acoustic takeoff 07 Jan 97

I prefer this procedure to 2010 and I think it gave better results, for a very subjective opinion there. There are no real comments on this. The tailscape guidance I think it's very very important and I like seeing that rotation guidance if you want to try and hit these numbers and that certainly makes it easier to hit the numbers and also I would like to fact that the guidance circle remained in view. On 2010 we did a cutback and it drops down precipitously, down out of field of view, so you don't really no where it is. This one stays in view all of the time. The first two data runs I had to work a little bit hard to adequately track the pitch rotation guidance, on the third run I thought it worked out very well, and I just tried to anticipate when it started, I think in the first two or maybe it was a slight delay in starting my rotation, and got behind and had to kind of bracket it to get the center point of the rotation bracket This time I tried to anticipate and that stayed right with me I thought went very well. "This time" being the third run. Okay for the Cooper Harper's. For the takeoff roll rotation, initial climbout segment, longitudinal, controllable? Yes, adequate? Yes, satisfactory? Yes, I would rate it Cooper Harper of 3, basically, this is kind of a solid 3, but the comment needs to made that it is kind of a minimum pilot compensation, it's not moderate, but it's more than minimal, in order to track that guidance, rotation guidance, you have to do a fairly high level of work load, more so than minimal, but I think the overall, I am going to look beyond that and rate it a 3 because it is a level 1 task. Lateral Directional same thing, controllable? Yes, adequate? Yes, satisfactory? Yes, for the initial part I think I am going to rate that a Cooper Harper of 2. (Changed to a 3 during comments on task 2030). I don't recall really putting in any compensation on the initial lateral directional. For the second segment the cutback PLR Longitudinal controllable? Yes, adequate? Yes, satisfactory? Yes, Cooper Harper of 3. No real comments. Just following guidance does take compensation, but it's not bad, it's not a whole lot of... you know, you close the loop on the guidance circle and it's just not that difficult, this control law. Lateral directional controllable? Yes, adequate? Yes, satisfactory? Yes, and 3 this time. Again in a the little bit of turbulence you have up there, that takes more compensation than you find on the initial segment so it is a little bit higher work load for a 3.

Pilot F

## Task 2011 Standard acoustic takeoff 22 Jan 97; Runs 107-108

Basically, I didn't see anything, any real problem with the task, the bigger problem, I think the thing that's impacting this task most of all, is the display, it's harder for me to see the little round flight path vector, based flight director display, and I think that impacts my performance some. Actually, I think we pretty much got desired, pretty much everything except for on the initial takeoff, the pitch control, and we're generally running between 70 and 80 percent on that, though 90 is desired, and then I guess, actually everything else we were in desired this time, weren't we, so everything else is desired, unfortunately that one adequate, I think is going to drop us down, I'm not so sure how much I would equate that to the flight path based vector cue, guidance cue not being real easily visible, and also the other thing that I noticed is, even when I tried to keep it constant rotation rate from what I had with the brackets, when the brackets go away, and I look down, it seems like I'm off the flight path vector guidance cue when the flight path finally comes up, and my point there is, I'm not really sure what I would do, I tried on the second data run being more aggressive and actually ended up doing worse. I'm not really sure what I could do to fix the problem here. There might be some learning curve to this, but I don't know that, I don't readily see a way that I could compensate for that particular factor. Anyway, so I guess I kind of somewhat think that perhaps this rating is not really indicative of what you could actually get with

maybe a different display scheme, and that would be interesting. Anyway, we got pretty good performance throughout, unfortunately, if I, we got the adequate performance so we come in and say it's controllable, adequate performance with a tolerable pilot work load, is it satisfactory without improvement? The answer would be no, because we can't get adequate, or desired performance at all, and so that would mean that the best that I could give it is a 5, and I guess actually I would give it a 5, again I don't really like splitting the axis, but 5 longitudinal, and lateral I could answer yes to that, and I would probably come up and say... it's kind of a high work load task, I would kind of be in the range, or be inclined to give it a 2 1/2 and again mainly because of the display and sometimes it takes a little bit of anticipating and guessing to make the small roll commands. I'm going to give you a 3, just because, because of the display I would generally go 2 1/2. Note that the 5 on the pitch is because of the longitudinal control, I didn't really see any, other than just not being able to perform the... get desired performance. I didn't really see any... I don't really have any comments concerning flying qualities, predictability, controllability, or anything that really effects that rating. I'm just not so sure how I can get from here to there. Anyway, I probably, I'm guessing, if we had gotten desired performance there, I'd probably would of given it a 3 in both, anyway. Yeah, okay, I'm sorry, are we doing four ratings here or three? Okay, so, that was the takeoff phase we just rated. The initial climb out, actually for all four phases I would think the same comment about pitch. When things settle down a little bit, and you can kind of lean forward and you're not really making a... I'm sorry, the same thing for roll, I'd probably give it a three on all four tasks. The only task that it's a little bit easier on, is the final climb out task. Okay, so there is only three segments, two segments. Okay, well the second segment I would go with a three and a three, and the reason is, I'll go through the cards just to get the comments. In both axis it's controllable, adequate performance is obtainable with a tolerable pilot work load, it's satisfactory without improvement, and the reason I'd give it a three over a two is just because, mostly because of the display. I think if the guidance cue was brighter, I might be inclined to give it a two. Anyway, that's it I guess.

## **Task 2030 Acoustic (Prog Lapse Rate) takeoff**

Pilot A

Task 2030 Acoustic (Prog Lapse Rate) takeoff 13 Jan 97; Runs 13-15

Lateral directional Cooper Harper for the initial phases, 2, and longitudinal, 2, and 2 and 2, for the climbout after the thrust cutback, and actually there were two cutbacks, which one...where do you segregate, okay, so after 2.60 DME, I'd call it, 2 and 2 Cooper Harper. It's quite...as far...of the 3, noise abatement procedures, I'd say this is probably the simplest and easiest, and most logical, fuel efficient, if it works, it's probably a good procedure.

Pilot B

Task 2030 Acoustic (Prog Lapse Rate) takeoff 06 Jan 97; Runs 18-20

On the rotation phase, everything in desired except for longitudinal control..it's just that I think the task is a little bit artificial on terms of trying to keep the brackets centered. Such that I wasn't able to get desired. I was able to get adequate routine...routinely, but not desired longitudinally. Lateral directional...I had no problems with , in all the parameters other than longitudinal control. In terms of rotation rate... rotation pitch rate control well within desired. So longitudinally HQR, it controllable, adequate, not satisfactory, deficiencies requires improvements, minor but annoying deficiencies, desired performance requires moderate pilot compensation...Hang on a second....I don't think I got desired in any of those ....either of those runs...lets call it a 5..Adequate perform....well see this is the trouble with this HQR scale. It did not require considerable pilot compensation for adequate performance. On the other hand, I wasn't able to get desired...I'm going to make a judgment call since I can't give 1/2 ratings and give it an HQR4. Yes..just on the rotation part of it. For lateral directional it's controllable, adequate, satisfactory, improvement not required, mildly unpleasant deficiencies, minimum pilot compensation, HQR3. For the second phase, I was able to get desired performance fairly easy in all of them . Again I am reticent to say that pilot compensation was not a factor. But that's pretty dag- gone close... particularly longitudinally...and it may be too that I am getting more practice today. Lets go for longitudinally first, controllable, adequate, satisfactory, improvement not required, negligible deficiencies, pilot compensation not a factor for desired performance HQR2. Lateral directional controllable, adequate, satisfactory, improvement not required, mildly unpleasant deficiencies, minimum pilot compensation HQR3 and that was due to the turbulence. No stick anomalies this time. So that was good. That ends my comments.

Pilot C

Task 2030 Acoustic (Prog Lapse Rate) takeoff 15 Jan 97; Runs 41-43

Segment one, very similar comments to the last one, except that it's a little bit easier, just because you're not going to such a high pitch attitude, and have as many changes in it. So, it's certainly satisfactory without improvement, and lateral-directional is still 2, and 3, or excuse me, longitudinal, I'm going to give it 3, but if you keep the comments with the Cooper Harper, just let me say that that's a better 3, than the other 3 was. It's significantly easier, however, both of them fit within the 3, one on the lower boundary, and the other one on the upper if you want to think of it that way. As far as the tracking up and away, it's, boy, I don't know how it's going to get any better than that, 2 for both longitudinal and lateral-directional for segment two, and all the other comments stayed pretty much the same.

## Pilot D

Task 2030 Acoustic (Prog Lapse Rate) takeoff 21 Jan 97; Runs 46-49

Compared to the other two takeoff tasks, this is a very easy task. It's essentially like a real airplane used to rotate and go, there's not the continual regulation required. I'm still having a hard time with the initial pitch rate and initial target pitch attitude, but I'm ending up very close to being on the desired climb gradient at the end of the rotation and everything, if anything, I tend to be a little bit on the high side, so it looks to me like maybe with some more tuning on the parameters of the takeoff and the criteria here, I think we'd be okay, but in the context of what we did, I was getting adequates on the rotation and the initial pitch attitudes, so we'll have to give it a 5 for the longitudinal, initial rotation and climb. Lateral would be a 3, because of the PIO problems, no change from the previous takeoffs. The cutback is a non task, so it's essentially a pilot rating of 2 longitudinally, and 3 laterally.

## Pilot E

Task 2030 Acoustic (Prog Lapse Rate) takeoff 07 Jan 97; Runs 40-42

This is the simplest from piloting point of view of the 3 takeoff tasks so far. Basically just following the pitch rate guidance and in the actual guidance circle, and nothing really to comment, no real problems on this one at all and I think the performance indicates a relative ease of this task compared to the other two. For longitudinal Cooper Harper rating for the take off roll rotation this requirement segment, it is controllable, adequate performance is attainable, satisfactory without improvement? Yes, rate a Cooper Harper of 3, the biggest problem is just trying to follow the rotation guidance after that it is a real easy task to follow the guidance circle throughout the program lapse rate. For lateral directional for the initial takeoff roll rotation climbout, is it controllable? Yes, adequate? Yes, satisfactory? Yes, Cooper Harper of 2, I don't have a whole lot of recollection of once we get airborne. I will comment that on the takeoff roll, you have to be careful with the rudders, that you can overcontrol those. But I guess I need to make a change here that, I know you guys are not going to like, I am going to change that rating back to a 3 because I made another mistake, I thought for some reason the task was from rotation on and it does include takeoff roll, so also we need to change the lateral rating for the initial segment on task 2011 to a 3. That was a 2 and now I need to put that back to a 3, and the reason being is that the takeoff roll once you get above 100 knots the rudders become very sensitive and it takes some very, very fine subtle inputs to keep you on the centerline. Since the takeoff roll is part of that task, those will be both be 3's. So 3 and a 3 for longitudinal/lateral. For the.... interesting to note a comment here, I felt that I met the desired criteria for plus or minus half a bracket 90% of the time. Typically I would be slightly behind the rotation cue as it started, I would then catch up slightly over shoot and then be on it for the vast majority of the time. The score card here did not seem to indicate that this as well, but I felt that I met well within the desired criteria for the... as far as I could tell for the performance standards as specified on the card referencing the rotation bracket. For the EPR cutback PLR segment, longitudinally, it was controllable, adequate performance was obtainable. Satisfactory without improvement? Yes, and I would have to rate it a 3. Pilot compensation is required because the guidance is changing and so therefore you have to readjust to your flightpath angle, so that makes it a 3, but it is very, very nice. Lateral directional, similarly controllable? Yes, adequate? Yes, satisfactory, yes, a 3 also. Then again you are having to put in compensation to account for the disturbances from the light turbulence.

Pilot F

Task 2030 Acoustic (Prog Lapse Rate) takeoff 23 Jan 97; Runs 6-7

Let's see, really... again, we're not, we're pretty much getting desired performance on everything except for the rotation tracking on pitch, and we got about 87, 88 percent on one run, and about 80 percent on the other run, 79 percent, somewhere in there. So, that would really drop us into the adequate performance range rather than desired. Although, we were very close to desired on the first data run we did with that parameter. All the other parameters were desired, and again, I'm not so sure that I, there's any compensation other than just really practicing the task over and over again, so that, you become very familiar with the rate that that bar moves at, to improve the initial part. So again, I'm not so sure that the ratings going to be totally indicative of the performance or of the, I guess of the flight control laws. Anyway, going into the task, it's definitely controllable, adequate performance with a tolerable pilot work load. Is it satisfactory without improvement? I'd almost be tempted to answer yes on this question, but we did only get adequate performance, which would really forces us to answer no, and really put us, the highest rating we could give would be a five (5). Again, I have a hard time, we'll give it a five in pitch, and we'll give a two (2) laterally. I don't like splitting up the Cooper Harpers like that, but it's really just that one parameter that's kicking us out of the adequate box, and that is a pitch parameter. I don't really... you know, the pitch is no different than on any of the other tasks that we've seen. You're not really doing high enough rates at predictability becomes a problem, but being able to do the fine tracking task of a bar, I guess there is some function of the flight control in there, in that, if the airplane was a little bit crisper, you might be able to track that rotation bar a little bit better. It's not... but the other side of the coin is, is the tracking in that bar is a pretty fine tracking task, so, I guess for just performing a takeoff, there aren't many problems, for doing this task, I guess I do think that if the pitch axis was just a little bit crisper, that you might be able to do a little bit better job at tracking that pitch bar on rotation, but again, that's a pretty tight task. I guess, the bottom line is, I'm not seeing anything that's really, really objectionable in any manner, and I'm not even saying that I would say it's moderately objectionable for takeoff. The tracking task that we're doing though, you would benefit, I guess, if you had a little bit crisper responding airplane. I'm sorry, the up and away step with cutbacks, I think everything is fine there. It's definitely controllable, adequate with a tolerable pilot work load, and I believe it's satisfactory for this task without improvement, again, my preference would be to have a little bit crisper responding airplane, but I would go in for this task, we did get desired performance, I would probably tend to go with the 2 1/2 range, if we were giving half ratings, because again, the display is not as clear as it could be, and that I think is effecting my performance a little bit, but or requiring me a little bit more compensation, but we'll go with a 2, a 2 and a 2.

## **Task 3020 Climb Trans. to Level Flight - Xsonic**

Pilot A

Task 3020 Climb Trans. to Level Flight - Xsonic 14 Jan 97; Runs 32-34

Not rated.

Pilot B

Task 3020 Climb Trans. to Level Flight - Xsonic 08 Jan 97; Runs 77-79

Block 4 - Climb, Cruise, Descent I maintained airspeed within a couple knots, within a knot on the last, as I got better at it. With a rapid change in climb rate, not a problem, evaluate coupling, between airspeed and flightpath, it's there, I mean it has to be there, but it's certainly do-able. No problems in handling qualities, nothing significant, a little bit of work load and longitudinal nothing to speak of in lateral directional, pretty much ignoring that. The transition was smooth and continuous, maintained a desired performance and all the parameters listed. Longitudinal; it's controllable, adequate, and satisfactory, a little bit of compensation to watch the pitch attitude, HQR3 for that minimal pilot compensation. For lateral directional, controllable, adequate, and satisfactory, and really I am kind of ignoring it, compensation is not really a factor, HQR2. That concludes my comments.

Pilot C

Task 3020 Climb Transition to Level Flight - Transonic 16 Jan 97; Runs 127-129

Adequate performance certainly, and satisfactory without improvement, no, turn the corner, to get desired performance it needed, moderate pilot compensation, the majority that I suspect was the throttle, it's just very hard to make a smooth small throttle correction on this, and so I tended to overshoot a couple of 3 times took a little work, if I wouldn't have, I wouldn't of been able to keep the desired, that's for certain. 4, for the level (CHR 4 Level 2). I didn't...the lateral task is such a, you know, kind of almost auxiliary task that I didn't see any problem with it, so yeah, I'd bring that up, and say satisfactory without improvement, that's probably a 2, a couple of degrees was the desired, okay yeah, then 2. Okay, 4 and a 2.

Pilot D

Task 3020 Climb Transition to Level Flight - Transonic

Not performed by this pilot.

Pilot E

Task 3020 Climb Trans. to Level Flight - Transonic 10 Jan 97; Runs 56-57

Block 4 - Climb, Cruise, Descent No real problems here, no pitch/roll coupling, no PIO tendencies, pretty easy to make the capture, well within the desired criteria. Longitudinal and Cooper Harper rating, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a Cooper Harper of 3. Lateral directional, the performance standards, basically maintain heading, there sure were no deviations that I saw, and bank angles, no problems there. Controllable? Yes, adequate? Yes, satisfactory? Yes, Cooper Harper of 3 also.



Pilot F

Task 3020 Climb Transition to Level Flight - Transonic

Not performed by this pilot.

## **Task 3022 Climb Trans. to Level Flight - Supersonic**

Pilot A

Task 3022 Climb Trans. to Level Flight - Supersonic 14 Jan 97; Runs 71-73

This is level off in supersonic flight 51,000 ft. The Cooper Harper for the pitch longitudinal controls, I would say is a 2, and probably a 3 for the lateral directional controls, and the rate of climb is very slow, maybe 500 ft per minute at the end, maybe even 300 ft per minute, and the final throttle position is only about a quarter of knob off full throttle, at 450 knots, and so it's a very minor, minor correction, and the display seemed to reasonably adequate for that type of an operation.

Pilot B

Task 3022 Climb Trans. to Level Flight - Supersonic 08 Jan 97; Runs 81-82

The ability to maintain airspeed during change in climb rate, there is not much of change in climb rate, you're high enough that you're climb rate is very, very low, it's on the order of 200 ft per minute or less, I think, I guess I didn't look at it during the climb, but it is fairly low. Very little coupling between airspeed and flightpath, you can do one and then the other, you can do them serially, you really don't have to worry about it, so I've become a serial flyer. Evaluated the handling qualities during the power of configuration change, there wasn't really much change there, so it was kind of benign, the transition was definitely smooth and continuous and I was able to maintain within the performance standards, we modified one of them, deviation and airspeed instead of Mach and we said plus or minus 5 knots, which isn't entirely do-able. I'm going to do both longitudinal and lateral directional at the same time here, because in both cases I pretty much was ignoring them. It's controllable, adequate, satisfactory, compensation not a factor, HQR is 2 for both longitudinal and lateral directional. That concludes my comments.

Pilot C

Task 3022 Climb Transition to Level Flight - Supersonic 16 Jan 97; Run 131

Satisfactory without improvement, in both longitudinal and lateral directional, lat-dir is a non-event, it's almost just hardly climbing at all, and not changing heading, just maintaining straight ahead with the track, the thing that is not a difficult thing to do, to say the least, so 2 and 2, for both, not much we can do there. The only thing I'm giving 2 and 2, but with those throttles, it likely could, you know, there was a little compensation due to the throttle, but I had to move them so little bit, that overall, it was not a factor.

Pilot D

Task 3022 Climb Transition to Level Flight - Supersonic

Not performed by this pilot.

Pilot E

Task 3022 Climb Trans. to Level Flight - Supersonic 10 Jan 97; Runs 58-59

Another pretty non-eventful task, no flight handling qualities close to an error at all, nothing... no PIO, no coupling to 2-axis, the wrong pitch. Real nice job, makes and captures all criteria. Longitudinal, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes a 3. There is compensation required to effect the level off, however, laterally there's no problem at all, and nothing that did nothing, so, it will reflect a higher Cooper Harper, controllable? Yes, adequate? Yes, satisfactory? Yes, for 2.

Pilot F

Task 3022 Climb Transition to Level Flight - Supersonic

Not performed by this pilot.

## **Task 3030 Profile Climb**

Pilot A

Task 3030 Profile Climb

Not performed by this pilot. Only pilot to perform this task was Pilot B.

Pilot B

Task 3030 Climb Trans. to Level Flight - Xsonic 10 Jan 97; Runs 16

Handling qualities in the climb were pleasant, no problems in following the desired airspeed and altitude ... attitude profile, and I think you probably could of done it either way, either with the head down guidance, or with the head up guidance, although obviously, the head up guidance makes it a little bit simpler. I was able to keep well within desired performance the whole time, without turbulence we're noticing coriolis centrifugal forces in the curved earth modeled, things like that, so, the handling qualities are pretty much transparent here. Both longitudinal and lateral directional are controllable, adequate, satisfactory, no improvement required with negligible deficiencies. Pilot compensation not a factor, HQR2. Caveat is that there...the apparent sensitivity in roll, and roll rate, the sensitivity increases as you get faster in Mach and higher in altitude, so, it's a little bit easier to control angle of back down low then it is up high, at the end of the profile that...those are minor differences still well within level 1 criteria. That concludes my comments.

Pilot C

Task 3030 Climb Transition to Level Flight - Transonic

Not performed by this pilot.

Pilot D

Task 3030 Climb Transition to Level Flight - Transonic

Not performed by this pilot.

Pilot E

Task 3030 Climb Trans. to Level Flight - Transonic 10 Jan 97

Not rated.

Pilot F

Task 3030 Climb Transition to Level Flight - Transonic

Not performed by this pilot.

## **Task 3040 Level Flight Trans. to Climb**

Pilot A

Task 3040 Level Flight Trans. to Climb 14 Jan 97; Runs 75-77

The transition from 250 knot climb, 10,000 ft to 2000 ft per minute...or level flight, transition to climb, 2000 ft a minute, and the...it seemed like a very simple straight forward task, if you...especially when you know the gamma that is required, and the thrust lever position and fine tune with the accel, decel cue, and minor adjustment to the gamma. It was very simple task, I'll give it a 2...and lateral directional and longitudinal.

Pilot B

Task 3040 Level Flight Trans. to Climb 08 Jan 97; Runs 84-86

The card was accomplished as per the card ability to initiate climb during normal operations certainly able to do that. No undesirable airspeed coupling, no problems at all really, it was a pretty easy task to do. The pilot compensation largely not a factor, able to keep within the desired parameters throughout. Longitudinal and lateral directional are both the same; controllable, adequate, satisfactory improvement not required, mildly unpleasant def... , I'm sorry, pilot compensation not a factor, good negligible deficiencies HQR2, 2 for both. That concludes my comments.

Pilot C

Task 3040 Level Flight Transition to Climb 16 Jan 97; Run 134

It was the lateral-directional, all I had to do was just kind of get it in a cross check, there's hardly any variable off, the bank angle for just a couple of degrees of bank, you know I have to actually look at the index up there, and it's a long ways from the flight path marker, but it's still, it was not a difficult problem, and probably if I'd just come inside, it would have been even easier. Okay, sure, satisfactory without improvement, definitely, lateral-directional, I'll give that a 2, and again, with the throttle, it's just making the work load, taking some compensation to keep the desired, so I'm going turn the corner one before, and make that a 4, and again, it's the throttle that's doing it, it's not any response to the airplane, otherwise. 4 and a 2. Yes.

Pilot D

Task 3040 Level Flight Transition to Climb

Not performed by this pilot.

Pilot E

Task 3040 Level Flight Trans. to Climb 08 Jan 97; Runs 60-61

No real problem here, a little bit of throttle friction that makes the throttle adjustments a little bit imprecise. I set a power setting, I figured out 82 percent after the first run, and set it on second run, it didn't seem to be enough to power, so it took a little bit longer to stabilize the two thousand as more of a slower, smoother, interceptor of two thousand ft per minute rate

of climb. Maintaining airspeed plus minus five knots, okay, actually I have even greater, plus minus 10 knots in airspeed, I was able to maintain a plus minus five without any problem. That's certainly well within desired, and target rate of climb I thought was definitely plus or minus 200. The second time I wasn't paying much attention to my heading, it drifted off. The first time it was pretty much right on, and so I, kind of just a lack of attention on my part, I think desired task in both lateral and longitudinal. So for longitudinal rating, controllable? Yes, adequate? Yes, satisfactory? Yes, for a 3. A little bit of effort mainly for work load, a little bit of hunting around for the proper attitude. For lateral, controllable? Yes, adequate? Yes, satisfactory? I'll say no, and rate it a 4, basically, again, this thing should just hold a heading pretty much, there's no lateral task involved here, and it did drift off, so, it should be easier to hold wings level, so it's going to come in with a 4, and be level 2.

Pilot F

Task 3040 Level Flight Transition to Climb

Not performed by this pilot.

## **Task 3050 Profile Descent**

Pilot A

Task 3050 Profile Descent 14 Jan 97; Run 79

Cooper Harper, lateral-directional a 4, because of the lack of a track hold function, would certainly help here, let bank angle get out. I think one of things that seems to be effecting the bank a little bit is the lack of a distinctive detent on this side stick. It seems awfully easy to get out of the detent and start introducing rolls...roll inputs, these because they're heavier forces on the pitch and the lack of the detent on the roll, so, summarizing Cooper Harper, longitudinal a 2, and on lateral directional, a 4, and the display for following the redline was more helpful the more you get used to using it, however, I'm still not sure if you had a flyoff between it and a standard airspeed indicator, whether there would be much difference, but that would be something to look at on the future, a future test. The strategy that I used, by given no procedures to follow on the descent, was to establish a...about a 3 degree, 2 or 3 degree descent, with partial thrust to hold the redline, and then gradually reduce the thrust further for the constant airspeed segment at 475 knots, and then as you get established on the decreasing indicator that keys...keys airspeed schedule, decreasing to 350, select idle thrust at that point, and that seemed to give a reasonable descent.

Pilot B

Task 3050 Profile Descent 08 Jan 97; Runs 88

Handling qualities; the airplane was fine in the descent, I didn't notice any overt gust sensitivity that was objectionable in any rate. I believe I was able to keep within desired performance criteria. Working a little bit longitudinally and not a whole lot at all lateral directionally, so I'm going to split the ratings just a little bit. Longitudinal; controllable, adequate, satisfactory improvement not required, minimal pilot compensation, HQR3. Lateral directional controllable, adequate, satisfactory improvement not required, with pilot compensation not a factor, HQR2. So the HQR's are 3 and 2. That concludes my comments.

Pilot C

Task 3050 Profile Descent 16 Jan 97

Not rated.

Pilot D

Task 3050 Profile Descent

Not performed by this pilot.

Pilot E

Task 3050 Profile Descent 10 Jan 97; Runs 63-64

Fairly high work load task, very long task also, the bank angle control is difficult to maintain wings level without concentrating on it, either the breakout and the sidearm controller needs

to be adjusted just a little bit higher, but I think it's more of a control law adjustments needs to be made to have some way to hold a bank angle more easily. This is mainly a problem up above in the supersonic speed regime where the bank angle, especially zero degrees phi was very sensitive. Bruce thinks he saw about a 5 degree delta at one point, I don't recall ever seeing it that high, but I wasn't always paying attention to it, as I was working very hard on flying the VMO curve, so that would affect the lateral rating, and so it goes on to previous comments about the ability of this thing to hold wings level very easily, it's a high Mach and high altitude. The airspeed worked out the most part very well. I did play with the throttles a little bit, and one little burble on the MMO curve, we... you're slowing down in the Mach number to around the 37,000 ft regime, whatever. I went ahead and pulled the throttles completely back to idle, or pretty close to it, and a decel rate a little more quickly than I was able to push the nose over without exciting the inlet unstart rings, but otherwise, it worked out pretty well, following within 10 knots of the airspeed. For the most part within plus minus... , yeah, the most part stayed pretty much within the 5 knots of the desired, so, I think for the aggregate profile, I would say it was desired. For the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory without improvement? No, a 4, and that's for work load, it's just very difficult to... with the cues we have here, and the task to tightly follow the VMO, MMO curve, although it is do-able it's a work load issue, for lateral directional, I'm taking my colleagues input, controllable? Yes, adequate? Yes, satisfactory? No, a Cooper Harper of 5, basically inability of the system to maintain wings level.

Pilot F

Task 3050 Profile Descent

Not performed by this pilot.



## **Task 3060 Level Flight Trans. to Descent - Supersonic**

Pilot A

Task 3060 Level Flight Trans. to Descent - Supersonic 14 Jan 97; Runs 81-84

Are we getting...were we getting desired or adequate performance or any of the above. I think the last two runs we had, desired performance of 2 of 3 captures, and inadequate on the rest. Okay, so we had inadequate...we had level 4 handling qualities, level 3. Let me go through this. Is it controllable, yes, is adequate performance obtainable with a tolerable pilot work load, no, so, I guess I'd have to give it a...adequate...I'll give it a 7, I guess, for pitch, and...well, what do you want to call that...a...a level 2 or level 3 performance...adequate to a tolerable pilot...well, I guess the key is, is adequate performance obtainable with tolerable pilot workload, it's marginal, it could be a 6 or a 7. I'll give it a 6 for pitch, and mainly because of the fact that what seemed to be limiting the performance was the displays that were available to determine whether or not you were getting, what your vertical speed was, and had to use the head down display, primarily, can't, and the...there's a lot of deficiencies in the HUD display that seemed to distract from this type of a maneuver, being able to determine exactly where your flight path vector is precisely, there's a certain vagueness in exactly where your pitch is, and you have to do some extreme fine tuning. The vertical speed scale on the HUD is rather gross, the tolerances involved are like one linewidth on the up display, whereas the head down vertical speed display for 1000, 2000, 4000, is much more readily apparent whether you're inside or outside the tolerance, so, you can fine tune a little better, using head down instrumentation. For lateral directional, I guess I'd have to give it a 3, Cooper Harper, what were you going to say. I was going to ask you if giving a digital box of speed digits would be helpful? If...I think it would be helpful if rolling digits existed for vertical speed on top and bottom of the vertical speed tape display on the HUD, I think that's what we do on the triple 7, is repeat the vertical speed in digits, and that is helpful, I think in this kind...especially in this kind of a task.

Pilot B

Task 3060 Level Flight Trans. to Descent - Supersonic 08 Jan 97; Runs 90

The problems in this card with envelope protection I think predominantly where if you've got to, you get a little bit fast, a hundredth of a Mach fast, it tries to raise the nose on you, and that's going to effect your decent rate, and cause you to pull back power and try to push the nose over and if you do it out of phase the Mach comes up again and you start into a cycle in that and so, desired performance is real tough in decent rate, in general, deviation in Mach is tough because you don't have a rate. The longitudinal flightpath acceleration doesn't give you valid indication because as you descend, you want to increase indicated airspeed in order to hold the same Mach, so to maintain constant Mach you're carrot is above the wing line. So you really don't have any good indication there either. Heading and bank was okay, not much of a problem there, a little bit of a fight in the angle of bank, but not much attention required. So, the longitudinal Cooper Harper with the caveat that I was able to get desired some of the time and only adequate some of the time, it's controllable, adequate, probably deficiencies were an improvement with that envelope protection, adequate performance, let's go, desired performance requires moderate pilot compensation, HQR4. In the lateral directional it's desired, it's controllable, adequate, satisfactory, and minimal pilot compensation, HQR3. So the numbers are 4 and 3. That concludes my comments.

Pilot C

#### Task 3060 Level Flight Transition to Descent - Supersonic 16 Jan 97; Run 137

The lat-dir is easy enough to control, I just remembered to keep it in my cross check, it just kind of wanders off very, very, little. So, for the lat-dir, certainly satisfactory without improvement, and well, I guess I should have used more compensation than I did, so I'll make it a 3 in lat-dir, it's kind of a toss up, I mean it's very...no, I won't even...it's too un ... lat-dir, that's just normal flying, that was me being lazy, so, 2 for the lat-dir, for the longitudinals, the actual control of the pitch attitude, I would say is satisfactory without improvement, but after all, the task was to maintain a reach, and maintain a rate of descent, and that was down in adequate, worse than adequate, okay, well, then that would certainly do it, well, if I didn't get adequate at all, I'm going to have to come down here, and turn the corner, adequate performance obtainable, tolerable pilot work load, and I think it was from an overshoot, primarily, wasn't it, that did that, yeah, and I certainly wasn't a problem in...with worried about control, so, 7 is what it would be, and just two factors, as I said, the attitude itself was easy enough to control, the problem is the mechanical characteristics of the throttle, with these kind of very minor adjustments, the breakout was noticed...problem was noticeable on the inceptor, but the...I'd say the major thing that was...the most noticeable thing certainly was the characteristics of the throttle and it's friction. 7 for longitudinal.

#### Pilot D

#### Task 3060 Level Flight Transition to Descent - Supersonic 22 Jan 97; Run 75

We just did some pushovers from cruise and we go to a 1000 ft, 2000 ft, 4000 ft per minute, which with the instrumentation here is pretty tough. Primarily I was using the head down vertical speed indicator, which is not an instantaneous vertical speed indicator, which I presume we'll have one in the airplane. So, it made it a pretty tough task, really the technique I was using was to try and set gamma then cross-check vertical speed, and of course this Mach number, the flight path angle changed for the small sink rates is very, very small and hard to resolve. So, I was pretty consistently busting the desired sink rates on the initial capture. You could milk it in with a couple of tries. So, my performance is really adequate, let's give it longitudinal, let's give it a 5 for all reasons named. Laterally, we've still got this roll PIO, let's give it a 4.

#### Pilot E

#### Task 3060 Level Flight Trans. to Descent - Supersonic 10 Jan 97; Runs 65-67

Starting out at, what is this Mach 2.4, and 64,000 ft, it's a very interesting task, a little bit difficult, and that takes very, very, very, subtle changes on the sidearm controller to affect the descent rates that we are looking for. Airspeed modulation and control airspeed was fairly straight forward, that does not tend to bleed or show any speed instability, maintain the airspeed tolerances well within the desired, most times within plus minus two knots, I'm allowed five knots. The vertical speed, using the HUD symbology, I though was pretty good, using the round dial down here with heads down, which I didn't even look at, I tend to be... I tend to be a little bit high on each of the descent rates. Based on the instrumentation that I have on display, I have... it's a little bit difficult to meet the desired criteria, though I felt from a handling qualities point of view, it did a fairly good job. Considering all that, in a kind of a gross overall rating. For longitudinal, controllable? Yes, adequate? Yes, satisfactory without improvement? No, I'm going to rate it a Cooper Harper of 4, I think, it takes just a little bit of, actually a fairly decent work load with very, very, tiny motions of the stick. Very,

very subtle, and you probably would need a little bit to do this task, you probably need a little bit more expanded scale on the HUD, and you'd be level 1 with it. The lateral, maintained the heading and angle of bank, it still though, requires effort it shouldn't, so, controllable? Yes, adequate? Yes, satisfactory? No, also a 4, main thing is the effort required to maintain wings level, so, this is not a lateral task. That shouldn't be a effort.

Pilot F

Task 3060 Level Flight Transition to Descent - Supersonic 24 Jan 97; Runs 40-42

Let's see, basically, a couple of up front comments, the gamma control works real well, although, you still have to pay attention to it in the manual throttles when you're adjusting throttles. Also, I realize that this speed and altitude, you know, a small change in airspeed is going to make a change in the vertical speed also, so, but, anyway, overall, I thought the task was fairly reasonable, I bobbled the 2000 ft per minute one a couple times, and got outside of what I decided performance was, I think... I'm not really sure I have a reason, or... except for just my cross-check kind of faulted there a little bit, both times I was kind of fixating an airspeed, and when I went back and cross-checked the vertical speed, it had gotten out of limits. And I think maybe part of that was, even under practice I didn't get the... I wanted to say pitch... picture, but actually the place to set gamma, I didn't really decipher that, I don't think until the final run. Anyway, I'm going in to rate the task, it's definitely controllable, adequate performance is obtainable with tolerable pilot work load, is it satisfactory without improvement? Yes, and actually I think the gamma control works real well here. Again for my taste, I would like the, I guess, in my mind and the manual throttle with the gamma control system, the throttle should control airspeed and if I don't touch the stick, as long as it's within the airplanes capability, I would expect gamma to remain unchanged, and that's not really my perception, I do think that we get a little bobbly in gamma as we adjust the throttles, anyway, going into the level 1 block. Again, the bobbles at 2000 ft per minute down, I would... I would characterize it as just a slow cross- check, and not really getting a good initial picture, at least that's my perception, I didn't see anything particularly difficult about the 2000 except I just wasn't setting the gamma in the right place, and the other thing is that I was hunting with the throttles, and the throttles being a little bit hard to move, does detract from the task a little bit, but not that much, and I guess I would... I guess I'd really have to say it's good, I guess I'd give it a 2, because compared to a conventional airplane where your flying on pitch, it actually is pretty... that the gamma law even with the manual throttles, seems to work pretty well.

## **Task 3062 Level Flight Trans. to Descent - Transonic**

Pilot A

Task 3062 Level Flight Trans. to Descent - Transonic 14 Jan 97; Runs 87-89

This task is a little difficult because of the stiff throttles, but once you determine what gamma is required for a vertical speed, and you usually have to use a head down vertical speed indicator to fine tune these maneuvers, and there's very little thrust change, if any, between 1000 and 2000 ft per minute, but it seems as though the longitudinal control is adequate to adjust the vertical speed, maybe a little learning curve on my part in terms of fine tuning the vertical speed to match the gamma, but the...I give the longitudinal a 3 and lateral directional a 3 on this maneuver, Cooper Harper.

Pilot B

Task 3062 Level Flight Trans. to Descent - Transonic 09 Jan 97; Runs 3-5

Let's see, the task was a transition to a transonic descent at 1000, 2000, and 4000 feet per minute. In summary the only work load issue really was the throttle friction, the combination, the display, and the flying qualities were relatively pleasant, no major problems. I'm probably going to stick the throttle friction task onto the longitudinal axis because that's where it effected the work load. So, longitudinal, controllable, adequate, satisfactory improvement not required, mildly, unpleasant deficiencies, HQR3. Lateral directional, controllable, adequate, satisfactory, pilot compensation largely not a factor for desired performance HQR2. Those HQRs were 3 and 2. That concludes my comments.

Pilot C

Task 3062 Level Flight Transition to Descent - Transonic 17 Jan 97; Runs 39-41

The lateral-directional will be an easy one, but I assume you want them both, yeah okay, lat-dir. in general is okay, I seem to have a constantly want to put in a left bank, and as a result, I was always over on the edge between desired and adequate with a turn to the left, and it's completely unintentional, and I have no idea why, but did bring some compensation into that. I'd say it's satisfactory without improvement, and I'd give it a 3, but it did take minimal, but some definite compensation for this odd, left hand turn. Okay, the pitch, the control is all fine, you know, I put the flight path marker where I wanted, we had two things though that kind of contaminate the task, one the indication of Mach acceleration and so on was, well with the karat, was inop, and so, that's a real big help, that takes all the work out of that kind of stuff, when you've got that operating, so that was kind of a contaminant, and also the friction in the throttle remains a problem when you're trying to do speed control, along with flight path, and just as an aside, the distance on the HUD of the information from the flight path marker over to the vertical velocity is quite a ways, it's things like this, it's kind of nice when you can catch those in your peripheral, and here you have to look at one or the other and back, and thus, builds in a little more work, in any case, toward the end there, I was getting desired, and I think I probably could keep desired pretty much from now on, I think we were looking at some learning curve, and one of them was the fact that the 4000 ft marker, the arrow was not sensitive enough for the task, and I should be using the round dial for the 4000, and when I did that, I brought her right up to desired, so I don't feel too bad about the desired part, however, will all those problems in there, I'm going to say it requires improvement, and we'd give it a 4 for longitudinal, 3 for lat-dir, 4 for longitudinal.

## Pilot D

Task 3062 Level Flight Transition to Descent - Transonic 22 Jan 97; Run 94

Mach .95 descents at 1000, 2000, and 4000 ft per minute straight ahead. Much easier to do pitch wise than at the high Mach case, because here we get enough resolution on gamma that I can really just sit gamma with -1, -2, and -4, and with a couple cross-checks on the H dots, you can home it right in. We're getting a big bias on the chevron symbol for Mach/knot as we descent, and that increases the work load significantly, but we're still in my 4 and 4 category.

## Pilot E

Task 3062 Level Flight Trans. to Descent - Transonic 10 Jan 97; Run 68

The big difference here is the turbulence is much more perceptible, and right about the desired boundary on VSI, and that it's offset by the fact that you have a larger flight path change to affect your speeds, so it's not quite so sensitive or subtle, just in when I'm here, in the interest of moving on, and I think pretty much I met the desired criteria all the way around. A little bit more effort of controlling airspeed, a little more throttle movements required, and... but, using the round VSI steam gage, I was able to close more, I think tightly on the desired VSI. The... a little bit more effort in lateral axis to maintain heading, and just barely stayed within desired boundary on heading, so for longitudinal Cooper Harper, controllable? Yes, adequate? Yes, satisfactory? No, 4 for work load. Lateral, controllable? Yes, adequate? Yes, satisfactory? No, a 4 also for work load and maintaining wings level.

## Pilot F

Task 3062 Level Flight Transition to Descent - Transonic 24 Jan 97; Runs 43-44

Basically, because the Mach numbers, only two tenths, I mean hundreds up in the HUD, and it's to thousands in the heads down display, and because of the... it's easier for me to read the vertical speed heads down, than it is on the heads up display, and the acceleration karat, is not working for the Mach number, I flew a good portion of the maneuver heads down. The reason is, is with the thousands of Mach number heads down, it was easier for me to see rates on the Mach number, and then I was also using the vertical needle heads down, and so, it was easier just to stay heads down for most of that maneuver. Really there's little difference in doing the other task, except for the Mach number, your airspeed is changing with altitude as you descend, it's going into the Cooper Harper rating, it's definitely controllable, adequate performance is obtainable with tolerable pilot work load, it's satisfactory without improvement. Because of the display issues here, there's less cues to help you out, I think that I'd probably, if we were doing half ratings, at least be inclined to go 2 1/2, I'm going to say it's a 3, just because there's not as much to help you out, we're flying heads down, the display is not as big, it's easier to see small changes in gamma, and small bank angle changes up in the HUD. You don't have the acceleration karat to help you out, and it's not that much more difficult, I'd really be inclined to kind of go 2 1/2, but... but since we're not doing half ratings, I'll go a 3 and a 3.

## **Task 3070 Transonic Accel**

Pilot A

Task 3070 Transonic Accel 14 Jan 97; Runs 91-93

This is accelerating from 250 knots to 350 knots in a 1000 ft per minute climb, and it appears as though with practice this can be done, and with the reasonable pilot effort, achieved desired performance, give a 3 for longitudinal axis, and a 3 for the Cooper Harper on the lateral axis. The...it appears to be some, perhaps some effect in...the adverse effect on the pilot ability to control vertical speed when moving the thrust around, because of...occasionally, actual gamma appears in and then it comes in and out from hiding, and perhaps when the actual gamma is not the same as commanded, there are very fine tuning that you need for this task is hampered to some extent, by pilot not knowing quite exactly what the real gamma is, and so you've got to kind of work a closed loop between vertical speed and changing commanded gamma ever so slightly to fine tune that. The captures on the airspeeds were reasonable when the airspeed accel-decel cue is helping you out, and that worked out quite well, once again, the friction is this particular simulator in the throttles, certainly doesn't help in terms of distractions and at the point of throttle movements.

Pilot B

Task 3070 Transonic Accel 09 Jan 97; Runs 6-8

Relatively difficult task because of the sensitivity in climb rate to gamma changes. Very, very little change required, you just have to touch the control column to get a 200 ft change, 200 ft per minute change in vertical speed and with the excursions due to turbulence being 1 to 200 ft per minute, it's pretty tough to stay within desired. It can be done, but you are working hard to do it, and even lateral directional you're working a little bit because of the attention you have to pay to the longitudinal. Also, exacerbating this a little bit, is the fact that as you change speed, your flight path angle requirements for constant vertical speed change, so you have to constantly make inputs in flight path angle and the sensitivity is enough that every few seconds you've got to make an input or you'll get outside the balance of vertical speed. I was able to keep within the adequate bound, within desired bound, a great deal of the time, within the adequate bound most of the time, we might of had a few ticks right at the adequate bound or maybe slightly outside, but for the most part, and I think by the way, that was...that was influenced by turbulence as well, but for the most part, I was able to keep it within, and I think all the other parameters I was able to keep it in pretty well. In fact, it did a little bit better than desired in airspeed and heading and bank, I was probably right at desired or less. Okay, for longitudinal, it's controllable and adequate, and I think the task is a level 2 type of task. With desired performance requiring moderate pilot compensation, HQR4. Lateral directional is controllable, adequate, satisfactory, minimal pilot compensation, HQR3. So the HQRs are 4 and 3. That concludes my comments.

Pilot C

Task 3070 Transonic Accel 17 Jan 97; Runs 43-45 Okay, controllable, yeah, adequate...let's do the lat-dir first, adequate performance is okay on that, but again right on the edge. Same comments I had before, satisfactory without improvement, well I'll say so, but there's still that little tendency to get off, because there's so much else going on, so, the fact it's holding heading is purely the airplane doing it more than I am, but it doesn't take, you know, a huge amount for it to keep within desired, but there's definitely some compensation, had to correct

back, some of those bank angles, incidentally, were 3 degrees or more, because I was correcting back, you know, in other words, they were intentionally over, it wasn't because of any problem with the control. So anyways, 3 for lat-dir on that, and controllable adequate performance with tolerable pilot work load, and I'm going to have to say no on that, on both counts, I couldn't get adequate performance, and I was still working harder than I would accept most likely for something like this. Would require improvement, no problem with controls, so, it would be a 7 for longitudinal, and the sensitivity at the 1000 ft marker on the HUD is possibly a little too sensitive, and I tended to chase that quite a bit, everytime that I reverted to interior VVI to watch what was going on, my performance improved, I was able to keep it more accurate, so, that's that, and the other thing is the, especially on the real large ones, boy, the...I'm afraid the throttle friction is overriding an awful lot of the flight control system here, it's almost dominating the task, it's a major contaminant on this particular task, and that ought to do it.

#### Pilot D

Task 3070 Transonic Accel 22 Jan 97; Run 79

Okay, we only got apparently adequate on the performance longitudinally because of the H dot control, which is pretty tough, again because it's similar. Task 3070, I'm sorry. The H dot control task is pretty tough because we got... we don't have an instantaneous vertical speed, and the resolution on the gamma is pretty small for this small number, or for this performance constraint, 300 ft per minute. Airspeed was fairly easy to control. I'm going to give it a pilot rating longitudinally, 5, and laterally, 4.

#### Pilot E

Task 3070 Transonic Accel 10 Jan 97; Run 70

And this task is long tedious one, but basically doesn't show any handling qualities problems, I don't think. For most of the time I felt I met the desired performance criteria on the deceleration back to 250 I got distracted by trying to null out about a 1 1/2 degree or so on a 2 degree heading change, and in correcting that with this kind of nuisance, lateral mode, we've talked about as far as trying to hold wings level, I didn't pay attention to the airspeed, and what got slow with... and then corrected back to 250. Most of the time I felt I met the target rate of climb, the airspeed carat is certainly a big help here in controlling the airspeed, and I think controlling the vertical rate using the analogue instrument, worked out pretty close with an occasional deviation of say 3 or 400 ft per minute, Bruce says he saw a 500 ft, I didn't see anything that large, but I think probably 95 percent of the time is going to be plus minus 200 ft, most of the time it was pretty close to right on, so with that in mind, for the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory without improvement... I thought the airspeed as far as the captures was very good, I felt within 2 knots, I'm going to say no, and give it a Cooper Harper of 4 for work load. For the lateral task, controllable? Yes, adequate? Yes, satisfactory without improvement? No, we really do need to get this thing easier to hold wings level, and I'll rate it a 4 also, because it met the desired criteria, but the work load was high.

#### Pilot F

Task 3070 Transonic Accel

Not performed by this pilot.

## **Task 3072 Supersonic Accel**

Pilot A

Task 3072 Supersonic Accel 14 Jan 97; Runs 95

In order to maintain within 50 ft on this task, you've got to sort of ignore that vertical tape kind of display, and scan between the flight path vector, and head down altimeter and vertical speed to fine tune the display, once again the accel-decel cue seems to work fine, as far as capturing altitude, and were we within desired performance on that? The most we spent about 90 percent of the time I would say within the desired and we would always be the plus or minus a 100 for adequate. I'd give it a 3 on longitudinal, and a 2 on lateral directional.

Pilot B

Task 3072 Supersonic Accel 09 Jan 97; Runs 9-11

Relatively easy task, those numbers are fairly loose for this task, since gamma isn't changing during the task, very few longitudinal inputs required and lateral directional is holding out pretty well too. So longitudinal, actually longitudinal and lateral directional both pretty much the same. Controllable, adequate, satisfactory improvement, not required, pilot compensation, largely not a factor for desired performance, HQR2. That concludes my comments.

Pilot C

Task 3072 Supersonic Accel 17 Jan 97; Run 47

Lat-dir, same comments, same rating, 3, nothing different on that one that I noticed as far as any of the lat-dir stuff. The ... longitudinally, was adequate performance, tolerable pilot work load, not satisfactory without improvement, and I seem to very consistently end up with only adequate performance usually when I'm changing from accelerating, when I'm making that initial power change, for instance, particularly when I get up to the 275, that a piece of cake, and then when I reduce the power, I tended to bump up into the 60, 70 ft over high mark, then bring it back on down, and it's very sensitive right there, and this 50 feet is pretty close tolerance, and I did get adequate, and I would say that it is fairly easy to get adequate, and as a result it would be a 5 in longitudinal, so, 3 lat-dir, 5 longitudinal.

Pilot D

Task 3072 Supersonic Accel 22 Jan 97; Run 83

We tried to accelerate this 475, but gave up and used 460. We were using the altitude tape for the altitude hold maneuver this time, plus or minus 50 ft, and the lubber line is almost invisible on the tape, which makes you really concentrate on where it is. I think a good heavy lubber line... then you kind of catch it with your peripheral vision a little bit. Also... and then of course adding to that problem is the fact that the tape is fairly far from the central scan point of the display. Still got a PIO laterally a little bit, so, let's give it a 4 and a 4.

Pilot E

Task 3072 Supersonic Accel 10 Jan 97; Runs 71-72



Pretty tight tolerances all the way around, but not too difficult to accomplish. The gamma dot V does not hold altitude perfectly during the accel or decel requiring pilot to get into loop ever so slightly to maintain the plus or minus 50 ft. The airspeed interception at 475 is very easy to do, because of the slow nature of the approach of a decel with faster approach in the... maybe the lag in the airspeed carat I went actually into 448, but also was distracted this time, there's some conversations going on in the cockpit, and I should have paid more attention to the task at hand. I think at any rate I could of easily captured the 450, and I've been trying harder, I'm not going to penalize the aircraft for that, so, for the longitudinal Cooper Harper, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, Cooper Harper of 3, minimal compensation is required to maintain the altitude tolerance. For the... and I'm assuming that the airspeed was fine, although you really can't rely on that airspeed carat for the decel as well as you can for the accel. Again, it did not seem to give the... the exactly clear cut trend, it could be the faster approach to the target airspeed on the decel, as opposed to the accel. For the lateral directional, controllable? Yes, adequate? Yes, satisfactory? No, 4. Same thing, it just doesn't seem to want to maintain even though you don't even get in the lateral axis, just the turbulence alone requires you to stay in the axis, and more certainly than you should be. Actually let me change that, it's minimal compensation required, make that a 3, so I would make that level one, but it does require compensation to maintain the heading within the tolerances.

Pilot F

Task 3072 Supersonic Accel

Not performed by this pilot.

## **Task 3074 Transonic Decel**

Pilot A

Task 3074 Transonic Decel 15 Jan 97; Runs 3-5

Say the longitudinal Cooper Harper two and two for lateral directional. The accel decel queues were quite useful in stabilizing on speed. The throttle friction for this task is quite high so it is a little more difficult. The flight path vector symbol on the horizon is not the occlusion protocol. The symbology there makes the symbols blend together so it would be a little easier if they didn't do that. It seemed to be a reasonably straight forward maneuver. No Mach number effects were noted at all. Everything seemed to be linear. No special trim changes or drag changes were noted. (What were the Cooper Harpers there?) Two, two.

Pilot B

Task 3074 Transonic Decel 09 Jan 97; Runs 12-14

The card was accomplished as per the instructions, I was able to keep it within desired performance parameters without too much work load, a little bit of work load. Accomplish the card as per the desired parameters, a little bit of work load in having to scan Mach number because it's located up higher on the left hand side of the display and I've got to move my head down to see it, but other than that fairly benign, not a real problem. Longitudinal, controllable, adequate, satisfactory, minimal pilot compensation, HQR3. Lateral directional, controllable, adequate and sat., pilot compensation, largely not a factor, HQR2. So, it's a 3 and a 2. That concludes my comments.

Pilot C

Task 3074 Transonic Decel 17 Jan 97; Run 49

Lat-dir same rating, same comment. Longitudinally, this is a much easier task, adequate performance, tolerable pilot work load, yeah, I'd certainly say so. Satisfactory without improvement, no, desired performance, and it took moderate pilot compensation. Not to beat it to death, but it's the driving force on how hard you have to work, and that's the throttle friction, and this time I was looking for the breakout in the inceptor as being a factor, and yeah, it's noticeable, so, those two together, I think those require most of the compensation that I had to do. 4 for longitudinal and 3 for lateral-directional.

Pilot D

Task 3074 Transonic Decel 22 Jan 97; Run 87

Another one of the up and away tasks accel, correction, decel .99 Mach .90 back up to .99 straight level. Digital H is a little hard to use, but... and we had a roll PIO tendency, that's the only things I can really comment on. It's really a pretty easy task. Longitudinal, 4, lateral, 4.

Pilot E

Task 3074 Transonic Decel 10 Jan 97; Run 73

Again no real problem, you had to stay in the loop longitudinally to keep the altitude within tolerances, but I think I stayed plus or minus about 15 ft. The airspeed capturing the Mach, it's no real rate indication of the Mach, or where you're always in that Mach level between point say .90, and .89. We slipped on a .89 once just due to ambient turbulence, I don't think that really was a reflection on capturing that Mach number, and similarly we did the same thing with .98 to .99, but I think I met the desired criteria as far as I can judge. So, for the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a 3, minimal compensation required, lateral directional, controllable? Yes, adequate? Yes, satisfactory? Yes, a 3 also, did require staying in a loop to maintain the heading at 360.

Pilot F

Task 3074 Transonic Decel

Not performed by this pilot.

## **Task 3076 Subsonic Decel**

Pilot A

Task 3076 Subsonic Decel 15 Jan 97; Runs -9

Cooper Harper in longitudinal, a two and in lateral directional a three. Lateral directional rated a little lower because there doesn't seem to be any detent in this roll axis when you roll it to zero ... it is very easy to get a roll input there even though you are not intentionally getting out of the detent. The accel-decels are quite straight forward, with the exception of the nominal throttle friction. You need to adjust the accel decel queue to capture the airspeed. Initially there is very little interference or cross talk between the thrust change. (You called that a two which is minimum pilot workload . Do you think you are doing minimum workload? You were working pretty hard at least on the throttles.) I think you would have to say, for a four, improvement is required. Actually It would be helpful to have an altitude hold feature. I guess I will have to say that, pilot compensation not a factor. The only thing that would be better is if you had an altitude hold function or a track function that would allow you to take your hand off of the stick. In that case it would be a one. I am assuming that in the aircraft you would have throttle friction that would be normal. Autothrottle would improve things considerably. Most of these, once you get five miles from the airport chances are that 95% of the time the pilot is going to have the autopilot engaged. The reason I gave it a two is that pilot compensation not a factor. What I'm saying is that the system is working as designed and it's reasonably expected on any airplane that you have to adjust the thrust for speed. On the throttles that is mostly friction. On a nice smooth throttle it would be much easier. What I envision for pilot compensation is that the thing is screwed up. You have to devise tricks to work around the design. In this case, the thing appears to be working as designed. (If you are happy with a two, I don't want to make you change it.) Yea.

Pilot B

Task 3076 Subsonic Decel 09 Jan 97; Runs 15-17

Done as per the card within desired performance. I commented on a little bit of pitch coupling with power addition this time, but even the gamma appears to change a little bit, I'm not sure why that is, that shouldn't happen, but I'm seeing a very slight change in gamma on the order of a quarter of a degree or less with power addition in that when I'm adding power, even long term, when I am accelerating, I'm having to keep the velocity vector just slightly below the horizon in order to stay level, and when I am reducing power just slightly above the horizon in order to stay level. I expected a short term effect due to heave and thrust inclination effects, but I'm also seeing a long term effect which I don't understand entirely. In any case, the task is do-able, it's fairly easy, a little bit compensation in terms of keeping the flight path vector near the horizon, so that altitude is staying tight. I'm probably holding altitude tighter than I need to. I'm trying to hold within about 20 ft and the requirement is within a 100 ft. So, HQRs, longitudinal, controllable, adequate, satisfactory, minimal pilot compensation, HQR3. Lateral directional I'm really kind of ignoring. So it's controllable, adequate, satisfactory, not a factor for desired performance, HQR2. So, a 3 and a 2.

Pilot C

Task 3076 Subsonic Decel 17 Jan 97; Runs 51-52

Lat-dir same comment, same rating, and pitch was adequate, satisfactory without improvement, no, and actually it's quite easy to get adequate, getting that desired is a bear, and actually, it's pretty much for the same reasons that I mentioned before with the throttle friction in particular. Okay, so 5 for longitudinal, and 3 for lat-dir. Okay, well, I have both of them to rate there, so let's start with a lat-dir, is it controllable, certainly, adequate performance, tolerable pilot work load, I think all the lateral directional things were adequate, and they were all tolerable pilot work load, satisfactory without improvement, no, and I think I was probably getting desired, there was a lot of work, but you'd expect to, there's a certain ... in need amount of work when you get so many variables going at once there, and I'd say ... I noticed going to the right, the 15 degrees was much, much easier than the 30, once I got to the 30, I think I was holding, having to hold it, I know the airspeed problem went away, it just took full power, so I didn't have to manipulate that, so that kind of simplified the being able to concentrate on the lateral-directional. I think I can keep the bank angle within desired as I recall, but there was at least moderate pilot work load, so yeah, that just verifies it, 4 on the lat-dir, and the longitudinal, however, adequate performance with tolerable pilot work load, and most of the time it was adequate, but almost every time when I would make the reversals and initiate the major changes I was getting out, and I think it got out of adequate, even so, I would turn right here, deficiencies require improvement, I guess, and a 7 I wasn't worried about controllability, but I don't think I was getting adequate performance, that was a lot of work, that real fine pitch tuning that you have to do, and I've got to put part of that to the display too. I had to really lock onto the HUD to make sure I had the majority of things okay, and that didn't allow me very much time to come inside to look at the vertical velocity, so I had to use the HUD one, and in general, I like that VVI, and I think that maybe it's pretty far away, and maybe a little sensitive about the 1000 mark or so, but that's a really high work load problem, and I got out of the adequate, so, 7 for longitudinal, and 4 for lat-dir

#### Pilot D

Task 3076 Subsonic Decel 22 Jan 97; Run 90

Okay, Pilot D on 3076, which is a subsonic decel accel, straight ahead, again as on the previous run, it's easier to control the H of the subsonic Mach number. Small changes in flight path give small changes in H dot. One thing I haven't really commented on the display and on these accels decels previously, which has been true previously, and been commented on here is that the lag that's inherit in the chevron symbol, really does increase the work load longitudinally. A little lead on that symbol with throttle would significantly decrease the work load, but overall the task is not much different in work load level than the previous task we've been doing. Pilot rating 4, longitudinally, and 4, laterally, and primarily the 4 on the lateral is due to the roll PIO tendency.

#### Pilot E

Task 3076 Subsonic Decel 10 Jan 97; Run 75

The turbulence down at 15,000 ft is much more apparent, and it's... it ends up manifesting itself as a plus or minus one or so knot oscillation. The G is plus or minus about 0.5 to 0, .05 to .08 G's, it's almost about tenth of a G, and you don't always get a good correlation between the acceleration carat, and what the airspeed does. In other words, one time on my decel I had the carat showing a very slow decel, and in fact, actually accelerated due to a... must be the turbulence effects, so therefore, it's kind of hazy as to what it to having zero overshoots when you make these airspeed intercepts, I think that, unless it's to assume, you

won't have a knot overshoot with the turbulence, especially looking at the performance of the acceleration carat, and what actually happens to the airspeed. So, I felt... feel like I have met the desired criteria for the overshoot of target airspeed, and met the desired criteria in altitude deviation also, so for longitudinal rating, controllable? Yes, adequate? Yes, satisfactory without improvement? And interestingly enough, there's really not a rating for airspeed control, as far as longitudinal or lateral, you need to have a throttle rating or something, because longitudinal is really throwing... holding your altitude, so, it's kind of difficult to judge those two on handling qualities while trying to do something with airspeed if you are level, but at any rate, with that in mind, I think I certainly met the desired criteria, and it may require a rethinking of how this is rated, for all of these decels, but controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, for a 3, for lateral directional similar, a little bit effort to maintain the proper heading, just minimal compensation required, controllable? Yes, adequate? Yes, satisfactory? Yes, for a 3 also, and again we probably need to think about using this overshoot of target airspeed to affect our longitudinal rating.

Pilot F

Task 3076 Subsonic Decel

Not performed by this pilot.

## **Task 3080 Heading Change - Transonic Climb**

Pilot A

Task 3080 Heading Change - Transonic Climb 15 Jan 97; Runs 12-14

In this particular maneuver it seems very difficult to keep your hand on the stick and separate out the pitch from the roll inputs. You virtually have to take your hand off of the stick and fly fingertip corrections in the axis that you are interested in. There is something perhaps not quite fine tuned enough in terms of the detent versus force gradient on the stick. I would rate this one, longitudinally a four and laterally a four. I think there are some improvements to be made. When you do a rapid roll to a 30 degree bank, trying to hold a constant vertical speed, there is a tendency to ... if you're grabbing the stick ... there is a normal tendency to put in some pitch inputs. Usually a climb. If you are adjusting the pitch, there is a tendency to put in some roll inputs into it. You have to very very consciously separate out those two axis due to the detents and the forces. (Repeat the ratings please.) A pair of fours.

Pilot B

Task 3080 Heading Change - Transonic Climb 09 Jan 97; Runs 20-22

Working a little bit on this one, but it's easier because all of the parameters are put up on the HUD on this last, and we put up the VSI on the right hand side, so I didn't have to scan down, and I think that pushed it back into level 1 again, I'm working, but I think it's a tolerable work load and I don't think I'm suffering substantially from the work load in terms of performance and we're able to keep it predominantly within the desired bounds, also the desired bounds are a little bit looser than in previous cards on this one. So, longitudinal, it's controllable, adequate, sat., minimal pilot compensation, HQR3. Lateral directional, same thing, controllable, adequate, sat., minimal pilot compensation, HQR3. So, those were 3 and 3. That concludes my comments.

Pilot C

Task 3080 Heading Change - Transonic Climb 17 Jan 97; Runs 54-56

Not rated.

Pilot D

Task 3080 Heading Change - Transonic Climb 22 Jan 97; Run 77

This is the turning climb changing heading plus or minus 30 degrees at two different bank angles while maintaining a constant climb and airspeed. The basic aircraft is really pretty easy to fly. I think that the scan pattern of the display for the task is to find, is really pretty bad. The... have to carry a bias on the karat to maintain the constant Mach, and the task definition is pretty tight also, but we were still able to get it within the desired performance parameters, but I was working pretty hard. Longitudinally, let's make it a 4, and laterally, let's make it a 4.

Pilot E

#### Task 3080 Heading Change - Transonic Climb 29 Jan 97; Runs 2-4

This is just kind of real nuisance task, it's a very high work load. It's made higher by the fact that the lateral axis is deficient and that it's difficult to command and hold a certain angle of bank, including zero angle of bank, it's a constant effort to hold the bank angle. The very, very, very, slight changes in gamma of course with that speed change or VSI, so, it's a very tight, and hard task to a 1000 ft VSI, and you're constantly making throttle corrections to maintain the very tight Mach tolerances, so, all and all, a fairly high work load task. Obviously it would be nicer in a realistic climb, you go in and set the throttle, and kind of allow a certain variation about that in a conventional airplane, certainly, your not controlling the throttles this tightly, as you are in this implementation, for one thing, constant throttle movements mean more fuel consumption. Any rate, it's fairly high work load, the... I believe I met all of the desired criteria, but at a work load price. Bank angle was most of the time, was within plus or minus two, occasionally it was slightly above that, but I think the preponderance of time is plus or minus two. Rate of climb was mostly plus or minus 300. On one of the runs, I kind of got distracted and got to a little above 500, but that was very brief, most time you can hold it fairly close, and the Mach I held I think all the time, within plus or minus 01 or at least 99 percent of the time, and the heading, made it within plus or minus two, so basically, all desired, but high work load. So, for longitudinal Cooper Harper, certainly work load is going to affect that, I need the Cooper Harper chart. For the longitudinal rating, is it controllable? Yes it is, is adequate performance obtainable? Yes it is, is it satisfactory? No. For the overall longitudinal time including speed control in that, which is probably a little bit of misnomer, but we're going to include that, it's certainly a deficiencies require improvement, it's a level 2 task, Cooper Harper of 4, and basically it's work load. For the lateral, controllable? Yes, adequate? Yes, satisfactory? No. Again, it should... this... this sophisticated airplane should have a much better lateral axis control, and having to constantly work to hold a certain commanded bank angle is unacceptable in my opinion. For the amount of money we're going to charge the customers, so, it's satisfactory without improvement? No, deficiencies do require improvement, I'll rate it a 4, I maintain the desired performance, but at a work load penalty.

Pilot F

#### Task 3080 Heading Change - Transonic Climb 24 Jan 97; Runs 46-48

I guess, we did three data runs, two of them were adequate for airspeed and vertical speed, the last one, hard to say, but it was probably, I think maybe desired. Difference in technique, well, two differences, first of all, the first two data runs we went to the left, the second one initially, and the second one... or the third one we went to the right initially, I don't think that really had too much effect on it. The big difference between the first two data runs, and the third data runs, was the fact that I used a little bit more aggressive roll rates, and actually I think that worked out a little bit better. With the display I'm using a heads down display for Mach, so that I can get some trend information on the Mach number as noted before. This time I was tending to use the heads up vertical tape for VSI just to try to keep the cross-check more simple, and it's not as easy to use as the heads down vertical speed, but it allowed me to have a quicker cross-check. Basically, trying to tightly control vertical speed, I'm assuming that we're getting some bumps from turbulence in the vertical speed, I was better off just to set the pitch, or the gamma, and kind of let the vertical speed bounce about it's condition, and not really try to control it too tightly. Bank angle oscillated a little bit, maybe plus or minus one degree hands off, but that was fine, so pretty much once you got it set, you could take your hand off the stick, and then concentrate on the airspeed control problem. Except for the roll ins and the roll outs, I noticed on that, that there was distinct



change in vertical speed associated with those maneuvers, and I had to really pay attention to that, I think that, that may be a combination of just the control law, and also it may be a function of the ergometrics on the stick, but I'm not sure, you'd have to look at the tape and see whether if there was some pitch inputs induced by the pilot there, or what. Certainly, as you roll out, in and out of bank angle though, the vertical speed is going to change, and you are going to have to make some adjustments. The point here is, is that the adjustments in pitch for vertical speed required a lot of effort trying to roll in and roll out. On the practice run I saw a little bit of roll ratcheting, trying to stop the roll, I think that was pilot induced, again, it's... the predictability, at least for my taste, is not great in roll, trying to capture an exact bank angle or an exact heading, it kind of drifts around. Also, I think you're getting a little bit of some lateral dispersions, slight lateral dispersions in the flight path vector as you roll the airplane, and that makes rolling on, in precise heading a little bit more difficult also. Let's see, I guess that was... that's pretty much it. Oh, the other thing I was going to say is, on the third run, one of the things that I did do is, when we were... I forget, rather rolling in or rolling out, I think rolling in to a 30 degree point, I stagnated around 20 or 25 degrees, because as I was rolling, I didn't keep up with the vertical speed, I saw the vertical speed make a big change, and it was easier for me to stop the roll rate, and play with the vertical speed, and then continue the roll, and I think that maybe a function, again on the flight control law, but also of the stick, because for the small fine tracking inputs, I have to be very careful that I don't... that I concentrate on getting the right input that I want and not inadvertently put a input into another axis. To rate it, we'll come in, it's controllable, adequate performance with a tolerable pilot work load, satisfactory without improvement, well, for this task and the way that we have it set up as far as the metrics go, we got probably one desired and two adequate runs. The adequate runs were close to desired though, but because of that, I'm going to answer no, and I'm going to come across and... you know, I think part of this is, is this isn't something, a maneuver that I practice everyday, the display's not optimized for this, and I'm not really, you know, I'm getting fairly used to your display after being here for, you know, the last three days, but I... you know, I think you can get desired performance probably with a moderate pilot compensation. Again, you know, in my mind, there's a big jump between a 4 and a 5, I think I'm going to go with a 4 and a 4. You know, I think had we taken a couple more practice runs, we might of gotten a little bit more desired performance, at the same time, you know, there's a little bit of gamenship to this, the compensation isn't all that difficult, but this is a tight task, and we'll go with a 4 and 4, I guess.

## **Task 3082 Heading Change - Initial Climb**

Pilot A

Task 3082 Heading Change - Initial Climb 15 Jan 97; Runs 16-18

This is turns in supersonic cruise. The Cooper Harper ... let's just go through the decision tree here. It's controllable and adequate performance attainable with a tolerable pilot workload. I'd say, yes. Satisfactory without improvement? Lateral directional I'd say no and I think I would be inclined in terms of roll to give this one a five because it had moderate compensation in terms of trying to stop this roll. When you start an aggressive roll, you actually have to stop the roll rather than just anticipate. You not only have to anticipate the roll and bring it back to the detent but you actually have to go the other way to stop it. If you just put in a roll input in and let it go, the roll just keeps rolling ... moving. You have to keep your hand off of the stick to avoid getting out of the detents and making inputs in pitch, to get roll and vice-versa. As far as longitudinal, I think I would give it a four. Well actually there is very little effort there, I'll change that to a three. Pitch was a little better than the roll mode. A little more of a detent there and minor compensation required for satisfactory performance. So a three on longitudinal and ... what did I call it on lateral directional? A five. On rapid roll-ins you have to stop the roll by opposite stick. I think on one of the first runs there was a tendency toward PIO. I would like to expand on that. If you were rapidly rolling out of the turn, if you get quite aggressive ... people have different gains ... but I was not in a full blown PIO but I could detect a slight tendency to PIO in roll, trying to stop the roll quickly. I think it had to do to some extent with the motion of the cab along with the rapid roll inputs when you physically move left and right. . Pilot B

Task 3082 Heading Change - Initial Climb 09 Jan 97; Runs 23-25

Kind of a borderline level 1 task, I was able to keep desired performance, but I'm working to do it. Although, I don't think to the extent that you could call it moderate compensation, it's just...you're working a little bit. Then you get real aggressive with it in roll, tends to overshoot right to the desired boundary, but again you can keep it within, without the work load getting to the point where I think it's level 2. So, both longitudinal and lateral directional, it's controllable, adequate, satisfactory, mildly unpleasant deficiencies, minimal pilot compensation, HQR3. That is a 3 and a 3. That concludes my comments.

Pilot C

Task 3082 Heading Change - Initial Climb 17 Jan 97; Runs 58-60

Okay, lateral-directional, adequate performance, tolerable pilot work load, I'd say yes, satisfactory without improvement, no, and the lateral-directional, I had a hard time, well, as it turns out, on one I was getting mostly desired with a ton of work, but the adequate was fairly easy, and the other two I was happy to be getting adequate on, so, it is adequate, but with the constraint, you know, the sizes that we had, you know, limits we had, it just took considerable pilot compensation, I wouldn't say that it's extensive at that point, but it's considerable, and just as an interesting observation, my bank angle seemed to wander, and I was fighting it and working at it more with the 15 degrees, than I was with the 30 degrees. I don't know why, anyway, 5 on the lat-dir, and for the pitch, because the...a couple of reasons, one, I'm not trying to chase a very sensitive vertical velocity as much, because I've got a real good flight path marker along the horizon, I've got a good indication and everything, it was much easier to keep the airspeed and altitude when I wanted to, due to lack

of ability to...with the thrust...the only control speed with that, sometimes I had to let the altitude go, so that kind of loosened up the task a little bit there, and I would say with the longitudinal then, it was satisfactory without improvement, and I thought most of them were desired, did you. Yeah, it's kind of hard with...we kind of let a lot of things go on purpose, so it makes it kind of tough to tell desired or adequate, and so, could either do a 4 or a 5 on that, and I'll give it the benefit of the doubt and say 4, if somebody wanted to question that, I'd be hard pressed to justify it, but it's either a 4 or a 5, it's easy to get adequate, difficult to get desired.

#### Pilot D

Task 3082 Heading Change - Initial Climb 22 Jan 97; Run 81

It was the level turns at Mach 2.3. It's really a fairly easy task. My big complaint, I think was digital H is hard to keep in your scan. You really have to force yourself to look at it. As I indicated the tough part of the task is the digital H is hard to keep in your scan, you just tend to not watch it, and all of a sudden you notice it's drifting just a little bit, and you do need to take it into your scan. The resolution on gamma equals zero. It's not good enough to hold you level for long at this speed. The only other comment I had was it was thrust limited at bank angle of 30, so we had to sacrifice altitude. So, let's give it a pilot rating of 4, longitudinally, and 4, laterally.

#### Pilot E

Task 3082 Heading Change - Initial Climb 29 Jan 97; Runs 6-8

This is another kind of a exasperating task. A couple things that are not good, there's the speed stability is poor, and the speed performance is unpredictable. I noticed on the last one, I got just a tiny bit slow, and at full power had to give up quite a bit of altitude to get back onto speed, where as at times, you could with power, increase speed rate rapidly at level altitude, not with the nose down gamma, so, at a nose down gamma of about a degree, full power, and it just wouldn't accelerate at all, so, I don't understand why in that case, this was wings level, I was just trying to get back on condition after the first 20 degree turn to the left. So, that didn't make a whole lot of sense, I had to give up about 800 ft of altitude to increase it about .01 Mach, it just didn't seem to want to increase at all. Other times you could be right there, wings level, or in a climb, and it would be increasing speed quite rapidly, so, there's really a very poor predictability between the speed response of the aircraft and what the pilot's trying to command. The bank angle hold, again, is a problem, it takes a lot of effort to hold the exact bank, and it's... it wants to kind of oscillate, especially when you capture, fairly aggressively, you get about a plus or minus one degree oscillation, sort of a quasi PIO. So, with that in mind, for the... Let's see, for longitudinal Cooper Harper which looks like, it would be altitude, the altitude is really not applicable because you have to dive it to keep your speed, so the speed becomes the overriding consideration, and that was probably level two performance, so we're look at longitudinal first on the Cooper Harper, I'll get the scale here. Okay, for the longitudinal task, is it controllable? Yes it is, is adequate performance obtainable? Yes it is, is it satisfactory without improvement? No it's not, I'm going to rate it a 4, I think it is kind of borderlined desired adequate on a speed performance, and this lack of predictability in response of the aircraft to power and nose attitude, as far as speed control, would get you there. For the lateral Cooper Harper rating, controllable? Yes, adequate? Yes, satisfactory? No, same things I've been kink of mentioning earlier, basically, a lack of sharpness about commanding a bank angle, including wings level, and especially if you make a very aggressive capture, you do tend to get into a little mild

plus or minus one degree PIO, and that's unacceptable. I want to say unacceptable, it shouldn't mean it's unacceptable as far as Cooper Harper. I think it's more of an unacceptable as far as I think, we could do a lot better. A 4 and a 4.

Pilot F

Task 3082 Heading Change - Initial Climb 24 Jan 97; Runs 50

Basically, it's easier to set 30 degrees of bank, because of the envelope protection, than it is with 15. Setting 15, you have to set a little bit more cautious. Still, rolling out to capture the heading for me is a little bit unpredictable, and I have to be fairly cautious, and try to be smooth, and roll it out. On the 15 degree, we under shot probably, I'm guessing a half of degree on heading, and we were right at north, in fact I had to bank back in the other direction to kind of kill our drift past north on the rollout from the 30 degrees portion of the maneuver, and again, I think we're getting some lateral excursions in the flight path vector, as well as trying to stop the roll out. And also again, I tend rather to make the smooth roll out to kind of make little step roll outs, and again I would equate that to the same predictability issue that we've mentioned in the past. Anyway, pretty much once you've established a task, you can go hands off. During the practice we didn't have to really descend to hold airspeed, going to the right, coming back to the left, until just, just, slightly at the very end, this way about half way back to right we had to just put gamma over just a little bit to get an amount of airspeed back, and then pull it back, but really overall it's pretty easy maneuver to do, the only tasks, the only part of the tasks that requires a little bit of effort and compensation, or actually the... setting the bank angle at 15 degrees, and the roll out to capture headings. It's definitely controllable, adequate performance with a tolerable pilot work load, it's satisfactory without improvement, and I guess I'd really have to give it a two (2), I mean compared to conventionally flight controlled airplane, it really makes this task pretty easy, and when you consider the Mach number that we're flying at, and how much deviation there would be in altitude for just a, even a tenth of a degree of pitch change, it really does this task pretty well. We just had a discussion about the predictability of the bank.. of capturing the bank angle and the heading, and, you know, the tolerance is for heading, or plus minus two degree... or, minus two degrees plus zero, and we're rolling out within a half of degree of heading, and the bank angle is plus or minus two degrees and the target bank angle of 15 is the only one that is somewhat difficult to capture. It also says; a smooth roll in and smooth roll out, and there is a slight tendency, at least for me, to kind of do the roll out, or the roll in to 15 degrees in steps, and the roll out for both in steps, although I'm a little bit more smoother with the 15 degrees than I am with 30 degrees. If I read the descriptor blocks for a two (2), pilot compensation is not a factor for desired performance, for a three, it's minimal pilot compensation, I really... I guess, I really wanted to give it a two, because the... it's somewhat... with a conventional airplane at these speeds, even a fighter type airplane, we're getting excellent performance, but the point is well taken, that the roll axis could be a little bit better, and this is really, you know, one of the points that this airplane is designed to operate at, and I guess, given all of that, I think... I think there's a good case for saying that it's probably not really a two. The difference between a two and a one is, you know, a one is excellent with highly desirable, which almost never exists, and then a two is good, negligible deficiencies, and I guess, this does warrant some consideration, if you have negligible deficiency, sometimes I guess, I have a hard time seeing how pilot compensation is not a factor in desired performance. I guess, and the reason I'm going through this litany of discussion here, I guess, I'm trying in my own mind, trying to decide rather if it should be a two or a three, I guess I can make a real strong case, that a 2 1/2 would be the appropriate rating here, we're not doing half ratings, so, you know, and I also think it's a little bit of a misnomer, anytime you have pilot in a loop task, there is some pilot compensation, I think

that if I opened up my tolerances and just shot for the plus or minus two degrees on the heading, that would reduce the... kind of a stuffiness that I used on the roll out, I guess, I'm... I guess, I'm going to go ahead and stick with a two and a two. Okay.

## **Task 3084 Heading Change - Final Cruise**

Pilot A

Task 3084 Heading Change - Final Cruise 15 Jan 97; Runs 20-21

This was lightweight. Somewhat similar to the heavy weight except there is not quite as much tendency to PIO in rolling out aggressively on the headings or zero bank. Perhaps not quite as much tendency to overshoot the target bank angle but many of the same comments apply. I would give it a four for lateral directional and pitch-wise a three, longitudinal-wise.

Pilot B

Task 3084 Heading Change - Final Cruise 09 Jan 97; Runs 26-28

Very much like before, do-able, work loads a factor, but not to the point where it's inordinate or degrades from the performance a whole lot, and I was able to keep within desired performance, I felt. So, both longitudinal and lateral directional, controllable, adequate, satisfactory, minimal pilot compensation, HQR3. Say, 3 and a 3. That concludes my comments.

Pilot C

Task 3084 Heading Change - Final Cruise 17 Jan 97; Run 62

Lateral-directional, adequate...barely, boy, I just kept it in the adequate, satisfactory without improvement, no, and 5 again on the lat-dir, adequate was considerable pilot work load, and the difficulty, probably the primary work load thing is the bank angle and 15 degree bank. Longitudinally, adequate performance, yes, satisfactory without improvement, yes, and again, we're off...we're a little loose on the altitude, I did go out of it, but you know, trying to keep that speed, I can only do one or the other, and keep them in desired, and I did keep the speed in desired, so, I kind of let the altitude slip out, but it wasn't due to handling qualities, it was due to other constraints, so 4 again for longitudinal.

Pilot D

Task 3084 Heading Change - Final Cruise 22 Jan 97; Run 85

This is the 20 degree heading change, this again is at Mach 2.3, not again, but this is now at Mach 2.4, but a lighter weight and it's just very, very similar to task 3082. The only really thing we saw different was, I did get into a little bit of a roll PIO, trying to stop one of the rolls one time there, but it wasn't high amplitude, and I've noticed this roll PIO tendency all the time, and that's why I have been, you know, lowering the ratings on the lateral axis to 4, as I'll give it for this task, longitudinal, let's make it a 4 also.

Pilot E

Task 3084 Heading Change - Final Cruise 29 Jan 97; Run 9

Very similar to card 50, however, this one was easier to do, and this is going to end up being probably pretty darn close to level one, when all is said and done. The speed predictability, speed stability seemed much better, and the ability to maintain speed, I didn't have to dump

any altitude at all on the 15 degree phase, and the... on the other one, the 15 degree phase almost was as bad in some cases as the 30 degree angle of bank, I guess just because it took you longer to get over there, and it had a longer time for the airplane to start slowing down, also this response of throttle seemed better to correct the speed deviation, so, all and all it's a easier task, lateral directionally, about the same, but longitudinally, as far as speed control, which we are, I guess, grouping as speed control, which probably really should be a separate Cooper Harper, it's not really necessarily, although you do use longitudinal control to position the nose if you need be, but any rate, we'll group that on the longitudinal rating. So, for the longitudinal task, it was controllable, satis... adequate performance was obtainable with a tolerable work load, satisfactory without improvement? I will say yes, I'll rate that a Cooper Harper of 3, it does take some compensation, slight nose movement to maintain the speed, and the speed stayed, I think within about plus or minus .005. For lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? No, a 4. Again, the same lateral characteristics we've seen on these other high altitude tasks.

Pilot F

Task 3084 Heading Change - Final Cruise 24 Jan 97 R 51

Not performed by this pilot.

## **Task 3086 Hdg Change - Xsonic Descent**

Pilot A

Task 3086 Hdg Change - Xsonic Descent 15 Jan 97; Runs 3-24

At lower altitudes the control response is much more crisp and a lot less overshoot. Very little coasting of the bank angle and very crisp stick and very responsive inputs in terms of roll. Little change or no problem at all with control. Cooper Harper for pitch, give it a two. The roll seems to be perhaps, the only unusual thing that I can notice is that the snappy roll in/roll out, initial motions of the airplane. It is a little uncomfortable. As a professional you can employ rolling in and out for passenger and pilot comfort. So the compensation you use would probably be greater than you would want to use in normal airline service. Controls were very responsive and I think I gave it a three in lateral directional on that one. It was so responsive that at this speed it is a lot less likely that you would get into a PIO because of the timing involved. It is not in the area of a delay that set up a PIO. It is a lot less likely.

Pilot B

Task 3086 Hdg Change - Xsonic Descent 09 Jan 97; Runs 29-31

Very much like before, except this time the work load was relatively low, good solid level one, I don't think it was borderline at all, I believe I was able to keep the performance within the desired boundaries and the compensation just consisted of scanning primarily, that the control system was fairly transparent. Let's see, the exception to that was that when you got a little bit fast, at 351, the envelope protection tends to put some nose up trim in, and it's a little bit disconcerting to be fighting that all of the time, so once again I preferred that protection be an excess of what you would normally fly the airplane at, by more than 1 knot, since I think 1 knot is a fairly tight tolerance. So, HQRs, both lateral and directional and longitudinal are the same. In this case, it's controllable, adequate, satisfactory, minimal pilot compensation, HQR3. So, the HQRs are 3 and 3. That concludes my comments.

Pilot C

Task 3086 Heading Change - Transonic Descent 17 Jan 97; Runs 64-65

Let me see, lat-dir, what do we got on that. Did get adequate performance, satisfactory without improvement, I didn't see any bank angle that got in there or overshoots and heading or anything, so, I'm going to say that satisfactory without improvement, and certainly a 3 on that would make sense, so lat-dir is 3. Longitudinal, adequate performance, yes, satisfactory without improvement, I'm going to say, well, one thing that we verified that time was that the throttle was in fact, likely a player in some of these longitudinal things, because when we switched to single throttle operation, it was ever so much easier to make fine adjustment, and so I'm going to say, yes, and 3 for longitudinal on that, and it's down where...the other thing that really helps is flight path marker, just drag it along the horizon, your altitude should stay pretty good, and of course it does, I guess that was 3 and 3.

Pilot D

Task 3086 Heading Change - Transonic Descent 22 Jan 97; Run 89



Subsonic 60 degree heading change with 30 degrees bank, plus or minus. Noticeably easier to control altitude at the lower Mach number. The resolution of the flight path simply gets a lot better for making small climb rates. Still have that roll PIO tendency, let's give it the pilot ratings of 4 and 4.

Pilot E

Task 3086 Hdg Change - Transonic Descent 29 Jan 97; Run 11

It was a fairly easy task, maintain airspeed plus or minus two knots for most of the time, and with a fairly moderate work load, probably if I'd been a little bit higher work load, plus or minus one. The display easy acceleration carat all work now fine for the airspeed control, and for the... as opposed to Mach control at higher altitudes where the carat wasn't really working properly. So, this combination of carat and tape make that a fairly nice task with the displays we have. The altitude control also is easy, it's plus or minus 20 ft most of the time, and probably could have been tighter, had I worked harder at that. So overall, a solid level one task. Laterally still on an aggressive phi capture, you do get a PIO, plus or minus one or two degrees, at about two hertz, and that's not real good, and probably I need a little bit more of an aileron interconnect to damp out a little bit of sideslip with roll rate. Okay, and actually roll acceleration is what really kicks the sideslip, the faster you initiate an input, the more active the sideslip problem becomes. Okay, for the longitudinal task, controllable? Yes, adequate? Yes, satisfactory? Yes, I met all the desired criteria quite nicely I thought, and so it does meet level 1, and we'll rate it a Cooper Harper 3, and basically does take compensation, a lot of... a lot of small rudder, or throttle inputs, and the gamma dot V holds altitude pretty well, though not perfectly, and so therefore did take some small longitudinal inputs also. Lateral rating, controllable? Yes, adequate? Yes, satisfactory? No, level 2 a Cooper Harper of 4, and the minor but annoying deficiencies are mainly the PIO on an aggressive phi capture and the... kind of... some type of aileron rudder interconnect is necessary to damp out the beta.

Pilot F

Task 3086 Heading Change - Transonic Descent

Not performed by this pilot.

## **Task 3088 Hdg Change - TCA Descent**

Pilot A

Task 3088 Hdg Change - TCA Descent 15 Jan 97; Runs 26-27

The overshoots in roll are very aggressively 4 to 5 degrees out to 30. That's about what you would expect. No surprises there. Lateral directional, a three and once again I'm using a technique that you keep your hand off the stick and just use your finger tips on the side of the stick for roll changes to avoid getting any pitch interchange in there. It is easy to hold vertical speed and airspeed, so I'll give that a three on longitudinal. So a three and three.

Pilot B

Task 3088 Hdg Change - TCA Descent 09 Jan 97; Runs 32-33

Once again, since we're back to controlling VSI with this flight path based system, the work load goes up commensurate, and it's more like a level 2 task now. I think in terms of being satisfactory or not for the mission, I think the task is fairly tight, having to control VSI to that extent, while having to control the rest of it to that extent. So, I'm able to maintain adequate performance, but desired is fairly tough. Also, adding to this is a fact that the turbulence effects kind of blow you out of the desired range, fairly quickly as well. If you happen to be correcting out of phase with the turbulence, and it hits while you are not looking at the VSI, you're outside the desired band immediately...immediately and approaching the edge of the adequate band immediately, so it makes the task a little bit more difficult. Lateral directional was not much more of a problem than it has been, the longitudinal does attract from a little bit though, so, that gets degraded as a result, but not, I think into level 2. So, longitudinal, it's controllable, adequate, and I think warrants improvement, and desired performance requires moderate pilot compensation. This is another one where I might like to give it a 4.5 if I was able to give it half ratings, because it's desired is probably more than moderate, although adequate is probably less than considerable here, but I'll give it a 4, because it's leaning towards that side for longitudinal. For lateral directional, it's controllable, adequate, and satisfactory, minimal pilot compensation, HQR3. So the HQRs are 4 and 3. That concludes my comments.

Pilot C

Task 3088 Heading Change - TCA Descent 17 Jan 97; Runs 67-68

The lat-dir, certainly adequate, satisfactory without improvement, yes, and I was really minimal pilot compensation, so, 3 on lat-dir on that, and pitch, once I remembered that this is gamma, you know, it will hold a gamma, so I shouldn't be making a lot of inputs trying to fine tune, because the airplane will do it for me. Certainly found it quite easy, and we had adequate performance, satisfactory without improvement, yes, and another 3, and that borders on 2, when I let the airplane do it. There was enough disturbances in there, either...I don't know...turbulence or whatever, that when I would see a change in the VVI, I would make an input that I would with a standard airplane, and that of course was not appropriate for this flight control system, it could do that quite nicely on it's own, thank you, if you could keep your hands off it, and so what was misleading before, I was chasing it around, because I was trying to put in controls that I would with any other airplane, with the gamma, well I know it's not gamma hold, but it's, you know, gamma dot command, the airplane could do it very nicely on it's own once I let it do it's own thing, then the workload, obviously, went

quite a ways away, and I was just a matter of asking it to do the right things. So, 3 and 3, longitudinal and lat-dir

Pilot D

Task 3088 Heading Change - TCA Descent 22 Jan 97; Run 92

It was a plus or minus 60 degree heading change, subsonic and 250 knots with a constant sink rate of a 1000 ft per minute. Again as similar task, we didn't have a... we don't have an IVSI, so, really controlling gamma, cross-checking the IVSI. Better resolution on gamma at this speed makes it a little bit easier. The heading is a little harder to read when you're... when the flight path is a depressed 1000 ft per minute. A couple degrees we had there. Still have my roll PIO tendency, but you know not a bit change in the work load. Longitudinal, 4, lateral, 4.

Pilot E

Task 3088 Hdg Change - TCA Descent 29 Jan 97; Run 13

Card 53, task 3088, heading change in Class B descent. Completing block 4. This task was not difficult in speed control, it was not too difficult in intercepting the heading, the same lateral problems do occur on a fairly rapid heading capture, where you do get some potential for PIO, the hardest thing was the VSI control, and I think part of the problem is the turbulence is about on the level of a desired criteria, so, it does take an effort. On the roll-ins and roll-outs, what you first mentioned they were interested in on these, as far as VSI control, there was no tendency to balloon or to dive, the VSI control, I think, or VSI maintaining was actually very steady on all the roll-ins and roll-outs, so, no problem there with any kind of coupling, or any type of trim problems. The hardest part though, was just maintaining a commanded gamma... maintaining a proper gamma for the proper VSI, there was no display guidance to follow, and so the gamma command seemed to be a little bit less stable than I would have liked. I was trying to hold an actual gamma, seemed to be a little bit harder, it could be because I was chasing it with turbulence, I didn't do it long enough to really figure that out. As far as the rating, longitudinally, I met the desired criteria across the board, kind of borderline on VSI, but I think overall I met it. Controllable? Yes, adequate? Yes, satisfactory without improvement? No, I'll rate it a 4, and mainly that's for performance based on the plus or minus 300 ft per minute vertical speed requirement, which is probably also a function, as I mentioned, of turbulence, but since that's there, that's what performance comes out to be. Lateral direction, controllable? Yes, adequate? Yes, satisfactory? No, also a 4, and mainly because of the slight PIO, roll PIO, and aggressive capture, and the inability for this thing to easily hold a commanded phi.

Pilot F

Task 3088 Heading Change - TCA Descent

Not performed by this pilot.

## **Task 4020 Nominal Approach & Landing**

Pilot A

Task 4020 Nominal Approach & Landing 15 Jan 97; Runs 58-60

I guess we got into the desired area, and I think I'd have to give a 2, lateral directional seemed to be pretty reasonable, I think I'd give it a 3. The... one of the things we noticed is on the... I noticed was on the flare, in order to get arrest of sink rate at 5 ft or so, you'd add about 40 to 30 ft, you'd need to, or 50 ft, you'd need to add 1 or 2 knobs of thrust, I'm not sure how many RPM that is, but you actually need that thrust when you flare. Some of the previous simulations, that wasn't required, you'd simply close the thrust to idle, and so after adding thrust and getting the touchdown, then close the throttles, if you don't add thrust, then you seem to get a hard landing out of it. That's making a nominal flare from on the glideslope, trying to touch the, touchdown in the desired touchdown zone, and it seems to be required to keep the sink rate down. At approximately... in order to get the sink rate within reason, I have to start flaring, shortly after 50 ft, and I try to get up to about 2 degrees of gamma by somewhere in the area of 30 ft, and up to about one degree of gamma by about 10 ft, and then very slowly raise it from there, and if the thrust is set right, the sink rate is about right, and get a touchdown, close the throttles, and lower the nose. I'm sorry, I'm merging everything into one inadvertently. The ILS approach, let's rate them both a 2, well, gee, I really didn't have any trouble with the lateral in this particular approach for some reason, I don't know if it's because of my gains are turned up more, I don't know, but let's give them both a 2 in the ILS part, and on the landing part, I think it does take a little special effort for longitudinal. It seems unnatural to add thrust in the flare. Most airplanes you wouldn't have to do that, so I'm suspecting the... that the simulation isn't quite right, but I suppose that's a... definitely a possibility. So, for that reason, I guess I would give it a 3 in longitudinal in the flare, and probably a 2 in lateral.

Pilot B

Task 4020 Nominal Approach & Landing 07 Jan 97; Runs 5-7

The card was accomplished as per the instructions and I'll go ahead and rate it. The performance tolerances are as per the card. In general, I was able to get desired performance throughout the approach in all the parameters and in the landing phase I was able to get it in the parameters with the exception of X-distance and landing H-Dot. There's an interplay there and I was right on the edge of desired performance. I think with a few more approaches I'll be there with this configuration. I feel like I'm fighting H-Dot a little bit more than I'm use to. And as such, there's a little bit of a tendency to float here. Didn't notice any tendency to bounce, no geometry strikes, no tendency to PIO or bobble in pitch or roll. And, lets see, everything else was pretty much nominal. In the approach phase it's controllable, adequate, satisfactory, improvement not required. This is longitudinal, by the way. And this is another case where I hate to give 2's. I'd like to give a 2.5 here but can't. I'll give it a 2, longitudinally pilot compensation not a factor with a carryout, that pilot compensation is a factor its just not much of one. Lateral directional it controllable, adequate, satisfactory, improvement not required. I'm going to say HQR3--- minimum compensation required, again it would be nice to have an angle of bank latch somewhere around zero and a true angle of bank hold mode. I feel like its a very soft hold mode and in the absence of turbulence it holds angle of bank but as soon as you get any disturbance its happy to go to a new angle of bank so you have to constantly provide inputs. On the landing phase, longitudinal HQR, its controllable, and adequate, however, I think deficiencies warrant

improvement. I'm going to say desired performance requires moderate pilot compensation HQR4. Lateral directional, its controllable, adequate, and satisfactory with mildly unpleasant deficiencies HQR3. And that's just in fighting angle of bank a little bit and the turbulence. That concludes my comments.

Pilot B

Task 4020 Nominal Approach & Landing (ASE ON) 13 Mar 97; Runs 21-24

Accomplished as per the card, we did three data runs, actually we did four data runs, the third one the rudder bombed out just prior to the flare. The fourth one, the motion system bombed out just after touchdown. I was able to pretty much get desired performance in the approach, predominately adequate performance on the landing. On the final landing the sink rate was inadequate. I feel like I'm really working hard to retain control of the aircraft. In fact on one of the runs, I smoothed out my inputs enough that the results were pretty good but I was really fighting for control. I feel like there is a definite relationship between the aggressiveness with which you put inputs in and how close you are coming to a handling qualities cliff. A pretty classic cliff type stuff where when I get really tight with the control and the gains really go up, my gains really go up, just prior to touchdown, I feel like I'm impinging on PIO. Again in the flare phase, just prior to touchdown is where it's really noticeable. Is it controllable? Barely. This is for the longitudinal CHR's now for the task at hand. Barely controllable. Adequate performance attainable with a tolerable pilot workload? No. I feel like the workload is really, really high. I am going to call it an HQR of 8, considerable pilot compensation is required for control. Although I am able to get adequate performance in general, on the one hand I was not on H dot on the final one and I wasn't even tempted to do what I had to do just to get control of H dot just prior to touchdown. I would have had to put a large input in and I felt like that was beyond what I would do. So again HQR of 8 longitudinally. Lateral directional, it's not quite as bad in terms of control. Workload is a little bit lower. It is controllable, adequate performance is attainable. It is not satisfactory, however. I'd say adequate performance requires extensive pilot compensation. Call it considerable so for a HQR of 5 for lateral directional. The workload requirement is predominantly longitudinal. Now ride quality is another story. Ride Quality is effected by both the longitudinal and lateral directional modes and I would not find this certifiable with a production program. That concludes my comments.

The last ratings were in the landing phase. In the approach segment, longitudinal, it is controllable, adequate, not satisfactory. Assuming we are giving half ratings here, I'm going to give it a 4.5. Desired performance requires something more than moderate. Adequate performance... desired is certainly achievable. I got it on every run so it is kind of hard to call it a straight 5. But on the other hand I think it is more than moderate to get desired performance. I going to call it a 4.5. That also applies to lateral directional. Same answer. So we are not complying with the TM on HQR's. This is an artificial constraint. This is the NASA modified CHR and I'll give it 5's for both longitudinal and lateral directional.

Pilot C

Task 4020 Nominal Approach & Landing 13 Jan 97; Runs 90-92

Okay, adequate performance with a tolerable pilot work load, I'd say yes. Did we have anything that went outside of that, if I'd of known the majority of them were at least in adequate, I didn't remember, did...we might of had one thing that was...in general I would say I could get adequate performance. Is it satisfactory without improvement, definitely not,

and deficiencies require improvement, and adequate was the best that I could get, and very objectionable with tolerable deficiencies or moderately...let me see, I'd say extensive pilot compensation, I'm going to give that a...for the landing, no, that sections what I was thinking of here, the...would be a 6, and the ILS part, again, I lost...usually it was glideslope, and that would be the end, but when I did lose it, at least stayed within adequate, so I recall with one exception, so, I'll call that a 5, that was considerable pilot compensation, now let me just go back and talk, is...are there more, okay, well, since I gave you the touchdown first, I'll give you that second. There is a awful lot of stuff going on when you get in close, below 150-250 feet, it feels like attitude changes, the glideslope drops out from under me, in other words, I'm ballooning, and I end up having to make a large change exactly what I don't want to have to do in a large airplane in close, and I feel as though, if I'm going to push over to put it where I want to, when I rotate it back, I'm probably going to hit the wheels just due to the rotation, and very reticent to do that, and as a result I'll go ahead...I tended to go ahead and accept the longer landing in order to keep from driving the gear up through the wings, or you know, in other words, exceeding the H dot limit, so, almost every time I expected to be long because the way I would get set up, I'd just, if I really, really, went for it, I was going to smack it down pretty good, so, I just accepted getting adequate performance as opposed to desired in order to keep something respectable on the touchdown rate. Left and right, actually I don't think it's that hard to align as it would sound from the work that I was doing sometimes, but I was so concentrating on the pitch, that I would just kind of drop out as long as it looked reasonable, I was accepting in roll, because I was concentrating on the pitch, because that's the one I was most concerned about, so, did I...I don't think I...did I give you a lat-dir for the touchdown, I would probably give that a 5, because when I really spent my considerable pilot compensation, I could keep it even in desired, but I'll accept that most of the time it was adequate, so a five because of the considerable pilot compensation, left and right, and the reason it wasn't even better than that, I suspect it was because I was working on the pitch so hard, that's my point. Okay, as far as the pitch goes, again, a lot of things going on, if I did what I really wanted to to, I think that I would be maneuvering this large an airplane, much too much close to the ground, and would have inadvertent H dot, or the wheels would be really low, even though maybe the...where I was or the CG wouldn't be too bad, so, I just couldn't try to be as precise as possible, the whole thing seemed to set me up long, everytime I would do something, and if I ducked under, in order to accomplish account for that, then the glideslope would go all to pieces, and I'd be way out of limits there, so, it was kind of a tradeoff, do I start out of limits on the glideslope with the idea of then, when I get down close, and doing a decent flare, keeping it in desired, or do I follow the glideslope and except a long run...longer landing. Now, there maybe some technique of what to do in close, that I haven't broken the code on yet, but just from my initial trying to take an airplane and go land it, you know, without trying to fox the system, those were the things that I noticed. Kind of got, getting out of the order of the way we did it. Back on the glideslope, intercepting the localizer is fine, piece of cake, intercepting the glideslope is not difficult, assuming you're watching it all, I mean the control of the airplane is there, a couple of times I drifted off, I guess, and let it get down on half a...half a dot before I really did some serious pushing, but in general, capturing both the localizer, and the glideslope, was not a big deal. When I got down low, keeping the glideslope is easy, but of course it should be with the HUD and the glide...and a flight path marker, so, the lat-dir would probably be a...see I'm, I think the localizer, I don't think I ever got out of desired, did I. I don't think so, yeah. I'm going to move that up to a 4, for the lat-dir glideslope, the lat-dir glideslope, doesn't make sense, lat-dir, lat. dir. ILS, yeah, in other words the localizer...flying. When we get to the pitch, now, to the glideslope, that's the thing that I haven't figured out if there is a way yet, because again, the gamma...the flight control system just was doing so well all the way down, and then we get in close, it starts apparently redeploying things, it wasn't keeping up with it, and suddenly now, I'm going to have to make some big motions, and

unfortunately the big motion that I have to make in close, is to put the nose down, that's very unnatural, when I get in that close, I don't want to have to be pushing like crazy to keep the nose down, and...but if I...the time that I did pushover, why then I ended up getting off the glideslope, and getting maybe even inadequate, so, it's...I'm back to the tradeoff, I could either fly the glideslope, or I could do the landing task, but I couldn't tie the two together, I guess, is probably the comment I'm trying to make, and again, my biggest concern is there's so much going on close to the ground, I just don't like that many attitudes, and some that I am not commanding is what bothers me, you get in close, and all of sudden you see...it looks...you know, the attitude changing, you're expecting your H dot to really increase like crazy, and it wasn't anything I did, and I just...when I got in close, I suddenly started to lose the nice, I know what's going on feeling that I like to have when I'm in close to the ground like that, are there any other specific subjects you want? It just gets...it gets uncomfortable in close to the ground with the airplane doing that many things without my inputs, and I can just feel my anxiety level rise as I'm trying to cross-check all these things to find out, okay, which one am I going to accept, and which one am I going to correct.

Pilot D

Task 4020 Nominal Approach & Landing 23 Jan 97; Runs 48-51

Okay, the... well, let's first talk about the glideslope, no problem keeping the glideslope and the localizer deviations, you know just a needle width off, you can get very high precision with this display, with the depressed pitch line, and the very large loc, and glideslope displays, but it is kind of a poor scan pattern, you've got to look all over the darn display to find these things, but with the straight end, and reasonably light turbulence, and no crosswinds, it's very do-able, but there is increase work load there, I have a tendency for a roll PIO, as I have all the way through with this system, and the flap compensation is not quite perfect, it tends to sink a little bit at first, and then tends to balloon you towards the end of it, so I'm going to give it a pilot rating based on these minor things of 4 and 4 for the glideslope portion, segment, or whatever you want to call it. Okay, landing, I had a heck of a time, I'm still having a hard time, the geometry is different than it was from ARC, I think they are saying that the ground effect is different, but I think also the geometry is different here. At Ames the visual intercept point was beyond 1500 ft, here it's at 1300 ft, and so if I follow that religiously, which I'm trying to do, then it requires almost a two segment flare to get up to the landing box, and so it's just a little bit unnatural, I'm not quite sure what to do, but that's what I've been doing, and making adequate, actually I got couple of them right in the desired, but I think statistically I'm going to be having a few of my x-dispersions out of the desired box, so, I'm going to give it a pilot rating for longitudinal of 5, because of the difficulties noted, and still a 4 for the roll PIO tendency.

Pilot D

Task 4020 Nominal Approach & Landing (ASE on) 24 Jan 97

Light turbulence and the ride is still acceptable. It's definitely not paying passenger type of ride, but it's not enough to impact the flying qualities of the airplane, and the flying qualities of the airplane aren't degraded significantly, you just have to watch out on the frequency content of your inputs, as long as you keep it below the structural modes, it doesn't seem to be a problem, so, it would be kind of interesting to see on some of the failure cases, or the crosswind landings, etc. where... how it might work out, but for this task, which is fairly benign, it's not too bad. One other problem is the fact that the display is biased off, and it makes it a little bit confusing when you see it at... particularly approaching the short final,

need to work on that somehow. Pilot ratings, I'm going to up, I had given 4 - 4's for the approach on this previously, I'm going to make it 5 - 5 now, just because you really do have to compensate a little more to keep from banging the structural modes, it's not effecting the performance though, as long as we do do that. Landings longitudinally, have to be smooth, let's make it a 5, and laterally not much of a task on laterally for this, for 8020, let's make it a 4.

#### Pilot E

#### Task 4020 Nominal Approach & Landing 08 Jan 97; Runs 40-42

Block 1 - Familiarization Okay, 4020, Card 17 for the evaluation segment with the glide slope and localizer intercept, it's very, nice characteristics, very minimal pilot compensation required. The gamma dot V control law works very well for just maintaining the altitude on a localizer capture. In the turbulence the lateral directional axis, you do tend get disturbed from a track, so you have to constantly stay in a loop to correct back to a localizer, but it's not too bad, certainly suggestions might be a track hold, submode, or you would hold a certain track if you were within a quarter, or half degree or so of wings level. I think there is things that we can do to improve lateral directional as far as localizer tracking, but nothing really significant, very nice, overall. For the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory? Yes, and I'll rate a Cooper Harper of 3 and mainly because the light turbulence does tend to disturb it slightly from the equilibrium altitude hold mode. There is no altitude hold submode, which will be nice also, and also when you make the speed change, the flightpath wants to sag, so you're having to put in back stick commands to keep it on altitude so it does require more compensation than really should be necessary with the state of the art in control law design. Lateral directional; controllable? Yes, adequate? Yes, satisfactory? Yes, a 3 also, and similar comments were made earlier about, we could make things a little bit nicer with some, using some state of the art techniques such as track hold that type of control law modifications. Okay, for the precision landing, the biggest problem that I am having today is that it is very difficult to judge the flare maneuver. I'm trying to close the loop on the actual gamma because there is a delta between the commanded and actual. It's very significant, and with the dynamic ground effects model right now and without as much of a ground effect cushion as we've seen in the previous REFH Cycles... What happens is, you get in there and you flare too aggressively, you will tend to float a little bit and go long, however if you don't flare quite enough you just go on through the ground effect and touchdown, and that's what I was... was happening to me today. I was getting a flare in, but not quite soon enough, I was trying not to go long and basically it didn't quite, probably I needed another second or so, or maybe I need to start my flare a little bit earlier than 50 ft, with the technique that I was using. I basically was slowly pulling the power off from 50 ft on down so that I still had power on at touchdown, but still I consistently landed a little short and a little firm. I think I met adequate performance overall for the longitudinal portion, basically the my H dots were between 4 and 6 and my touchdown distances were just under a 1000 ft I believe... yeah 718, 823 and 944 with H dots of 6.2, 4.6 and 6.0, so I'm very consistent, try consistently bad, but at least very consistent. I think that's just a reflection of the lack of ground effect cushion that we are seeing. The longitudinal rating controllable? Yes, adequate? Yes, satisfactory? No. I have to rate it a 5, because the adequate performance was all that I was able to obtain. Lateral directional however I didn't meet the desired criteria all the way across as far as Y position and heading error and that type of stuff. So for lateral directional, controllable? Yes, adequate? Yes, satisfactory? Yes, a Cooper Harper of 3, and basically you still having to put some compensation in there with the light turbulence to keep it on track.



Pilot E

Task 4020 Nominal Approach & Landing (ASE On) 29 Jan 97; Runs 20-21

The work load as far as this compared to a nominal landing, is about the same, the ride quality is horrible compared to the two, but the work load is about the same, however, you are obviously, right on the hairy edge I think with more turbulence or any type of crosswind or lateral offset where you can really excite this thing, you might have a more colorful ride, and what you don't want to having going, is a lot of ASE motions there in the flare, which would then mask what the performance of the aircraft was doing, you might misjudge a flare. As you get high gain in the flare, in approaching the flare, what happens is the very quick input you make, even though a very, very, small amplitude will excite the ASE motions of the aircraft, and can get it moving around a little bit. The... overall we did two for data, they were pretty close to desired, but just slightly in the adequate range, the first one makes desired H dot just a tiny bit long, so that's kind of borderlined desired, and the second was just slightly firm, and a little bit long, it was a floating approach that I had to actually dump a nose a little bit to get it to land, and the floating approach comes about from the dynamic ground effects where I've probably flattened out a little bit too much too soon. I don't know if the ASE effects cause that, I think this performance is probably fairly close to my nominal 40/20 landing performance. So, with that in mind, for the approach phase of it, I've got a approach and a landing phase. The approach phase, longitudinal, I met all the desired criteria, I'm quite sure... yes, it's right on glideslope and localizer, so, it's controllable? Yes, adequate performance? Yes, satisfactory? Yes, I would rate it a Cooper Harper of 3, for the lateral directional, up and away, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, also a 3. Interestingly, I did a flat rudder turn from the approach to the localizer from the 30 degree offset to the... correcting to the localizer, and had a fairly good rudder input, about 8 degrees of beta, and there was not feeling of that, no NY was felt in the cockpit, so, we might have a slight motion model following problem. For the landing, longitudinal, we talked about that just didn't quite make the desired, but close, that's going to affect the rating there, obviously, put it in the level 2 area, controllable? Yes, adequate? Yes, satisfactory? No. It has to be a Cooper Harper of 5, mainly for performance, however, it... I would say it's not... rating wise, it's not a whole lot different than a nominal airplane without the ASE effects. Lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? The lateral performance, basically, my wide dispersions were almost non-existent, they were a .2 and a 1.5, and the heading deviations were well less than a 1 also, so, the lateral performance in the landing worked out pretty well, let me just check the criteria, heading well within the desired there. Okay, it appears that I met the desired criteria quite readily with the lateral, so I'll say yes, it is satisfactory without improvement, and rate it a 3 also for workload.

Pilot F

Task 4020 Nominal Approach & Landing 21 Jan 97; Run 86

Okay basically, we did quite a few practice runs on this, which is indicative that this is a learned task, one thing that's really notable, and although it's obvious when you talk about it, it took me a little bit to really get ingrained, even though I've done it with this control law before, but if you over rotate, you actually end up having to bunt for the stick to get the flight path back down during the flare. The airplane is easy to fly. The first part of the task, the ILS approach down to 200 ft, it's pretty easy, controllable, hasn't required a lot compensation and gamma flight control law works real well for that. Pretty much give it 7 (2), it's almost hands off. For the landing task, distinctly different than I remember the Ames

model being, in that there's not the tendency to float as much, although, because of that, and because it seems like the... going through the boundary layer, or going through the ground effect, does vary a lot on how much descent rate you have when you hit it. It's still not real predictable, but you can learn the task, I guess, and basically all I'm doing is I'm getting autothrottles off at 50 ft, as I bring my flight path up, I'm letting that bleed the airspeed, so I'm pretty much leaving the throttle set, and I'm just trying to start the nose up at 50 ft, at a rate so that it's fairly controllable, and so that I have just a slight negative gamma of touchdown, and so, I'm not really flaring like I would, I guess my mind set is different than it is for a traditional airplane, and it's different than what I use for Ames, I'm basically just trying to play the round out, so that I time the gamma with the touchdown. You can do it fairly easily with the radar altimeter readout here, and the voice callouts, I think there are some pros and cons about using this technique, and I'm not so sure that if I flew the airplane on a day in and day out basis, that I'd necessarily really want to use this technique. Although, with the gamma dot control system, unless there are allowances made for a landing flare, if it stays in that mode, I'm... I think you're always going to see an aspect of this technique, during the landing. I guess on the actual data run, we got desired performance, which is kind of a flute, because on all the practice runs we were not doing quite that well. I'm going... for the Cooper Harper for first portion, I really don't think there's a big difference between the lateral and correctional, so, I'm going to rate it, and we'll use the same rating for lateral and directional, so, this is from 1500 ft down, to 200 ft. It's definitely controllable, adequate performance with a tolerable pilot work load, it's satisfactory without improvement, and I guess I'd probably say that... again, I would probably kind of drift towards a... I'll give it a 2, I guess. I think there's negligible deficiency, it works pretty good. There is a little bit of... you see the commanded and the actual flight path vector split with the flat movement, it's pretty stable and pretty steady throughout that. For the actual landing task, it is controllable, you do get adequate performance with a tolerable pilot work load. Is it satisfactory without improvement, and this is kind of hard question to answer for me because, it's not a real familiar control law for me to be using and so I expect that there is some learning curve on this, and I'm going to be interesting... it's going to be interesting to see how I do on subsequent runs, but right now I guess I would drift towards the 4, and say it's not satisfactory without improvement, let me think about this for a second. For the spot landing task with the minimal descent rates, and I guess by the reason I'm kind of hedging on this, is I guess I kind of feel like it's more of a minimal pilot compensation, because it took me so many runs to really learn the technique. I think I'm going to go with a 4, although, I suspect that once I kind of get... internalize how the control law works, and kind of get the technique down, I am expecting my performance to improve, but we'll see. So, let's go with a 4, and although, it's kind of against my nature to split axis on the Cooper Harper, I will say that it takes, even though it went here, I have to look down the runway and make sure that the flight path is pointed where I want it, and that's right underneath the waterline to get the runway alignment, and make sure my heading is aligned, so I guess, I'm going to go with a 4 for pitch, and a 3 for lateral directional. One additional comment that I noted is on the practice run just previous to this everything seemed to work out pretty well, on this particular run, I got a little antsy at the end, and increased the pitch rate up to a little bit higher than I wanted it to, and the airplane actually started to level out, and I had to bunt forward, and put the flight path vector below the horizon slightly again, and the later portion would flare to make the touchdown in the touchdown box, and it might be interesting... it might be good to look at the data tapes just on the control inputs on that, yeah I think, using gamma dot in the landing case, or this kind of control law in the landing case has some interesting ramifications, because it doesn't fly like a conventional airplane there, and pilots are very used to being able to just release back pressure, if they over rotate in the flare, and it seems like that may not be an option with this control law.

Pilot F

Task 4020 Nominal Approach and Landing w/ASE 24 Jan 97; Run 85

This is condition 4020, and basically we just did one run, this is the first time that I looked at this with ASE on, basically, I saw a lot more lateral motion with roll inputs, than I did before. I really... I think that motion is worse with the roll inputs, than it is with the pitch inputs, it's easier for me to control pitch, at least for the localizer tracking portion than it is roll, just because we get bounced around so much with the roll. The landing phase, the landing phase is still real similar if you're lined up. If I... we were fortunate enough that we were... pretty much got our lineup early, and it was okay, if we had been trying to make lineup adjustments down low, I think we would have gotten distinctly different results, I think it would have made the pitch task much more difficult. Basically, compensation that I'm using is reducing my gain, doing everything slowly, trying to get set up, and do everything with a very smooth, slow, intercept for any parameter that I'm trying to control. Basically, we were fortunate that we didn't get real far off on anything that time, if you got very far off a nominal kind of approach, or flight path that you were doing, I think it would be very difficult to correct in any timely manner, particularly in roll. Your correction would have to be right the first time, it would be hard to make a couple corrections I think, in a timely manner. The droop on the display, down close it didn't seem to effect performance too much, but it was discrepant on final with the horizon drooping below the horizon outside, and that is a little bit disconcerting. I'd go in and say, at least from what we saw for this task, it is controllable, is it adequate performance obtainable with tolerable pilot work load? That was no turbulence, correct, light turbulence. Just the way the roll is and the bouncing around and everything, I'm going to answer yes to adequate performance obtainable with a tolerable pilot work load, but overall, I don't think bouncing around that much probably would be real good for a long term day in, or day out kind of approach, especially if it required any roll control, you know, another task in the cockpit, and maybe some radar vectors or something in a busy terminal area, I'm not so sure that, that would work out real well. Is it satisfactory without improvement? And I think I'll answer no to that, we did... we got desired performance in everything, except for we were about 90 ft long of the desired box. I think... I think I'd probably get the same general kinds of performance that I did before with maybe desired sometime, but I think I'd probably get more adequate than desired, particularly if I got off any on the approach portion or the later part of the approach. I'm going to come in here, we did not get desired performance, that really kind of zeros in on the five or six range. Moderately objectionable, adequate performance requires considerable pilot compensation, very objectionable, but tolerable deficiencies, adequate performance requires extensive pilot compensation, again, disregarding the fact that just generally maneuvering the airplane around with the lurchiness that we have laterally, or directionally, I guess, from lateral control, that accompanies lateral control, I should say, ignoring that, I think that that's very objectionable, and probably not real suitable, ignoring that for this task, and just looking at the compensation of work load, I guess, I would probably, if we were giving half ratings, be in the 5 1/2 range to 6, but I guess for this specific task, I'm going to go... I guess I would go with a 5 1/2, I'm not sure that I quite say that it's extensive, but I'm leaning more towards that, than considerable pilot compensation, so, let's give it a... I would really like splitting the axis, but let's... I'm going to split them here, even though I think there is some lead through into the pitch range, and I don't think that pitch is quite as bad, I'm going to give it a 6 laterally, and a 5 longitudinally. That's for the flare and touchdown? Yeah. For the approach, let's see, you know, even though I'm trying to ignore the fact that I think it's problem with pitching around is probably unsuitable in the terminal area to begin with, it influences me enough, that I guess I'm going to... it's

hard enough to track with that lurchiness, I'm going to go with a 4 and a 4 on the approach, actually I'll tell you what, I'll go with a 4 laterally directionally, and a 3 in longitudinal on the approach.(Special Task not crossreferenced.)

## **Task 4050 Nominal Approach and Landing with Ground Effects**

Rated by pilot E only.

Pilot E

Task 4050 Nominal Approach and Landing with Ground Effects 18 Feb 97

We looked at task 4050, the nominal approach and landing with dynamic ground effects as modeled on the cycle 3 implementation both on and off. And when they are off we go back to more or less the Cycle2B implementation like we flew at Ames dot two. (AMES.2) Very obvious and apparent difference. There is a lot of ground cushion when the ground effects model is turned off. I did eight approaches all of which were long with dynamic ground effects off but with very nice H dots and they were also very predictable. As I started trying to go below glide slope and get into the box, I got a couple down around 1760 - 1740, and I think my last one would have been very nice, I had what I thought was an excellent flare, and looking very good and at the last minute the actual gamma jumped above the commanded gamma. I had the commanded gamma about a half a degree below the horizon in my flare and there is a slight lag in the response and all of sudden the actual gamma jumped above the horizon ever so slightly. We probably leveled off at about a foot or two and I had to tweak the nose down just a bit and it came down and landed but at 2200 feet. The dynamic ground effects model on, you have no cushion whatsoever. The best thing you can hope for is what I did on my last landing after we came back to the dynamic ground effects model where you get your flare just perfect and it pretty much is going to land. So there is not nearly the tendency to float although you can over control your flare to save your landing and get into a floating situation but if you do the flare just perfectly you'll get a nice spot and a nice H dot, but it certainly is not as predictable. If you look at the dispersions, there is probably a 50% or better maybe more like a 100% dispersion on X position with dynamic ground effects on and with them off before I started actually trying to force myself below the glideslope, the dispersion was on the order of about 300 ft out of about 2000 ft. So you are looking at about a 14% delta as opposed to going from 775 to 1751 with Dynamic Ground Effects on. My H dot similarly except for one where I was really floating and just gave up on it were all within about probably a standard deviation of .15 H dot, with a high of 3.3 and a low of 2.9 for the large majority of those. So very very consistent H dots, very consistent placement although be it long. But with the Dynamic Ground Effects off we noticed that the actual velocity vector would tend to jump above the commanded velocity vector. In other words, I would command a certain attitude and the ground effects model that was in Cycle2B would actual cause the floating tendency to actually raise the actual gamma to a positive value, so you would actual balloon a little bit. I have never seen that with an in ground effects model on. You typically get a dispersion where you are commanding less of a gamma and in fact the actual shows a more negative gamma. And that was very apparent in that, that contributed to the floating tendencies. We may not have hit the trigger to get the dispersion between actual and commanded but in most cases when I had what I thought was a pretty good attitude all of a sudden I would get a positive gamma actual velocity vector indicating that we were ballooning a little bit. So huge differences, much more of a cushion with the ground effects off. You could make a late flare and get away with it. You could arrest your sink rate. If you tried to make late flare with the ground effects model on you would have firm landing. The higher the H dot and the more aggressive the flare, the less likely it is to work with a Dynamic Ground Effects Model and you would be getting a short, hard touchdown. However you can make a late flare with the Ground Effects off and salvage your touchdown and not get a hard touchdown. So a lot of differences between the two.

## **Task 4069 IAG (TIFS) Approach**

Pilot A

Task 4069 IAG (TIFS) Approach 15 Jan 97; Runs 77, 79-81

I encountered about half of the... anytime during the approach if you maintain your hand on the stick and try to make quick corrections, lateral corrections in the flare, or during the aggressive portion of the alignment, you get into a PIO, so, I have to give the lateral directional a 10, and the pitch, I would give a 3, there doesn't seem to be any particular problem in the pitch area. Are you rating the two segments, or... Okay, for the first segment, I'd give them both a 2, and for the alignment segment, realignment segment, lateral directional a 10, and the longitudinal a 3, and that would be from both left and right of the alignments. This is run 81, and it's condition, what is it, 4069, and what was the other one, from the left and... it's all one, okay... it appears as though the PIO is caused by maybe some body movement, hand movement due to the cab reactions to the previous movements and so forth.

Pilot B

Task 4069 IAG (TIFS) Offset Approach and Landing (ASE ON) 13 Mar 97; Runs 27-29

Okay on this one, the approach and landing are considerably different. The approach is similar to what I saw before. Longitudinal, controllable, adequate... I would say adequate performance requires considerable pilot compensation, HQR of 5. Same thing lateral directional. 5 and 5. The only modification here, the technique, is to back off a little bit on the aggressiveness, I'm finding that a lot of times, I'm keeping my hand off of the control and making bang-bang type inputs which is kind of classic in a sensitive situation like this. To avoid getting high frequency with the system, we are getting real high gain. The landing phase is considerably different. The lateral directional modifications of my technique, dominate the effects of what I'm seeing. When I put in what I thought were reasonable inputs considering the amount of offset in the short amount of time to try to get it in that box, in the desired box, I was into rate limiting immediately, both times. Rate limiting is as we've talked about before, is insidious, in that you don't feel its onset. It is not something you can feel happening and back off on and prevent. Once it has actually occurred, it's too late. Particularly if you are low to the ground, the only thing you can do to successfully get out of it is to let go of the control and when your angle of bank is increasing and ground impact is imminent, you can't let go. So you have to stay in the loop and as long as you stay in the loop you are going to get it, so that's a lose control and crash type situation. That happened twice when I made what I considered ordinate inputs to get into the box. On the third approach and the fourth approach, I modified the technique considerably for landing. I put in very gentle inputs to not try to get into the desired box but to try to stay in the adequate box and on the third approach, I was successful in staying in the adequate box, on the fourth approach I was not. But again I'm modifying the task in order to compensate for deficiencies in the airplane a lot. I going to say, considering the first two, given that it was the worse of the cases... Well let me you two of them. With the former technique, in the lateral directional axis it is an HQR of 10. Control's going to be lost in some portion during the ground operation. Longitudinal did not seem to be as bad a problem, I don't sense any rate limiting there. It is controllable. Adequate performance, I'm going to say, is not attainable. Considerable pilot compensation required for control, HQR of 8. Now after I modified the technique, where I wasn't really trying for desired performance any longer in longitudinal position, the longitudinal is... assuming that's fair, Dave? Those ratings that I

just gave you were for the task as written and that would be my single rating. So that what is going to follow is kind of a foot note. When I modified the task, reduced the gains, and said, I'm not trying for the desired box anymore, I'm trying for the adequate box... Now I'm feeling from a lateral directional standpoint, intense pilot compensation is required to regain control, HQR of 9. And again, Longitudinal, HQR of 8, so the point here is that even when I modified the technique to reduce the aggressiveness quite a bit, I'm still fighting pretty hard to regain control of the airplane, to maintain control of the airplane to keep from getting into rate limiting. And that concludes my comments.

#### Pilot B

Task 4069 IAG (TIFS) Approach 07 Jan 97; Runs 24-27

Accomplished as per the instructions on the card. Let's see, glide slope and low glides are intercept from lateral offset. Okay, no problem accurately maneuvering in the initial phase ...maintaining the approach profile and speed. And.. pretty much attaining trim flight on the offset half a mile prior to the end of the runway. In the final phase, similar to what I've seen before except the workload is higher. I don't think that I was able to get desired performance in sink rate or longitudinal position. The tendency to float, there is that and that's due to the problem in sink rate control. There is no tendency to PIO or bobble in pitch and roll. And no tendency to bounce, no geometry strikes noted. The lateral directional is a bit of a problem this time, that's strictly because of the task which I feel is a bit artificial . Okay, so in the initial glide slope and localizer intercept point. Longitudinal HQR it's controllable, adequate, satisfactory, improvement not required.....minimal pilot compensation HQR3. Lateral directional, same thing, controllable, adequate sat, minimal pilot compensation HQR3. In the landing phase, longitudinal it's controllable, adequate, deficiencies were an improvement, adequate performance requires considerable pilot compensation HQR5. Lateral directional, controllable, adequate, I think deficiencies warrant improvement for this task. Desired performance requires moderate pilot compensation HQR4. That concludes my comments.

#### Pilot C

Task 4069 IAG (TIFS) Approach 14 Jan 97; Runs 49-51

Okay, for the lateral-directional, once I learn how aggressive to be and all, I didn't really have a lot of problems as far as the bank angle control went, and by being aggressive you begin to feel some of the NY come in, the little side to side forces, they weren't real disconcerting I don't think that effected performance and didn't have...and I didn't intentionally do any compensating for it. The power seemed to be there to get the attitudes that I wanted, so, in general the lateral-directional was considered pretty good. The biggest reasons why occasionally I dropped into the adequate ranges were concern with the pitch and kind of dropping the lateral-directional out of my concern once I saw that there was concrete under the wheels, I was more concerned with trying to get that pitch taken care of. I tried some, with rather rapid harsh turns so that I could be wings level earlier and I did some others that were a little smoother which meant for left and bank angle a little lower to the ground than I'd like to have, so, I saw kind of a range in there, but in general, as far as the lat-dir, adequate performance tolerable, yes, satisfactory without improvement, it's going to make the lat-dir look worse than it really felt to me, when I...keep the fact that there were several in there that I had adequate performance, and I would say that considerable pilot compensation would be reasonable, so, I'll give it a 5 on the lat-dir for the...oh darn it, you wanted two segments on this again, didn't you? Okay, very quickly the first segment will be the same as

it's always been, we'll leave that up at 2 and 2, there's very little work to be done. My comments, original comments had to do with the corrections, so that was segment 2, so, for segment 1 we'll leave it at 2's for both on the segment 2, lat-dir 5, and I'm probably being a little bit harsh on it, I suspect from the, certainly from the bank angle, that was always desired, but I did have some dispersion left and right there that dropped into adequate, you could make a case either way, but I'll leave it at 5, not a big thing. The pitch, there is no way if I had 500 runs that I'd feel comfortable putting this down into the desired block. There is just a certain amount of sense of survivability that keeps me from getting to the ground until I've got things pretty well under control, and that just seemed to automatically put me long. A couple of times I was just a little slow retarding the power, but even on the times when I did do it, I still landed long, it wasn't adequate, so adequate performance obtainable, well I didn't see it this time and maybe with practice I could, but in any case the work load would have been intolerable, does require improvement, and to do that task, which is a pretty, pretty heavy duty aggressive task for an airplane of this size, and so it would be a 7 for pitch. I think that will do it, right? So, 2, 2 for segment one and 5, 7 for segment two.

Pilot D

Task 4069 IAG (TIFS) Approach 24 Jan 97; Runs 32-36

Okay, this is the offset landing with the ASE in, that's a much higher frequency task than the normal landing we just did, and it's making it almost a marginal level 3, due to the induced banging, due to the frequency content of the controller during the offset correction. I thought we would have a problem with the droop of the display, but it really doesn't seem to be a big factor. It's going to be a little tough to rate this one, because I've got one landing that's out of the adequate box, but approach is the same as before, 5 and 5. Landing, I'm going to give it a 7, because of the... being out the touchdown dispersion box, I... you know, as far as the impact of the stability modes go, I would make it just a 6, and I'm going to give it a 6 laterally, that the adequate compensation requires extensive pilot compensation during that offset maneuver to keep the structural modes within reason.

Pilot E

Task 4069 IAG (TIFS) Approach 08 Jan 97; Runs 93-96

Okay, for this one... the obvious high work load task is the offset correction. Up and away on a glide slope and localizer tracking is not a problem. Same comments about the turbulence effecting the track and the flight path germane, it's little bit of turbulence caused a little bit of nuisance, extra work load for the pilot. The correction is very high work load and it really puts you in an unstabilized situation to set up for the flare. The... I was having a hard time judging my flare properly and I was not real consistent, sometimes landing a little long and sometimes a little firm. I did have one landing that was pretty good, it was right almost in the mid-point with a really good H dot, but I was wide to the right, so it's hard to put it all together. The glideslope localizer intercept down to 200 ft, longitudinal Cooper Harper, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a Cooper Harper of 3. Lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, because it is down below 250 ft before it starts the corrections, so it's also a 3. Okay, 3 and 3 then. For the precision landing from the lateral offset, overall I met adequate performance for the longitudinal portion of that for the touchdown think rate, X position. Is it controllable? Yes it is, adequate performance attainable? Yes it is. Is it satisfactory without improvement? No. I met the adequate performance criteria, so that will be a 5. For lateral directional, controllable? Yes, adequate? Yes, satisfactory without



improvement? No. Kind of borderline adequate desired, I'll rate it a 4 and a little bit on this one brings out the fact that the lateral axis a little bit slow to respond and a little bit imprecise in when you want to point roll attitude of the aircraft exactly where you want it.

Pilot E

Task 4069 IAG (TIFS) Offset Approach and Landing (ASE On) 18 Feb 97 ; Runs 38-40

This was the Offset Approach and Landing from 700 ft with Dynamic ASE. We did a couple of task 4069 approaches before that with no ASE just to kind of warm up on the offset approach technique. With the Dynamic ASE it obviously behooves the pilot to be very smooth and make slow inputs. You can get the amplitude that you want but you just can't make abrupt inputs. You've got to smoothly and rather slowly input the inceptor and that is with the aileron or lateral input rather than a pitch input. However I still try to be smooth and non aggressive or non abrupt for the longitudinal also which means once I got into the flare I pretty much accepted, if the attitude looked okay rather than make any high gain very quick input at the last change. I would prefer to be smooth and just let it do what it did. So the H dot's tend to be in the adequate range. I tend to be a little bit on the long side and I think that also came from my reluctance to be aggressive with the control inceptor coming out of that turn, and rather to accept what I had. The line up which I would have thought to be a very difficult problem based on the fact that you are reluctant to get into that lateral axis, worked out very well. In fact I met the desired criteria on all of the approaches from within 10 ft, so I'm hitting the desired box laterally every time. As far as the general comments; obviously the ride quality is very poor. I think having learned to be very smooth with the roll into the offset correction, we didn't get any really untoward ASE motions. Interestingly enough, the first approach, I was a little more high gain in the final flare and we saw a lot of ASE type responses after that I tended to be gentile and kind of take what I had attitude and we didn't get those ASE inputs in the flare but of course the flare performance and the landing performance kind of suffered a little bit. Basically it is pretty much solid level two or solid adequate performance longitudinally. Laterally which kind of surprises me, I met the desired criteria, however the constraints to the work load, I think, would make that level two also. So for the approach, up and away, you just got to make small inputs and we've learned how to fly that now. From a handling qualities point of view it's not a real problem, it's going to be desired for both lateral and longitudinal. So for the longitudinal rating for the approach segment, I believe this is down to 200 ft is that right? 250 ft down to the correction. Controllable? Yes. Adequate performance? Yes. Satisfactory without improvement? Let me make another caveat here. I'm going to rate this strictly on handling qualities and not at all consider ride quality or responses that kind of effect the way I do things. I'm just trying to rate this thing on how it can actually perform, taking into consideration the caveats of how you fly it. So I will say that, satisfactory without improvement? Yes, Cooper Harper of 3 as far as... No I'm going to take that back and I'm going to go with a 4, because the glideslope deviation effects were not as tight a control as I would like. So I met the desired criteria but I think it was not a good solid desired. So that's a Cooper Harper of 4 for the longitudinal approach rating. For the lateral rating, similarly the workload to maintain localizer was a little bit high because the turbulence would create lateral dispersions, which meant you were slightly chasing the localizer. Very slight deviations but enough to increase the workload. So it was controllable, it was adequate performance was attainable. It was not satisfactory without improvement it will be desired performance but level two with a Cooper Harper of 4. For the landing rating, the longitudinal rating it is clearly... the performance indicates adequate performance and... I'm trying to decide whether it will be a 5 or a 6. It was clearly controllable. Adequate performance was attainable, is it satisfactory without improvement? No, it is not. I'm

probably rate it a Cooper Harper of 6 due to the workload and kind of the fact that I feel so constrained to not make the corrections I want to make for fear of triggering a bad response. For the lateral rating, I met the desired criteria but also It's one of those kind of things where I'm flying with one hand tied behind my back, it seems like. I really have to be careful what I do. So it was controllable, adequate performance was attainable, satisfactory without improvement? No. I am going to rate it Cooper Harper of 4. I met the desired criteria but I didn't feel that I could aggressively hone in a good dispersion. I kind of tend to be... I went to the left one time, the rest of the time to the right and they were an average of about 6 feet or so 6 and half feet. So it is not the real good solid desired. Yes, when I say something bad, what you don't want to have happen is in the flare have some big... typically when you make an aggressive lateral input you get this... the nose would directionally shift quite rapidly. You get a pretty appreciable nose movement left or right and I guess... of course the center of gravity may still be lined up but I Guess you hate to think about your nose making such a sharp movement when you are right there getting ready to touch down. So I think I tended to try and not be too aggressive in the flare. The first approach, I was a little bit more aggressive and it really did have some sharp response inputs because of it. I feel that I can make very aggressive lateral inputs with the rigid aircraft and if my lineup is slightly off I don't have any problem about making a little quick correction. I'm more reluctant with the ASE because of fear of getting a pretty good lateral shake. Obviously you're trying to be smooth in the flare and you don't want to getting some real abrupt nose input that might couple with the roll and you might get a nacelle or something. I think I tend to try to be very very smooth and kind of accept things rather than try to correct them.

Pilot F

Task 4069 IAG (TIFS) Offset Approach & Landing (ASE) 24 Jan 97; Runs 94-95

The first two practice runs that I did, I noted that, well, the first one I wasn't aggressive enough, I took too much heading off on the initial correction to the runway, and I didn't turn back to runway heading soon enough and overshot the centerline, and I really was hesitant to do too much close to the ground with that, anyway we, and in the second one we, I was a little bit more aggressive with the roll, we did get banged around a little bit more with that, that predictability suffers from that. I was more aggressive in my heading off hack that I took, but then as I got down close to the runway, again, I had overcorrected to the centerline, and I had a hard time getting it back, I also noted on that practice run, that we got a big deflect... or a big split between the commanded and actual flight path vector with the commanded being down more than the actual, which increased our tendency to float at that time. I think I'm getting very inconsistent performance from the gamma control, right down in the flare near the runway. You can do this task, as long as you do it on profile. If you get off profile, and have to correct back with any significant deviation at all, it's very hard to get everything back under control, and again with the bouncing around and everything, it's very uncomfortable, and if I was in a real airplane, this would be very disconcerting, I'd be very concerned about being this close to the ground and lurching around like this. For the task, is it controllable? I'm going to answer yes, although I really don't... for this task, for what we're doing, we were able to maintain control and everything else, I still don't know that... I think that this would be suitable in the terminal area. Adequate performance obtainable with a tolerable pilot work load? We did get adequate performance, and again, disregarding the, I guess, the apprehension that I would have operating the airplane like this, a real airplane closer to the ground, if I ignore that, I could answer yes to this. There's also a matter of, let me look at the descriptors between a 6 and a 7, a 6 is adequate performance requires extensive pilot compensation, and I definitely think that's true, a 7 is adequate performance not obtainable with maximum tolerable pilot compensation, controllability not a question.

Again, if I took my apprehension and factored it in here, we would easily be in the level 3 block, in fact I might even consider readjusting the controllability question. If I'm going to ignore the apprehension right now, and also that apprehension might change if I was more familiar with the flight control system in the airplane, but still I don't think it's suitable. I could possibly... anyway, I guess I'm going to give it a 6... a 6 and a 6. I'm real tempted to go to the 7 route, but... here let me think about this for a second. I guess I'm going to go with a 6 and a 6 for the actual offset landing task, although, again, I have a real feeling that maybe that's a little bit inflated, I'm trying to balance off the fact that, you know, just looking at this... we'll go with a 6 and a 6. For the glideslope tracking task, we'll go with a 3 in pitch, and a 4 in lateral directional.

Okay, this is a additional comment on [4069], after further consideration, I guess it was just kind of grating on my mind about rating it a 6 and a 6, and I think I'm going to go ahead and answer... I'll split the axis up, and answer, is it adequate performance obtainable with a tolerable work load? And say no, and I think I'm going to go in and give it a 7 in the lateral directional axis, and then answer yes to that for pitch, and come up and give it a 5 for pitch. One thing that I noted, and we've done the takeoff since we've done this, done the offset landing task, one thing I noted is that, during the takeoff, I just played with the pitch once we were airborne... the roll, once we were airborne, and the performance you get really doesn't seem to be too bad as in the performance out the window, it's just hard for the pilot to really be able to do it comfortably, because he's getting banged around, and I guess that really shakes my confidence in my ability to ensure that I make the airplane go where I want it to go, so, anyway, so, we changed the ratings to a 5 in pitch, or in longitudinal axis, and a 7 in roll and directional. On the takeoff, and I think this is a simulator limitation, we did a very slow rotation rate, and did the takeoff. On the runway, the lateral tracking, getting bounced around, left and right, did complicate the lateral tracking task a little bit, once again, I think it... my perception right now, if we... you know, I think if we had time to look at this in more detailed we could maybe confirm or deny this, but my perception is, is you can probably get the performance from the display, and what you're seeing outside. It's just very disconcerting, it shakes a pilots confidence, because you're getting bounced around so much, but I think the frequency and the magnitude of the hits we're taking laterally, and really having not a whole lot effect on flight path. Now, for again, you know, this is based on tracking the centerline, and then the little bit that I did rolling up and away, you know, for the landing task, when you're talking about just a few feet, even though I think the frequency and magnitude is not really moving the airplane that much, it still may be moving at a few feet, which would be enough to degrade the task performance, but anyway, you know, I think that's something that we need to look into. Again, I'm still not convinced that this would... even if you're not changing performance that much, I'm not so sure that the lurching would be suitable, anyway, but it would be interesting to see how much the performance is really effected by the lurchiness, and how much of it just effects the pilots perception.

#### Second rating of task.

After the go-arounds we came back and did a couple landing tasks, offset landing tasks. On the first one I tried to use a little bit of rudder to bring the nose around, and in retrospect I think that would of probably been okay, and I don't think I would hesitate to do it again, I guess I thought there was a need for some lateral input at the same time, and that may have been that I had a little bank in already, or when I saw the drift, I was trying to kill it with lateral input, and I think that's the point, you know, doing the steady heading sideslip, I could put in rudder and not touch the stick, and no, we wouldn't of been doing, you know, actually can you reset us, so we can actually do a steady heading sideslip, because that's not

what I did, I just made a rudder input. Let me come back and comment on this in a minute. Okay, continuing on, we went back into another run, because I got so mesmerized by how well the airplane held, zero bank, as I put in the sideslip, I didn't do a steady heading sideslip, which didn't answer any of the questions that I had the first time, anyway, the point is, on the first run, I tried to soothe the nose over a little bit to help myself out with runway alignment, and when I did, in order to kill the drift, I went to put the wing down a little bit, and precise bank control for the steady heading sideslip, or for the landing task in particular, I ended up inducing some oscillation. I don't know that I actually coupled up with the airplane, but I definitely could not control the bank precisely, you know, within a degree or two of what I wanted to. Doing the steady heading sideslips out here, again, getting a predictable bank angle, and being able to hold that was difficult for me, and I don't think, even using the ailerons, I don't know that I really got a decent steady heading sideslip on the maneuver that we did the second time trying to come down there. But I did illustrate to myself, or I saw what I wanted to see, and that was that fine bank angle control with this mode on, is more difficult, I think, at least that's my perception right now. And I'd think it would be interesting to look at that in more detail, maybe later on, as you look at the AFC model a little bit more. And again, you know, I'm not going to go back and change any of the ratings that I did for lateral offset, I wanted to go back and look at this, because the go-around seemed okay, and this task seemed rather difficult, there is definitely in my mind a learning curve or a comfort level that changes, and you learn that you're getting bounced around, I guess I'm more tolerant to being bounced around after flying this for about a hour than I was before, and I think that would change the way I would end up rating tasks in that, although I still think that in the actual airplane, I would be a little bit apprehensive bouncing around and seeing some of the perturbations close to the ground, anyway, that's about it. This is just a general comment, you know, I went back and looked at the suggested pilot techniques for the control law, and they do put in a bias at 40 ft, nose down bias, so that the pilot can release some back pressure to make corrections if he over rotates in the flare, but I think we saw some pretty good discrepancies between commanded and actual flight path, with and without the ghosted flight path, actual flight path marker coming up, and my point is, is there were a few times where I really felt like I need the bunt forward on the control stick to readjust my flight path in the flare, so, I really think that, that whole area needs to be looked at, in a little bit more detail.

## **Task 4085 Go-Around, 30 ft (TS OFF)**

Pilot A

Task 4085 Go-Around, 30 ft (TS OFF) 16 Jan 97; Runs 80-83

Okay, the go-arounds were made up from an approach. It's basically CAT III approach, at 30 ft, the... at 50 ft, the init go-around is initiated with slight thrust increase, and then a go-around at 30 ft with a pitch up to a gamma of 12 degrees, and the PIO tendencies in roll did not appear on this particular approach, and the ratings, Cooper Harper lat... lateral directional, I guess we're meeting desired requirements, I give it a 3, and for the pitch, I guess we're going to call this desired performance, or adequate? Okay, well, what is a desired altitude loss? 20 ft, and... okay, so, I'll give it a 4 for the longitudinal.

Pilot B

Task 4085 Go-Around, 30 ft (Tailscape Off) 07 Jan 97; Runs 84-87

In summary we have four data runs, we have one tailstrike on the third run, the problem is a technique sensitive one, it's tied in with the aggressiveness that is used in the go-around. If you get real aggressive, particularly about the time the velocity vector goes through the horizon, or slightly thereafter. It's really easy to get a tailstrike, if you keep the pitch rate at a moderate level, and can semi-gently pull the nose up, desired performance is achievable. I think you are going to have a problem in terms of the training issue, in terms of the certification issue here with getting this through. I think the tailstrike indicator would have been helpful here. I am not sure if it would have prevented the tailstrike in the third run, but it certainly would have been useful in terms of feedback. Okay, I'll give this a CHR, longitudinally and lateral directionally with the caveat, I was able to get desired performance, but I am working pretty hard to do it. Longitudinal; it's controllable, adequate, I think the deficiencies were an improvement, and I think it safe to say that desired compensation requires, hang on, I think it's more like adequate performance requires considerable pilot compensation, HQR5. Lateral directional is not much of a problem here, it's desirable adequate, satisfactory, minimal pilot compensation required, HQR3. That concludes my comments.

Pilot C

Task 4085 Go-Around, 30 ft (Tailscape Indicator Off) 14 Jan 97; Runs 113-115

Okay, certainly got...for lateral-directional certainly got adequate performance, tolerable pilot work load, satisfactory without improvement for the lat-dir, yeah, didn't see any problem there in improvement, not required, probably give that a 3. I did see a little more action in roll that I needed this time because I was trying to line up a little more, the 50 ft mark, I just was breaking out and never had time to put in a correction for line up, this time I did, and I saw a little more roll action, but it was not a problem, I don't think, nothing that upset me, and minimal pilot compensation, desired performance a 3 on the lat-dir, and the pitch, satisfactory without improvement, yeah, this is probably one of those things that automation could help quite a bit in consistency, if nothing else, but for what I had, flying it like I was, satisfactory without improvement, I'd say a yes, improvement not required and that would be another 3. So, I'd give that 3 and 3, just in the side, one of the things, and it's a sinism, I know, is that the TOGA button is in a awkward position, so, to go from autothrottle disengage and then still have to reach around, and you are close to the ground and you had

been planning on landing all this time, supposedly, it kind of aggravated the situation and I tried not to rate the position of the TOGA button, but if I were, I wouldn't give it very high marks, but as far as the go-around and ability to keep from exceeding my pitch attitude and so on, there was...I didn't see any problem with that...felt fine, okay. A lot of times when you hit the TOGA button, why that will put the throttles in for you, if it doesn't raise the nose, it certainly doesn't hurt anything to do that, and likely something to do with the throttles would have helped that considerably, because at the same time, I'm trying to push the throttles forward, I've just pushed one button, now I've reached for another one, and then to bring the nose up, so, a little more automation on that probably. I suspect in those winds, that probably...or those conditions, likely the airplane is going to be on autopilot anyway, so, it's just a matter of a good autopilot go-around, but handflying it like that, it certainly was doable as I saw, and while I may of...this is a little contrived a task, because we're starting out with the idea of going around, and that is a long ways from planning to land and at 30 ft, seeing a fuel truck or something to miss, so, but for the task that I had, you know, that's what we've got, so, that's what we'll rate, it's okay.

#### Pilot D

Task 4085 Go-Around, 30 ft (Tailscape Indicator Off) 24 Jan 97; Runs 21-22

Ditto on the comments on the go around at 50 feet. It's just pretty much an open loop maneuver. The additional comment here though is that the performance seems to be just way too sensitive to the flare profile. If I overflare a little bit we make it and a little late on flare, we don't make it. I think from an operational stand point it is just not acceptable. We give it, longitudinal, a seven and no additional problems lateral, give it a four.

#### Pilot E

Task 4085A Go-Around, 30 ft (Tailscape indicator off) 09 Jan 97; Runs 99-102

Okay, this is very similar to the 4085 with tailscape indicator. The last run I did, run No. 98 on the previous card really set me up to be very cognizant of tailscape. These three runs, I think 100 and 102 were a little more representative. You'll notice that probably you'll see a reduction in pitch rate as the waterline moves up towards the target gamma reference marker of 12 degrees, and this is kind of my way of insuring I don't scrape the tail until I have some ground clearance. The comments are pretty much the same and the ratings are going to be the same between these two tasks, the fact that I am aware of the tailscape problem is definitely effecting my performance as far as once I have broken my initial sink rate, I do tend to slow down on my pitch rate as I approach a waterline of about 12 degrees beta to ensure proper ground clearance. So, for longitudinal, again I met the adequate parameter for altitude loss of between 20 and 30 feet and probably I think I could do that very consistently. So, there is a learning curve over the previous test card without the tailscape angle, so in fact, based on the learning curve, my longitudinal ratings are probably going to improve. Anyway, for longitudinal Cooper Harper, it was controllable, adequate performance was obtainable, satisfactory without improvement, I would rate this a 5 and I think the difference between this rating and the previous rating is a lot of learning curve and so I think I'm actually finding this task a little bit better. For lateral, is it controllable? Yes, adequate? Yes, satisfactory? Yes, Cooper Harper of 3, again it's not really much of a lateral effort on this task. I do think that this is a very good test card and I think that this would warrant some further investigation because I think we do have a real potential to get a geometry strike on this maneuver.

Pilot F

Task 4085 Go-Around, 30 ft (Tailscape Indicator Off) 22 Jan 97; Runs 96-100

Okay, basically for this maneuver we were getting back in and retrospect that I probably should have ran a few more practice runs before we started taking data just to kind of get back into the scheme of things. One thing that I noted on the first few runs, is the same thing that I commented on before, is during the transition around the 200 ft level, you tend to almost actually, my perception is, is that left to it's own devices, it will start getting a little bit low on glideslope, and you put in a correction to correct back to glideslope. This is just a real slight tendency for the airplane to settle low, and then about the time that you're trying to reestablish the 3 degree glide path to get this big balloon, which you only see initially in the glidepath, and the airplane going high in glidepath, and at that point when you push over after a decrement of time, you get a split command and actual flight path vector cue, and then it's obvious that the airplanes ballooning. So, after a couple runs I started anticipating that, and flying that a little bit more tightly. I missed... after having done this with the tailstrike indicator, I really missed not having that kind of as just a guide so that I knew I was okay, and I think I was having the tendency not to really rotate at the rate that I really normally would in that situation. The other thing is, is on the first few of those runs, because of the balloon and then we were correcting back, we came in a fair amount steeper, I think, than what we would have if would have been in a nominal 3 degree glide path. I think initially getting back in and being told that my flare rate was not what it normally would have been, if I was trying to land the airplane there until it was a little bit slow. Had we landed it, I think we would of had hard landing. So anyway, towards the end we did get desired performance on the first few runs, I think we kind of covered what we saw. I'll go ahead and rate the task, is it controllable? Yes, adequate performance obtainable with tolerable work load, yes, is it satisfactory without improvement? I guess I'm going to say yes, because there was really nothing to me to indicate that we really had to be concerned about hitting the tail here, in that you could use a pretty aggressive rate, and so I guess, I'd give it a 3. Although, again, having started with that indicator up there, I kind of felt, it kind of gave me a warm fuzzy feeling that I could rotate at a pretty good rate, and not worry about hitting anything. The other thing to note, two separate from this, and I'll do that for lateral and longitudinal both, the... just to show that my normal flare rate probably wasn't appropriate, using the flare rate and then transitioning to the go-around, we touchdown fairly firm, and got the over G indication a couple times, and again I think that was part of just getting back in and kind of getting used to the flare again, I don't think I... I think I was coming in steep and not really doing a sufficient flare like I would if I was really trying to land, so, I think that might of skewed the data a little bit on the first couple of runs. One more comment on the Cooper Harper, I guess, you know, I'm kind of disregarding the fact that... I'm going to stick with a 3, I'm not going to change the rating, but I guess I think it's important to note that at least in my mind, because geometry strikes are a factor here, I would be a lot more comfortable doing the task with the indicator, I think the indicator could be optimized more than it is, but I would still be more comfortable doing it with the indicator, and that probably, I don't know if it's really reflected in the rating that I gave it or not, but it does have an impact on the task.

## **Task 4085 Go-Around, 30 ft (TS ON)**

Pilot A

Task 4085 Go-Around, 30 ft (TS ON) 16 Jan 97; Runs 86-89

Okay, the tailscape indicator, I don't believe I ever saw. You may... I think I saw it out of the peripheral view, but my attention was diverted to the flight gamma indicator, and during the approach, concentrating on holding the glideslope when the flare started, disengaged the autothrottle, and start pitching the airplane up, typically the gamma gets to about two degrees at 30 ft, and the thrust is coming up a couple knob widths to provide some flare. If this is all performed per normal... normal requirements, then a go-around is an issue, even at 30 ft, and I think typically we lose about 20 ft, and plus or minus, and then the next area of attention is to get the gamma positive, so the gear can come up, and at that point, I'm not really looking at the tailscape indicator, so by the time I need to look at a tailscape indicator, it's too late. So, I never really saw it, or used it at all, and I don't think it appeared in some of our runs for some reason, and on occasion, we did touch down, because of fixation on various things, and improper timing on getting thrust up and starting the flare, and so at 30 ft, when we started a go-around, we had a large vertical speed that resulted in a touchdown. Cooper Harper wise, lateral directional, I'll give it a 3, and longitudinally, what are we going to call this? Adequate or desired performance? I think nominally, when there's a proper profile, it appears as though we're getting desired, off and on, and half and half approximately, what do you think, are you saying, are you recording the data there. Yeah, the three of the four data runs, you had desired performance, one of the runs we had a gear touchdown, and that one you said you were distracted on, because you were talking about the flight com position. Yeah, so I think that I can give it a 3, there's nothing really... we're looking at the longitudinal control... the characteristics in the longitudinal axis, and so, I don't think there's anything really in that axis that would create a problem in a go-around, as far as, as far as I... that is concerned, except that the... in a go-around, it is critical that you do have some thrust, and you can start the flare, so that at the proper time, so that the rate of descent is not excessive. If that is excessive, then you're going to touchdown, so, given the fact that you add thrust, you start flaring, and then you go around at 30 ft, then there's no problem performing this within desired standards. We were getting on occasion where... on the occasions where we didn't get the thrust up quite quick enough, and a lot of elevator was required, we were maxing out the elevator travel, but when the thrust was applied, early... early on for the flare, and the nose brought up normally, we're getting half to two thirds elevator travel, roughly.

Pilot B

Task 4085B Go-Around, 30 ft (Tailscape Indicator On) 07 Jan 97; Runs 84-87

Okay, just as a caveat, if you had ask me to rate the longitudinal CHR during the approach phase with plus or minus a half a dot, I would have given you a real degraded rating , because this was a...basically a raw data approach down to well below cat 1 minimums. You didn't ask me that so I won't give it to you, but, just so that you'll know there's a lot of workload down low this with respect to both longitudinal and lateral direction in terms of maintaining flight path and localizer without the use of a flight director. For the go- around itself, the basis was to evaluate the ability to go-around from low altitude without contacting runway and a minimum of airspeed loss. I think that was doable, with some attention to the technique. There is no ....naw there is a...there's a limited tendency for PIO that I saw in some of the practices, I didn't see it in the data runs. There was a geometry strike in the 3rd



of 4 runs. That was when I was real aggressive with the elevator getting a pitch attitude up. When I relaxed that a bit I didn't have a problem with it. Longitudinal, it's controllable, for the most part, it's adequate, in that I can get adequate performance, say HQR6 longitudinally....requires extensive compensation. Lateral directional it's controllable, it's adequate, and I'm working pretty hard in lateral axis, I'm going to say it's desired performance requires moderate pilot compensation, give it an HQR4. It's just that I'm working so hard in longitudinal that the lateral directional degrades a bit until it gets some...until I get some bank angle, then I have to go back and correct for that. There were a couple of times when I found myself recorrecting . So, I'm working lateral directionally as well. That concludes my comments.

#### Pilot C

Task 4085 Go-Around, 30 ft (Tailscape Indicator On) 14 Jan 97; Runs 117-119

Okay, first off, lat-dir was it's usual non-problem, so, leave that at 3 that I had before, no change on that and in the pitch. You only got to hit the tail once, you don't have to...two out of three times is not really that good, the fact that the tailstrike marker was there or not obviously didn't make any difference to me because I managed to hit it, and on the other times, I was more focused in not touching the tires down than I was in pitch attitude and was focused so on the flight path marker, to tell you the truth, the tailstrike marker and waterline combination wasn't in my cross check at that point. It certainly should have been on that one, and I should accept the touchdown before I'd accept a tailstrike, but I didn't, so, I have to go with what I saw, and as a result I would have to, I don't know how I can do anything but adequate performance obtainable with a tolerable work load because I did hit it and, so, it would take considerable pilot compensation and 8 is required for control, because that's certainly exceeding a limitation of the airplane. It's interesting all of the times that it did successfully go, I had desired performance and everything, but the fact that I did get one strike is of importance. Some other variables now, whether it's in there or whatever, could very well be the last correction I was making, in other words, if I was making a correction down and had just started the flare and so on, I could have a pretty good H dot before I rotated, and that could make the difference, so the last correction I had to make could have been in there, but for whatever reason, I can't just disregard the fact that I did have a tailstrike and so, that's why I gave it an 8. Another little side point without the tailstrike thing, I must have been pretty close to the attitude to get a tailstrike, but didn't...if you don't get it, you don't realize it, it's a cliff that you don't see, in any case, going around from 30 ft with this airplane, is a good trick, not touch the wheels and not touch the tail and whether...no matter what your indications are apparently, and so, yeah, I got your Cooper Harpers there, 3, lat-dir, and 8 in longitudinal, and that's because of the tailstrike I got.

#### Pilot D

Task 4085 Go-Around, 30 ft (Tailscape Indicator On) 24 Jan 97; Runs 25-28

Okay we had the tailstrike indicator to help this time. I think it definitely is an aid. At least on one there, I actually had to push forward to avoid striking the tail and it did keep us from striking the tail. We made it, but the performance of the ... the bar really does help, but if you have a late flare, you know, you just can't change the physics of the airplane and you are still going to get a tail strike. I think a reliable go around from 30 feet is just not possible. It looks like it is just way too sensitive to what part of the flare you are in, your sink rate is at the time of the go around initialization. Another comment, I don't like changing the reference from the flight path, up to the waterline and then back to the flight path. Same problem, I

was having during the takeoff. Maybe I didn't really characterize that well enough on the takeoff but I think that is a problem where flight path, waterline, back to flight path, for your guidance reference (is used). At any case the pilot ratings are seven and four.

#### Pilot E

Task 4085 Go-Around, 30 ft (Tailscape indicator on) 09 Jan 97; Runs 93-98

This task I think is very illuminating to me in any rate, we had... well, the first run, run No. 93 we had a tailstrike which probably should have been a practice run and that is my mistake, and I wanted to go right into the data to keep moving, but basically using my same aggressive techniques from my 50 ft go-around and just drove the tail right into the ground, so I can throw 93 out. 94 we had a main gear touchdown, 95 was a pretty good run, with a 22 1/2 ft altitude loss. That was just a nice... I started to flare... a nice controlled go-around power application and nose pitch up. No. 96 we had main gear touchdown also and don't recall much about that. 97 we did a little bit of the late go-around call and got a tailstrike, what was interesting is that until that run 97, I wasn't paying as much attention to the waterline and the tailscape warning bar. Run 98 which I think is a very good run to look at, I did pay a lot of attention to that and if you all want to look at the data on that one more closely, you'll see that I started the go-around and saw a pretty rapid pitch rate increase of the waterline up towards the tailscape bar and actually had to stop my rotation rate until we got some altitude then continue. So you'll see on the strip chart or on the data stream, you'll see an actual, probably a forward application of elevator to stop my pitch up rate. What this tells me is that this task is very susceptible to a tailscape with the current geometry of the aircraft and certainly it's something that would probably warrant closer scrutiny. As far as the Cooper Harper ratings, the longitudinal Cooper Harper where I'm looking at is overshoot of target flightpath which is not a problem, altitude loss would pretty much always exceeded 20 ft and no PIO and the one... both geometry strikes were really not the fault of the aircraft pilot/system. one was just an incorrect technique and the other was incorrect pilot not flying technique. It was probably incorrect pilot technique also, but at any rate this task does show a real danger, a real kind of a cliff here where you could get a tailstrike pretty easily I think. Another thing I want to point out is that, interesting when this is done properly, the same aggregate altitude loss occurs from 50 ft to the ground with this technique as with the max rate technique on the 50 ft go-around minimal altitude loss. In other words you would start the flare and then you would do a general or fairly controlled go-around of 30 ft and you could probably, if done right, you could probably lose around the same amounts of altitudes if you start with a very aggressive go-around at 50 ft, so that may be interesting to look at in the future. At any rate, the longitudinal Cooper Harper looks like adequate performance was obtained, so it was controllable, adequate performance was obtainable with a tolerable pilot work load, is it satisfactory without improvement? No, the criteria is no more than 30 ft altitude loss and you start at 30 ft and the runways 30 ft below, there's no way you could ever get inadequate on this. However, I'm going to rate this a 6 because I think, I think the task is real borderline where you could get into some trouble with tailstrike or obviously main gear touchdown which would indicate and exceedance of the 30 ft limit... So, you're really borderline adequate, inadequate for several of my runs. For lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a 3 and no real problems laterally.

#### Pilot F

Task 4085 Go-Around, 30 ft (Tailscape Indicator On) 22 Jan 97; Runs 70-72

Okay, first comment about the approach phase, on this approach, and I don't know if it is just because it's instrument and I notice it more... or, but it seems distinctly getting it from the other runs on the glide path with the flap extension and the ballooning. What is happening, is about around 300 ft I guess somewhere, I see the glideslope, I started to go above glideslope, at that point the command in the actual flight path markers have not spread, I only have the commanded shown, and I have to start pushing the commanded below the three degree line and then at some point after that, I get the split in the command and the actual, and then I correct back to glide path. A couple comments about this, I guess... in thinking about this a little bit more, you know why, certainly if I can't get the performance that I'm demanding, I should have some gamma control system. I think it's probably appropriate that I have some indication that I'm not getting that performance, but for normal maneuvers, like just a automatic flap extension on the airplane, I guess I kind of think that I should not see any difference between commanded and actual and not see this ballooning, and I realize that, that would require a fair amount more refinement on the flight control system, but I guess one could take the point of view that if I set 3 degree gamma, in the airplane, and I don't command anything else, I'm not causing the airplane to exceed it, and then environmental conditions aren't causing the airplane, not to be able to meet that gamma, in steady state flight, as the airplane uses its flight controls systems, and secondary flight control systems, to maneuver the airplane, I probably really shouldn't be getting something away from that command, and I guess I'm looking at this philosophically from using a command, a gamma control based system, and a gamma control based HUD display. Anyway, I'm not saying that it has to be that way, I'm just saying that I think we need to look at that and make sure that we're philosophically consistent, with how we're doing this. The other thing is the tailstrike indicator and I realize that we're trying to be consistent with the takeoff, I agree that on a takeoff the airplane... the pilot rotates the pitch attitude of the airplane, and that's what he does, and that's what it should show, and I would be opposed to having a gamma that sits on the horizon, that is not meaningful, well, if it's set on the horizon, I guess it would be okay, I guess what I'm saying is, I think there's a lot of value in rotating the airplane to a pitch attitude to the takeoff, and I'm not so sure that I would want to go to a gamma based rotation on takeoff. I'm not so sure though that it wouldn't be appropriate to have two kinds of tailstrike indicators here, one for the gamma, and one for the waterline, or something like that, you do have a pretty big split, the pilot, for the approach phase, and the landing phase is using the gamma, simple, with this gamma based flight control, probably to control the airplane. I expected you probably are going to have a gamma based flight director on here, and unless... I guess... having said all of that, in ten words or less, here's the issue, my task during the go-around is to rotate the gamma symbol to twelve degrees, but my limit, is that I have to respect the tailstrike indicator, is based on the waterline, which is not what my task is, and I'm wondering if maybe we should have tailstrike limitation being also respected to the flight path vector. To rate it, it's controllable, it's adequate with tolerable pilot work load, it's satisfactory without improvement, although I do think there is some display issues that need to be discussed, so I'm going to kind of take the display out, and just rate the flying qualities, I guess of the task, if you will. Anyway, well, I guess we realized the display is not necessarily the final form, but I guess the display does impact the task, I'm going to go in and give it a 3, I guess. I'm going to give a 3 because of the display, and this is also a high gain task, where I'm trying to set a gamma, I have to respect a pitch attitude limitation, and we're all very close to the ground, trying to get everything to come together. Anyway, and I'll do that for lateral and pitch together. So, it will be a 3 and a 3.

## **Task 4086 Go-Around, 50 ft (ASE OFF, TS ON)**

Pilot A

Task 4086 Go-Around, 50 ft (ASE OFF, TS ON) 16 Jan 97; Runs 74-76

The go-around seemed to fairly consistent and straight forward. Very consistent performance, with a maximum... the elevator required is close to the maximum, I think this probably comes in initial pull, to check the rate of descent. Cooper Harper wise, the lateral directional task, or the rating, I would give a 3, and the longitudinal Cooper Harper would, I think, be a... Let's take a look at the Cooper Harper definitions. It looks like... I believe I'd give a 3 for Cooper Harper. There's some breakout of the actual versus commanded gamma, especially when zeroing in on the target climb angle, there's about a one to two degree split at that point, and it appears to be due to the acceleration with full thrust. On the go-arounds we've been using maximum thrust, and manually set, and so the airplane has continued to accelerate all through the go-around maneuver, and is actually accelerating at 12 degrees of gamma.

Pilot B

Task 4086 Go-Around, 50 ft (ASE OFF, TS ON) 07 Jan 97; Runs 79-82 and 10 Jan 97; Runs 14-15

Okay, for this task I was consistently getting altitude losses in excess of 30 ft, in fact there's a band of about 2 ft between 34 and about 36 ft or so that I was getting on each of the runs. Despite immediate go-arounds at 50 ft, immediate TOGA press, relatively quick gear retraction. It's not a handling quality issue, it's a performance issue. I was pegging the elevator as well at 30 degrees on the indicator. So, I think just in terms of the technique I was using, I was not...the airplane was not capable of achieving the performance it was specified for adequate. In terms of other parameters, over shooting the target flight path all that was desired, bank angle control was desired, no PIO's, no geometry strikes, although we got reasonably close on the tail about 4 ft. as I soften the pin out. But the only problem was the inability longitudinally to achieve the altitude loss required. So let's rate the lateral directional first, it was controllable, adequate, and satisfactory, this is another where I would like to give a half rating but I can't, and I'm going to give it the benefit of a doubt and give it a 2, pilot compensation largely not a factor in lateral directional. Longitudinal was the issue, it was controllable, however, I could not achieve adequate performance. Controllability was not in question. So, I'm limited in terms of the HQ that I can give on it. So HQR7, adequate performance not attainable with maximum pilot...tolerable pilot compensation controllability not in question. Again, I don't think that the imposition of maximum altitude loss is an appropriate metric for an HQR. I think you are looking at aircraft performance not a handling quality criteria. That's the caveat I would give to it. I did not feel that there is any handling quality issues here. I did not appear to be in rate limiting. I did not have a problem setting the pitch attitude, it just that I could not get the altitude loss within in the tolerable specified range. That concludes my comments.

Pilot B repeated this maneuver on 10 January 1997, after the card was modified to ignore the altitude loss metric:

This is a repeat of the one we did the other day, ignoring the altitude loss metric, which in this case was probably better than, certainly better than the worst that we saw the other day, in any case, we're ignoring that, desired performance obtained other than that, with relatively

minor work load, both longitudinally and lateral directionally, so, I think we're back in the level 1 territory again. It's controllable, adequate, satisfactory, minimal pilot compensation, HQR3, and that's the case for both longitudinal and lateral directional, so, in summary, 3 and 3.

#### Pilot C

Task 4086 Go-Around, 50 ft 14 Jan 97; Runs 108-110

Got adequate performance, tolerable pilot work load, satisfactory without improvement, yeah, I would say yes, improvement not required, minimal pilot compensation required for desired performance. It's a fairly high anxiety level because of suddenly seeing the runway, and having to go around like that, is kind of a tough position to be in, but if you talk about the compensation it takes as far as handling qualities and so on go, then it really wasn't that much compensation. It's just there is a fair amount of learning curve, if I were doing this again, I think my practice ones, I'd like at least one of them without the weather in there, so, I could just see what the performance and what it takes to keep from touching down would have been a little bit easier than seeing it for the first time with the cloud there, and of course after you see it once, and you know how quickly you have to move the nose up to keep it from touching and so on, a lot of the problem goes away then. As far as the segment one, it looks like our left drift was very, very slight out of trim in the rudder, and if it's that sensitive, then there should be a big indication of rudder trim, because that made quite a difference between those runs, so, that's a little side comment, but in general, the ILS was the same as it always has been and will be as long as we don't change anything, 2 and 2 for the segment...or the go-around part, I guess that's still segment two, whatever you want to call it, than I would give probably the lat-dir a 2, I did not have any problem holding a bank angle at all, and the pitch just did require some compensation, so, it's a 3. So, longitudinal 3, and lat-dir 2, if you put it in the order you've written it there, I guess.

#### Pilot D

Task 4086 Go-Around, 50 ft 24 Jan 97; Runs 15-17

That's really a pretty easy task. It's like ... just a pull and go, with the exception of trying to find the go around button. I was using the technique of disconnecting the autothrottles as I was advancing the throttles to 100 per cent, then groping for the go around button. Sometimes that would cause a little bit of a pause in my pitch rate but still we had a good positive rate of climb going by that time. Other than that it was just a pretty straight forward task, very easy. Very easy except the inceptors were kind of a bear. So longitudinal, because of the throttles, I'll give it a four and lateral, I'll give it a four because of a tendency to PIO and the loose roll characteristics.

#### Pilot E

Task 4086 Go-Around, 50 ft 09 Jan 97; Runs 89-92

Okay, for this one the main thing we're seeing is that I was unable to meet even the adequate minimal altitude loss. The last two of the four runs I did, runs 91 and 92, I basically, as soon as I heard the go-around call, I as rapidly as possible went to full aft stick, only limited by the actual damping and velocity gradient characteristics of the MacFaden. I was as aggressive as I could possibly be, and I got pretty... what I thought was pretty good response from the flightpath of the aircraft, nevertheless, we lost an average of around, the

best we did was 35 feet, but the average was around 40 feet or so with altitude loss. Let's see, as far as the performance standards, it's pretty easy to meet the target flightpath, I think within the seven seconds especially there is no problem. It's very easy to close on that. Altitude loss, we did not meet the adequate requirements of less than 30 feet. Bank angle control was similarly not bad, mostly was around 2 or so. Pilot induced oscillations, none noted and no geometry strikes. For the longitudinal Cooper Harper, it was controllable, adequate performance was obtainable, satisfactory without improvement, actually I take that back, let's see, for longitudinal, I guess that would include the altitude loss. So... we do that, controllable? Yes, adequate performance is not obtainable, adequate performance is not obtainable with maximum tolerable pilot compensation, controllability not in question. That's a Cooper Harper 7 descriptor and I think that adequately sums it up, the... it looks like the best you can do... at least the best I can do is around 35 feet so that makes it a Cooper Harper 7. For lateral directional all the criteria were desired as far as, really all you're looking at is a max spec... max bank angle and PIO. So, for lateral directional, controllable? Yes, adequate performances obtainable? Yes, satisfactory without improvement? Yes, Cooper Harper of 3. You get up to... when you're making that huge longitudinal input with the way the MacFaden is set up, the harmony is very good, we do have to be careful that you don't end up getting a slight bank angle, so there is certain amount of compensation required for that, so a 7 and a 3 for the Cooper Harpers.

Pilot E flew this task again, ignoring the altitude loss metric, and awarded it a 3 longitudinal. His comments regarding the new task definition are found above in Task 4085.

Pilot E

Task 4086 Go-Around, 50 ft 29 Jan 97; Runs 16-18

Pilot E flew this task previously, in which a minimum altitude loss metric was included, and awarded it a 3 longitudinal. His comments regarding the original task definition are found above.

The task was changed from how I flew it the first time, so we redid it, basically, the minimum altitude loss requirement was deleted for the rating. We just didn't want to touch down, I was going down to between 5 and 10 ft, basically with the 50 ft call for the go-around, and maybe a moderately aggressive pull, I was trying to fly that seven seconds that Dave Rainey suggested to the... suggested 12 degree gamma of climbout reference mark. Basically, I met the desired criteria, which was don't touch down, and don't have a tailstrike, and capture the 12 degree gamma fly out path without... with less than 2 degree overshoot, which I've did, and having bank angle control of less than plus or minus 5 degrees, and it was probably plus or minus 1 degree. So, therefore desired criteria were met both longitudinally and laterally. For the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, for a Cooper Harper of 3 due to work load, and the work load, is basically you have to really kind of be careful when you start your initial pull, and kind of play that pull to not meet the tail strike bar with the waterline marker. For the lateral directional, no real problems on that, controllable? Yes, adequate? Yes, satisfactory? Yes, for a 3. Didn't notice any PIO problems or any difficulties. If you're having to hold, having to work in a lateral axis because of the light turbulence, but there is no coupling with the rapid pitch rate onset, or with power onset, power came in symmetrically, and no... any beta effects, or corresponding lateral upsets.

Pilot F

Task 4086 Go-Around, 50 ft 22 Jan 97; Runs 66-67

Let's see, basically, I don't think this task is real difficult. One thing that I did notice is, just the way the go-around buttons and the throttles are, it's kind of awkward giving the throttles up to getting the TOGA button pushed, but anyway, just to rate the task, it's controllable, adequate performance with a tolerable work load, is yes, is it satisfactory without improvement? I'd say yes, and then going into the parameters her, except for the throttles in that, I think it's a pretty reasonable maneuver, I'd probably give it a 2 in pitch and a 2 in roll. That's basically it. One thing to note to, is I think I probably jumped the gun on both the data runs instead of the go-around just slightly, try to go around right at 50 ft, again with the display, it's taking a fair amount of effort for me to really read the digits just because there not as crisp and clear as they might be.

Pilot F

Task 4086 Go-Around at 50' AGL (ASE On) 24 Jan 97; Run 93

Surprisingly, you know, I think that I'm kind of getting used to the bouncing around with the ASE model, you know, I may be missing something, but the go-around just didn't really seem that difficult, although, it's mainly a pitch task. But it's still disconcerting, though, bouncing and lurching around that you get on final. But as far as actually being able to control the airplane and make it do what you want to do, for that particular task, it really wasn't too bad, but again, you know, we're not really doing too much lateral maneuvering. We are going to go back and look at the offset landing tasks, hopefully just to kind of look at the delta between those two, but is it controllable? Yes, is it adequate performance obtainable with a tolerable pilot work load? The answer for the go-around task is yes, is it satisfactory without improvement? And I'm not going to consider ride quality issues. For that particular task, it wouldn't have been the most comforting thing in the world, and if you turned up the turbulence level, it might become very uncomfortable very quickly, but really, I don't know that the AFC really affected task performance that much, or required much additional work load or pilot compensation to do the task, so, I'm going to answer yes, that it's satisfactory without improvement there, not that, you know, again, flying around and this lurch bobbling, banging mode is not really comfortable, but it didn't really effect the... didn't seem, my perception was, it didn't really effect the flight performance parameters that much. So I'm going to go in, and I'm going to give it a 3 in pitch, and 3 laterally and directionally, and again, you know, that's not to say that I'd want to fly around, or that I think it would be suitable to fly around like that all the time, but for this particular task, just looking at it without any upsets, turbulence wind sheer, you know, any of that other stuff, it really wasn't all that much different from the normal go-around was. (Special Task not crossreferenced.)

## **Task 4093 Crosswind Landing - 25 kt (Procedure A)**

Pilot A

Task 4093 Crosswind Landing - 25 kt (Procedure A) 16 Jan 97; Runs 11-13 (forward slip technique), 16-20 (decrab technique)

This is run number 20, and crosswinds using a decrab, but once again, each run seems to encounter, I seem to encounter a tendency to PIO, especially it seems to be onset triggered by the decrab maneuver, and it's extremely difficult to stop the PIO. Part of the... I attempted on several runs to just release the aileron, and to stop the PIO and make minor corrections, however, that doesn't work very good, because you're really into very precise flare and pitch, and so it's difficult to separate out the two, so, even if the PIO is successfully avoided, than the hard landings are often the result, because of the attention required for the PIO. As far as the Cooper Harper ratings for down to 200 ft; pitch I can give a 2, and lateral directional a 3, and below 200 ft, lateral directional, I guess, is it controllable, and I'd say no, it's a 10, and during... as far as lateral. As far as longitudinal is concerned; adequate performance is obtainable with pilot tolerable work load? no, and I'd give it a 8, I guess, but it's... well, let me back off on that. I'll give it a 7. We've compared the two types of crosswind techniques, and the last minute rudder kick is probably the more difficult and the more likely to be inducing lateral PIO's for that reason, I would prefer the wing down technique that, and I'd prefer to start at somewhere around a 100 ft. The... better than 200 ft... the... usually in the kicking out the rudder, or the... crab, decrab, using the last minute decrab, it seemed as though better results are obtained if just a very small portion of the crab angle is kicked out, say to leave about 4 to 5 degrees of crab remaining at touchdown, that seems to work best, if you try to eliminate all of the crab, touchdown perfectly aligned with centerline, that produces so much excess drag, it takes almost maximum thrust to arrest you're rate of descent at the very last minute, and the engine response times are critical, and at the same time, we were making a very large thrust change, and trying to precisely flare, it's kind of a demanding... demanding task. Normally my technique is to use a wing low technique starting at perhaps about, for subsonic airplanes, starting at perhaps 100 ft, or so, and that seems to work out quite nicely.

Pilot B

Task 4093 Crosswind Landing - 25 kt (Procedure A) 07 Jan 97; Runs 64-67

The approach segment, the workload was relatively high. Just coordinating the gust and with the scan particularly when the crosswind was from the right with the velocity vector well on the left hand aft of the display and having to scan across the entire width of the display to see a glide slope. So I'll call that moderately higher than normal. I felt like I was able to get desired performance however, throughout on the approaches. The landing phase, in the landing phase the workload was intense in terms of retaining control. And on the practice runs I often didn't, on the data runs I was able to on all 4 runs, but there's a learning curve associated with it. But I felt like the workload was extremely high. There is a PIO tendency and I think that's due to rate limiting on the lateral control system. It's an association with large rudder inputs down low. I was deliberately reducing my rudder inputs trying to make them as smooth as I could to reduce the requirements for lateral inputs to compensate for the increase CL- Beta in this configuration. And, I was able to do so successfully and keep with an adequate balance. There is no way I was going to get desired performance and do that, however, in terms of touchdown position. Had I sacrificed longitudinal and lateral control to get an adequate touchdown or to get a desired touchdown, I feel like I would have lost probably lateral control in terms of large inputs, so, it would not have fit with the



technique that I was using. And as such, accept adequate performance on all of those. CHR's for the approach, on longitudinal, it's controllable, adequate, and let's call it satisfactory and give it an HQR3, minimum pilot compensation. However, the caveat that the workload was higher than it was without the approach and without the crosswind rudder. Lateral directional, controllable, adequate, and satisfactory, again, HQR3, with the caveat that the workload is a little bit higher. Okay, longitudinal in the landing phase, it's controllable, it's adequate, I was able to get adequate performance and I think adequate performance requires extensive pilot compensation let's call it HQR6. Had I rated this in the practice run It would have been an 8, because I felt like considerable pilot compensation was required for control and at times I lost it. However on the data runs there were a learning curve so I'll upgrade it to a 6. Lateral directional...hey let me back up on that, Dave, because I think what I just gave you was a lateral directional, I was kinda thinking ahead. Let me think about longitudinal for a second. I'm going to change that...longitudinal it's controllable, adequate, satisfactory with moderately objectionable deficiencies, and considerable pilot compensation for longitudinal, give it an HQR5. For lateral directional I'm going to repeat what I just said...it's controllable, adequate, and satisfactory and not satisfactory rather with intense compensation required for adequate performance, give it an HQR6 for lateral directional. And again, had I rated that in the practice runs I would have given it an 8 for lateral directional. Whenever, I had a problem, it was in association with lateral control following a directional input, so I'll say it was CLB, CL beta fit requirement to the lateral control system and whenever I felt a PIO...or pending PIO it felt like a rate limiting situation that I've experienced before. And that concludes my comments nicely.

#### Pilot C

Task 4093 Crosswind Landing - 25 kt (Procedure A) 14 Jan 97; Runs 65-66, 68-69

Okay, I might preference this by saying this isn't my correction of choice in most any airplane, but on the airplanes you have to, that's all you got, what the hey. Anyway, adequate performance with a tolerable pilot work load, in most of the cases I was getting adequate performance, and when I didn't I don't think I was very far out, and also this was very little practice time considering the importance of the timing of the inputs and so on, so, I am going to say that it is adequate performance with a tolerable pilot work load. Satisfactory without improvement, no, I don't think so, they require improvement, and the adequate performance I was getting, the thing is...the work load isn't hard, but the ability to put in the right amount and so on is, which makes it kind of a difficult thing to rate right here, it was certainly never better than adequate performance, and again no better course, and for the longitudinal...due to the difficulty of the lat-dir, the longitudinal kind of got away and so that was...I'm going to give that 5 because I don't think I ever did any better than adequate on it, and it would be considerable pilot compensation in any case, so, 5 for the longitudinal in the second segment and I think I'm going to go with 6 on the lat-dir in the second segment due to the caution that I gave before. It's something that...that's a tough one to learn in a short period of time. For me, I would give it extensive pilot compensation, so a 6 for the lat-dir. As far as the segment one, there isn't any difference, if you look at the data, and you see me off, it's because I either wasn't paying enough attention to it or quite often I was purposely putting the...going a little low on the glideslope in order to get the touchdown performance longitudinally as best that I could, and there's no changes, I couldn't see any difference between actually keeping it right on the glideslope and on the localizer from the last one, so, that again is the usual 2 and 2. Okay yeah, this is an interesting, which one do I prefer between the two procedures, well, if we took the handling qualities cliff out of there I would have preferred the wing low, but with that in there, that's completely negates using that as far as I'm concerned, so, to go to 35 knots, I would do it with the Procedure B, I think it was

just kicking it straight, and as I said it was the PIO that could come in there with the bank angle and I never saw any tendency to PIO with the rudder that I could see, they all looked pretty benign, it had enough authority, this is kind of tricky because you're sitting so far ahead that if you put your...while your still in the crab, if you put yourself over the center of the runway, centerline of the runway, and then you kick it straight you actually translate what amounts to down wind, and you are now almost out of the box, because of how the airplane rotates, if you see what I mean. So, I noticed that more on the second two when the crosswind was from the right and I did from the left, but I don't know, there might have just been a coincidence, but I did notice a couple of times I had to purposely put myself on the upwind edge of the runway before I kicked it out because if I just...and by myself I guess it may not be myself, but that's the way it looked, and that was a little disconcerting and then when I...then if you do that...and then when you push, you see, that brings you back to the centerline where you want to be, so, that's all learned stuff, there's nothing you can put in flight controls that I know of that would take that out of there, so, that's pretty much what I saw that time. So, when we get ready to do the big one, it will be the rudder only.

#### Pilot D

Task 4093 Crosswind Landing - 25 kt (Procedure A) 23 Jan 97; Runs 66-68

Okay, very difficult task, it took me a lot of practice to be able to get it into the adequate box, got a couple wing tips to start out with, because of rolling out coupling. I personally don't recommend this task, it's not my normal task, and that maybe part of it, but the reason it's not my normal task, is that I never have felt that the very dynamic character of a decrab at low altitude is a good thing to be doing, some airplanes you have to though, as in our DC8. Okay, I think... let's just go ahead and give us a pilot ratings for the glideslope, essentially no different than before. The display makes it very easy to compensate for the crosswind, in fact, you hardly even notice it's there, so it would be a 4 and a 4 again, just due to the same reasons as previous. Landing, both the longitudinal and lateral, I'm going to give them sixes (6), I was working very hard at both axis to get into adequate performance, and I think there is a very high probability of missing that adequate box if we, you know, made a series of ten runs.

#### Pilot E

Task 4093 Crosswind Landing - 25 kt (Procedure A) 08 Jan 97; Runs 100-104

Okay, the evaluation segment for the up and away glideslope and localizer intercept at 200 ft, that's basically... most of these approaches are hands off until around 500 ft. The... editorial comment, I'm not sure we really need to have the tapering crosswind as far as learning anything from that, I don't think we gain much, it just seems from the videos I didn't even touch the side stick until most of the time until around 500 ft. So, I don't think it's much to be gained from having a crosswind taper from 35 to 25 for future assessments we want to save some time. There is no problem with glideslope or localizer in the steady crosswind, you need one to taper almost hands off it almost tracks the localizer pretty well, usually around 600 ft, so you've got to put in one tiny little correction just to ease it over and take out some of the crab, but otherwise it's very simple well behaved, and the glideslope is very easy to fly. So the longitudinal Cooper Harper for the glideslope and localizer intercept, controllable? Yes, adequate? Yes, satisfactory without improvement? I'm going to say no, rate it a Cooper Harper of 4. When you get below 500 ft and this evaluation goes down to 200 ft for this evaluation segment, the combination of the winds and the moderate turbulence in the autoflap transition makes glideslope control more difficult. I was really

working to hold the glideslope within plus or minus about a third of a dot, down to around 300 ft and the work levels, let's give it a Cooper Harper of 4. The lateral directional also required a higher work level, it was controllable, adequate performance was obtainable, satisfactory without improvement? I'm going to say no and rate it a 4 also, just a higher work load with the crosswind to maintain the localizer and especially as you get down below 500 ft, it requires more effort and the moderate turbulence is tending to upset it from it's wings level position requiring more frequent pilot inputs. So 4 and a 4. For precision landing segment, from 200 ft down touchdown, this technique using the decrab at 50 ft, a lot's happening at one time, you've got to do a lot of lateral directional work and a lot of longitudinal work in order to try and set up a flare attitude which we know is harder with these new dynamic ground effect models and at same time trying to align the fuselage. So, it's just an awful lot going on at one time. One technique I used, was I would add a little bit of power or at least not retract any power, in fact, sometimes left the auto throttle on, onto almost touchdown in order to keep the power up. I had intended for the ones we rated here, I tended to have slightly long landings with fairly good H dots, but to the practice ones, even with that technique, I sometimes landed a little short and firm. Certainly there is a learning curve on this one, the practice approaches I flew I had H dots at around 9 or 10 and on the evaluation ones I had a 1.85, .1 and 2.8, so there was a huge learning curve as far as starting the flare attitude. The... there is one more thing to note and my point I was going to make... I had one geometry strike and that was just probably more a reflection of just inattention rather than anything else. However, it does show you that certainly is one of the pitfalls of this configuration, so I think it is interesting even though I'm blaming myself more than on the aircraft. It appears that my performance was mostly for X position, I was mostly in the adequate range, laterally I'm going to kind of say it's more towards the desirable range. So for the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory? No, it will have to be a Cooper Harper of 5 for adequate performance. For lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? No, I'll rate it a 4 for this task, and basically the task is just so high gain, that the work load is so high that it's difficult to rate it higher than a 4.

Pilot F

Task 4093 Crosswind Landing - 25 kt (Procedure A) 22 Jan 97; Runs 44-48

Okay, a couple things, for some reason I thought it was harder to do the crosswind from the left than it was the crosswind from the right, and it was harder for me for some reason to see the alignment task, or to get everything aligned, just right, I did three runs with it from the left, two runs with it from the right, I got better performance with the crosswind from the right than I did the left, in general, of all, I'm not so sure that there is something specifically in the control system or if it is just a pilot preference. The only thing that I can think about is, and I looked at this on the last part of the run, is it's easier for me with the ergonomics of this stick, to hold right bank in... and adjust for the right bank, or make right bank adjustments in the flare with blended pitch inputs than it is left bank, pushing my hand out, out board, and that might be something if the stick was placed differently in the cockpit and optimized a little bit more, that I might not have had that same feeling. Again, I'm still getting used to the airplane and I'm not so sure that, I guess what I'm trying to get at is, it's hard to really pick it out for sure, but I think that was one of the primary factors in the comfort level. The last run that we did, though, I paid particular attention to that and I did mess up the flare a little bit, as far as touchdown sink rate and longitudinal position are concerned, but I was really trying to look for what was making me uncomfortable and I don't think it was really a factor of the stick causing the performance as much as I was just trying in my own mind to figure out rather... if there was just a preference issue, or what was causing me not to see the

alignment earlier on the previous two runs. Anyway, if you train up parameters between runs, I guess from the left we had all the desired performance at one time or another, just not on all of the same runs. On the right side, I think we were closer to desired performance, and I guess I want to emphasize that the stick and holding left bank in the flare is just a feeling of slight perception, it's not a... not something that is real definitive or real strong, it's a very slight, slight preference to holding right bank versus left bank in the round out and flare. I liked aligning the airplane early at 200 ft. I think this works out well, I'm going to be interested to see the other point where we align the airplane with runway low or down. Getting back to predictability and crispness before, crispness before, that we talked about before, it's very controllable to make a slow alignment maneuver starting at 200 ft. Again, my biggest... I guess complaint if you will, is if I get off of the basic profile that I'm doing, I try to align it with the runway, or get off the profile because I started the round out flare just a little bit late, it's very hard to come up with a consistent appropriate correction to get back on profile, I have to work very hard to do that. Let's see, the other comment that I was going to make, is that on all these runs, because we busted the 50... or 5 degrees of bank below 50 ft parameter, I've been very sensitive to bank deviation below 50 ft, and... not knowing the geometry that well, I guess I would be more inclined on any airplane when I make the alignment maneuver then to make any bank adjustments as high up as I can, to try to have the bank more stabilized when I enter the actual flare close to the ground, and so that caused a fair amount of attention on my part on subsequent runs, after the practice runs that we did. For the rating, we're rating both the localizer, okay, for tracking the localizer, you know, this is just tracking raw data, it would be nice to have a flight director, it's not required. One thing is if I were in instrument conditions, and I had to establish the offset... heading offset, for the course, I could do it, but with the flight path vector, it's not a... I guess what I'm getting at is it's not as obvious as with an HSI of what crosswind correction you have. You can see it in the HUD, all of the information is there, it just requires a little bit, at least for me, a little bit more of cognitive process. For the approach, laterally and longitudinally, though, I don't think the rating would be significantly different for this task, than what we've rated it before, it's obviously controllable, adequate performance with a tolerable work load, and it's satisfactory without improvement, you could do this... I just... it would be nicer to have an HSI or more of a... like at least have a reference marker for where the course is on the heading scale, so that I can see the difference in heading and course, without having to remember that the course is roughly 360, but since we started out established on the course, that really wasn't a big deal, I mean it was pretty easy to hold it, hold course for this maneuver, particularly visual, which you have the runway out there in addition to the localizer helping you out. So, for this task, I guess I would... I'd probably go 2 1/2, again I don't really like to split up the axis, but we're not going to do half ratings, I'll guess I'll give both 2's, although, I'll just note that in another maneuver, like if I was doing this IFR, I might be inclined to give the lateral directional axis a 3, simply because, not because of the flying qualities, but because of the display. For the landing task, it's definitely controllable, adequate performance is obtainable with tolerable pilot work load, is it satisfactory without improvement? I think again... again I think I'd probably answer no to this question. I think you can land in a crosswind safely on the runway every time. Landing in the 500 ft box, with the alignment maneuver, and the fact that if you make small errors, it's hard to get back onto the nominal approach and because of the gamenship that I kind of talked about, or at least my perception of gamenship in the flare, I guess I would answer no to satisfactory without improvement, which puts us into the second block, and kind of a dilemma here. Four is desired performance requires moderate pilot compensation, I guess if you want to be real technical about it on any given task, I don't think we really got desired performance. Five is adequate performance requires considerable pilot compensation, and I guess I really don't want to give it a five, because I don't really think that it's considerable pilot compensation just to get adequate performance. I would really be inclined to fall back to the

four here if I put the runs together to look at all the different aspects, but I'm not really sure that's appropriate. This is a tough one. I guess I'm going to give it a five (5), laterally and longitudinally... hold on a minute... okay, here's what I guess what I'm going to do, the pitch task here, again I really don't like breaking these up by axis, but the pitch axis here is really no worse than it is in any of the other maneuvers, although it is harder because it takes more of your attention for the lateral command, it also... I do think that with this particular stick, the way it's installed in the cockpit, I'm not saying that this is true of all side sticks, but just the ergometric or ergonomics of this particular stick. I think that holding the bank while you're making the pitch inputs does make it more difficult, and I guess I'm going to go with a 4 for pitch, and if I break up the axis, I guess I can at any one time get desired performance for that axis. I guess I'm going to go with a 4 and a 4.

## **Task 4093 Crosswind Landing - 25 kt (Procedure B)**

Pilot A

Task 4093 Crosswind Landing - 25 kt (Procedure B) 16 Jan 97; Runs 11-13 (forward slip technique), 16-20 (decrab technique)

One of the things that seems to give trouble in this approach is a tendency towards PIO. It begins about the time you start trying to decrab, when the gains are starting to go up in roll, and it can... it's quite... it takes quite a conscious effort to try to keep from PIO, getting into a PIO in roll. The other complication is the very significant increase in thrust is required when you start to establish a wing low condition, as you get all of the... as you get approaching all of the crosswind compensation in, and a lot of rudder, it takes almost three quarters thrust to arrest the descent and get an adequate sink rate. All my landings were either adequate, or excessive rate of sink, most of the ones that were aborted, were due to the PIO getting... going divergent, as in the flare, so, are we rating these prior to 200 ft, and then after, or...? Okay, I'd say for the segment down to 200 ft, lateral directional is probably a 3, and a 2 for longitudinal, and for below the... below 200 ft. lateral directional, let's go through the chart here. Is it controllable? no, I'll give it a 10, and... let's see, I'll take that back, it may or may not be controllable, adequate performance obtainable with tolerable pilot workload, no, deficiency requires improvement, I'll give it a 9, lateral directional, and in longitudinal, does that include the thrust aspect of it? Okay, it's fairly intense... activity is required. Let's see, is adequate performance obtainable with tolerable pilot workload? I'd say it was fairly high work load, just to get adequate numbers, and let's see, is adequate performance obtainable with tolerable pilot... tolerable work load? Well, it's on the verge of a 6 or a 7... adequate... I'd... I'll give it a 6.

Pilot B

Task 4093 Crosswind Landing - 25 kt (Procedure B) 07 Jan 97; Runs 69-72

The approach phase on this technique is the same pretty much because I'm not initiating the technique, the change in technique until about 200 ft. The landing phase however is fundamentally different, although the work load is still pretty high, I didn't feel like control was an issue. Although it was reported that I was rate limiting, I wasn't feeling any rate limiting up here. So, I feel like this is in terms of preference, this is definitely the technique for me. I was able to get adequate performance routinely and on occasion, desired performance. So, its much improved over the previous one. For the approach longitudinal controllable, adequate, and satisfactory, minimal pilot compensation HQR3. Lateral directional, controllable, adequate, satisfactory, and minimal pilot compensation HQR3. for the landing phase longitudinal CHR, controllable, adequate, and this is another one where I would like to give it a 4.5 if I could, I'm going to say 4 on this, desired performance requires moderate pilot compensation HQR4. For lateral directional, it's controllable, adequate, and deficiencies warrant improvement, adequate performance requires considerable pilot compensation HQR5. I feel like the lateral directional task is still a little bit tougher than the longitudinal task. That concludes my comments.

Pilot C

Task 4093 Crosswind Landing - 25 kt (Procedure B) 14 Jan 97; Runs 59-62

Well, this was an interesting time. The segment one, however, is the same, it's no more difficult or no easier with the crosswind than without it as far as holding it, it's very easy to do, both longitudinal and lateral-directionally, segment 1, 2 and 2. Now, here's the interesting part, when we get down to the...let's talk about the pitch first. So, this is pitch, segment two. For some reason, I have no idea why, but it was much easier for me to put it in the desired box with the crosswind than without. Each time I was coming up with desired in the box and I can't for the life of me figure out what I'm doing differently here than that I was doing before, but something sure happened because it was dropping into the desired box each time, rates of descent, when it was...we're talking about longitudinal characteristics here, as long as they were...the airplane was in it's normal state, was quite...certainly was controllable and was quite pleasant. So, satisfactory without improvement, longitudinally requires improvement, I still have some...trying to keep these in is working pretty hard, even to get the desired, so I come over there and I did get the desired and so and so, this is strange why I would give it a higher rating for crosswind than without, but I'm not here to analyze, so, a 4 in the longitudinal segment two. Now, here this one is the tough one when we start talking about the lateral-direction. First off, the rudder, the yaw control, no matter what technique I was using...a fairly rapid crosswind correction or just easing one in, the yaw control was fine. The problem came in, in the roll control and most of the difficulty was in the practice ones, but none the less, I saw the problem at least once in the data runs, and that is once I get close to the ground and start really having to fine tune the bank angle, and increasing my inputs somewhat, but nothing that's outlandish, and this isn't a "oh boy", I've got to go wild with this thing to control it, but as soon as I started picking up the motions as say a gust would hit me, something would happen, and there would be a very sizable PIO, and that's the classic...the closer to the ground I got, the more apt I was to see it, and the one that I saw on the data runs which are the only ones that I'm going to be counting here other than I already have the knowledge of what happens if I go further, it had not gotten to the point where I hit anything yet, but it was a PIO, and at a minimum it was undamped and I only got a couple cycles of it, and very well could of been heading for the moon, I don't know...soon after...what I saw, I felt it was at least self-sustaining, in another words the oscillations were at least staying the same size. In order to stay away from that, on a couple of them I intentionally backed out of the loop, which is compensation, and unfortunately we're talking about hitting things and so on and that's exceeding the limitations, so now we're talking about controllability, well I saw that with proper compensation I can keep it controlled, so, adequate performance obtainable with a tolerable pilot work load? no. Deficiency requires improvement, and yes, controllability was in question and I did have to compensate for it, so, I'm going to give that an 8 for the...specifically for the roll control, but for our purposes here, it's lat-dir, and for the reasons that I said. Very strange results from this that the longitudinal suddenly is improved with a crosswind and yet they...Cooper Harper...excuse me, the lat-dir went all to pieces on me, and my concern is we're right on the edge of that cliff at any time just a little more gain and you're over the edge on it, so that's what my concern is.

#### Pilot D

Task 4093 Crosswind Landing - 25 kt (Procedure B) 23 Jan 97; Run 70-72

Much, much easier task I think, you eliminate that dynamic maneuver in the flare, particularly with an airplane that's so sensitive to geometry strikes, and actually I'm going down a learning curve on the landings, we had two out of three of those were in desirable in all parameters, but still the yaw task, definitely increases the work load over the normal landings, so I'm going to, for the glideslope, let's rate it as before, 4, 4. For landing, let's make it 5, 5, we did get some adequate performance, and I think the work load is up there

and the probability of staying in that desired box a 100 percent, or nearly 100 percent of the time is pretty nil.

Pilot E

Task 4093 Crosswind Landing - 25 kt (Procedure B) 08 Jan 97; Runs 106-109

Okay, my preferred technique is a forward slip, it gives you more time to get established, I actually, at a couple 3 of these landings I really liked even though they didn't... the last one I thought was a very good landing and approach, it just probably... I overcontrolled the flare by I would say, on the order of maybe a tenth to a quarter degree which is almost imperceptible to figure out. I leveled it out just about 9 ft or it would have been an excellent approach, it felt real good, I had much better control of my lateral deviation. I had one kind of outlier which I'm going to kind of toss out, it's just a function of trying something that didn't work, but most of the lateral deviations were on the average of around 3 or 4 ft if you average the 3 good ones, and the heading corrections were all very nominal except for the one kind of outlier. The... what this does show you though is that with the dynamic ground effects that we aren't as predictable in the flare as we could be. I had two approaches that were roughly around a thousand feet and the two were roughly around 2300 feet and one of the thousand ones had a firm H dot and one of them had a very good H dot, similarly one of the longer ones had a good H dot and one of them a firm H dot. It's just... I'm finding out there just not as predictable in the flare and certainly when you have extra considerations like the crosswind turbulence, it makes it worse. Any rate, up and away, no real problems, still a little bit of effort on controlling the glideslope due to the turbulence and winds. So for the longitudinal up and away we'll consider it controllable, adequate performance was obtainable, satisfactory without improvement? No, we'll rate it a 4. Laterally similar rating, controllable? Yes, adequate? Yes, satisfactory? No, also a 4, and this is just due to the effects of the winds and turbulence on the work load. For the longitudinal task, it's probably sort of semi-borderline desired adequate for both longitudinal and lateral using this newer technique, of using this different technique to commence your forward slip. I'll go ahead and do longitudinal rating first, this is controllable? Yes, adequate performance is obtainable? Yes, satisfactory? No, it's borderline desired adequate, I'm going to go ahead and rate it a 5 for basically adequate performance. For the lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? No, but I am going to rate it 4, give it desirable, I'm going to throw out the one outlier which I'm not really sure what happened there, it could just be my kind of illness right here is making me not concentrate as far as I should, so that would be a 5 for longitudinal in the precision landing and 4 for lateral. It actually, I'll tell you what, the work load is certainly going to make it a 4, it certainly does require moderate compensation. That would be a 4 regardless. The ratings for both the 50 ft decrab and the 200 ft forward sideslip are identical, however, I think that just kind of fell out, they are both hard tasks, but considerably my preference is for the more controlled forward sideslip task.

Pilot F

Task 4093 Crosswind Landing - 25 kt (Procedure B) 22 Jan 97; Runs 52-56

Okay, basically a couple things, I think this is a harder task than doing it at 200 ft, and I think the reason why is because I can't rapidly put in the rudder at the rate that I would really like to and I don't expect that, I really would necessarily always be able to that in an airplane that's this big. I think a couple factors too, seeing alignment, or heading alignment, I can use the flight path vector and the waterline, but when I'm doing this very dynamic



maneuver at 50 ft, I can't, first of all the waterline, I can't keep in my cross check as much, and the second thing is, is if I use the rate of rudder to get me aligned with the runway, from 50 ft and with the sink rate that is going to get me in the touchdown box, it requires a very rapid, rudder input, and it's very intolerant to errors. If I don't do it just right, it's hard for me to correct. The other thing is, I did a... just a open loop dynamic look at Dutch roll, and when I put in the rudder, I do this on final, when I put in the rudder, the nose yaws over to the left and then after some period of time, the airplane starts to roll and then those slices back to the right, and it damps out in about one cycle, and I think when you are, when you put in a rapid rudder rate down at 50 ft, I think you're seeing this Dutch roll come in a couple times, I really had my eyes watered by the bank perturbations that I was not expecting with the rudder input, and what would happen is, I'd start to nose over at a comfortable rate, and I would see that I was not going to get my heading aligned by the time that I was on the runway, and therefore I'd increase the rate that I was bringing the nose across and then some decrement of time later, the airplane would start with a roll response that was hard for me to predict and hard for me to counteract, and close to the ground, that's not very comforting. If I had to decrab the airplane at 50 ft, what I would do is, I would extend my aim point and take longer to decrab the airplane so that I could bring the nose across at a lesser rate, and I would probably accept some crab angle at touchdown. Anyway, let's see, what else about this, on both the cards, I think the target bank angle, at least on the computer generated score card that comes up is zero, and I also... I guess what we're saying is that the range is plus or minus 5 degrees, and I don't have a problem with that, but just as a point of clarification, especially decrabbing at 200 ft, you're not going to have zero bank angle, and even decrabbing at 50 ft, you're going to have to start the wing down, or even if you align the heading, the airplane is going to be drifting, and you'd have to line up off centerline so that you can drift back to centerline, and which is not really an acceptable technique, I guess my point is, I'm just saying, is that you are going to have some bank at touchdown. The 5 degree at bank thing, I guess what I'm getting at is that I think we need to be very realistic about the bank angles that we would expect to see in service with an airplane and the geometry for that airplane. If we have very tight geometry, the handling qualities need to be much improved to insure that we don't get a strike, and I'm not sure what angle we get strikes at, is it like 10 degrees or 11 degrees or, okay, so anyway, I think that is something that deserves some consideration. As far as rating the task goes, let's see, for the approach, did you want me to rate that again? Okay, it's basically the same as we rated before with the same comments, which was a two and a two, I believe. For the landing, it's controllable, is adequate performance obtainable with a tolerable pilot work load? Okay, the reason I'm pausing here, is that I'm looking at the descriptor for a 7, it says adequate performance not obtainable with maximum tolerable pilot compensation, controllability not in question. I believe we did get adequate performance, is that true, on some of those runs? I'm going to answer yes to this, simply because if I would of backed off, backed off the gains and just tried to hit the, the two techniques that I did not do that I could have, if I had backed off the gain and just tried to hit the adequate box, and sacrifice trying to hit the desired box, I think that, that would of given me more time to do the alignment maneuver, and I might of been able to do that. The second thing is, is I could of performed a slight duck under and then extended the aim point down the runway and I would have been given more time for the alignment maneuver. I guess I'm having a real hard time answering this question here, because both of the those techniques that I just described, to me would fall into maximum tolerable pilot compensation, it's not something that I would want somebody to do operationally, certainly, although, at the same time I will say that operationally most of the pilots will aim at the 1000 ft marker, and really their box would start past that point. Let me think about this for a second. Okay, I am going to answer yes to that, I don't think it's satisfactory without improvement, and I think you're at the level... I guess for me you're kind of right at that breakpoint between level 2 and level 3, I guess I'm going to answer yes, so,

kind of give it the benefit of the doubt, and go in and I'm going to say that it is very objectionable, but tolerable deficiency, adequate performance requires extensive pilot compensation, I'm going to say that for pitch, again I really don't like breaking up these task, and the pitch task is really not that hard. I'll tell you what I'm going to do, since we are breaking it up, I'm going to give it a 5, I'm going to say for pitch, it's adequate performance requires considerable pilot compensation, and I'm going to give it a 7 for lateral. I just... I don't think the airplane is crisp enough, or predictable, enough to be performing this maneuver at 50 ft and be able to consistently get good adequate performance without... I guess what I'm saying is that I think that you can consistently get adequate performance, but I don't know that I'd say that you're going to do it with a tolerable pilot work load. Let me... I'm going to turn the tape off again, and think about this one more time. I guess I'm going to change it, I guess I'm going to... hold on... I guess I'm going to change that, and I think the main contributor that was influencing my judgment there was the fact that if I bring the nose across at the rate that I want to, it causes roll perturbations that I'm not willing to live with, and I definitely think that if I don't back off from my gain, I'm bringing the nose across, you're definitely level 3, and I guess in my mind there is a question as to whether of backing off in the gain, of bringing the nose across, as much as I'm doing, if that's an acceptable type of compensation that is in the maximum tolerable... not maximum from a work load standpoint, but maximum from... I'm trying to do the task and I'm having to sacrifice my... in other words, I have to stop trying to do desired performance, I have to stop trying to track or do the task to the target, I have to back off in the gain and just try to do it within the adequate box, and I guess that's why I'm having such a hard time with this break between level 2 and level 3. Thinking back though, it is a compensation that I can use, it is a compensation that, I mean, after a couple runs it was clear to me that I didn't want to bring the nose across at that rate, and I think I was influenced by the two practice runs that we did right after two where I looked at rating the nose across, so, I'm going to kind of back pedal here, and I'm going to say 5 for pitch, and 6 for lateral directional, and I'm going to put... just my comment is, is that I really think that for this maneuver, and maybe this has worked for some guys, and maybe I'm missing something here, but I really think this is at the bottom of level 2.

## **Task 4095 Crosswind Landing - 35 kt**

Pilot A

Task 4095 Crosswind Landing - 35 kt 16 Jan 97; Runs 23-24 (right xw), 27-28 (left xw)

Okay, the... once again, there's a tendency to PIO in lateral mode. The only way you can make reasonably decent landings, is not to put any, especially during the flare, not to put any roll inputs in, and strictly put in, set up the bank angle prior to flare or where you want it, and simply apply a flare input, of pitch input, and increase the thrust as you're taking out the crab, it really requires careful timing in adding thrust, usually you have to spool up the throttles, and get a high thrust setting prior to bringing in rudder, because if you wait until your rudders in, and apply thrust, then the sink rate gets excessive. So, as far as Cooper Harper ratings are concerned, pitch; put down to 200 ft, it would be a 2, 3 for lateral directional, down to 200, and as far as below 200; is it controllable? say improvement mandatory, it's a level 3, plus... your deficiencies are kind of 10. And as far as the pitch axis is concerned, we haven't seen adequate sink rates, and that's primarily due to the timing of an application of thrust, and relationship to applying rudder, and kicking out the drifts at the last minute, if thrust is applied just slightly ahead the rudder input, then the two compensate, and the descent rate is reasonable, but the throttles are inadequate in getting thrust in during the flare then the, but... they're excessive. One factor that was observed during this task is that it takes very intense, and special attention to not making any roll inputs, and that tends to detract from the pitch task. Well, maybe I didn't say what it was, it is, longitudinal for the final segment would be, well, let's see, very... is it adequate performance obtainable with tolerable pilot work load? probably no, major deficiency... adequate performance not obtainable with maximum controllability, a 7. The Cooper Harper ratings, it's a little bit hard to separate them out when you've got one that's a 10, it's hard... difficult to rate the other one very high, I think that's a factor here.

Pilot B

Task 4095 Crosswind Landing - 35 kt 07 Jan 97; Runs 74-77

The approach phase was similar to what I had seen before. The workload is relatively high in the high crosswinds, but, not enough, I think it bumps over into a level 2. So we'll rate it on level 1 in both. Longitudinal is controllable, adequate, satisfactory, improvement not required, minimum pilot compensation HQR3. And lateral directional the same, controllable, adequate, sat, minimum pilot compensation, HQR3. For the landing, we're back up to real, real, high work load, intense workload, primarily lateral directional, longitudinal is level 2 but it not...the workload is not as intense as a lateral directional. That primarily consist of monitoring sink rate and longitudinal position but I'm primarily I'm sacrificing a lot of that in favor of getting the lateral directional under control at touchdown. So longitudinal it's controllable, adequate, deficiencies warrant improvement and adequate performance requires considerable pilot compensation. This is another one I would give it a 4.5 if I was allowed to but I'll push it over into the 5's since I can't give a half rating, so HQR5 longitudinal. Lateral directional is controllable, adequate, and it's real close here, I'm going to call it adequate because I was able to get adequate most of the time there were times when I wasn't, but, I'll make a judgment call and push it up one and say deficiencies requires an improvement, adequate performance requires extensive pilot compensation HQR6 in longitudinal.....and the ....lateral directional, rather, I'm sorry. The longitudinal remains at what I just gave it. And the primary problem was controlling the bank angle, the drift across

the runway, and the touchdown wide position all at the same time, just a very very difficult task. That concludes my comments.

#### Pilot C

Task 4095 Crosswind Landing - 35 kt 14 Jan 97; Runs 100-103

Okay, do the quick one first, the segment one stays the same, 2 and 2, no difference there. The only thing I noticed this time I hadn't seen before is whether I had a left crosswind or a right crosswind, I seemed to have a little bit of left drift in when I was not making any inputs, and I don't recall seeing that before, to correct for it was not a big deal, but that might have had something to do with some other problems later in the flare. So anyway, segment one, 2 and 2, same thing. Okay, for segment two, let me give it a rating here first, adequate performance, tolerable pilot work load, I'm going to have to give that no, for double reasons, (a) with the exception of the last run, I didn't get to adequate performance particularly in the heading, and that's important because we're talking about stresses on the gear and stuff, so, you know, certainly didn't reach that, and even on the time that I did get it, there was an awful lot of...well I don't know if you could...if you can consistently do it, it's judgment, if you can only do it once in a while, it's luck, but in any case, it's going to make me turn the corner here at this question, and deficiencies would require improvement. A case could be made that we're going to overstress the gear in thus controllability is in question, that I'm going to soften that a little bit, and adequate performance not obtainable, with maximum pilot compensation, so, I'm going to give it a 7, keeping in mind that I am using the crab method, it takes a lot more training to do, and with my level right now, that was more compensation than I could really handle, so it's a 7. Just a remark, with the winds out of the left, it appeared an easier task than winds out of the right, and I don't know of any particular reason why that would be, whether it's tied in with that slight drift that we have in general, I don't know. I did notice that after touchdown, I had a very difficult time keeping it on the runway with a right crosswind and yet with a left crosswind, it was not nearly as difficult, who knows why, I sure don't. Due to the concern with the lineup and touchdown...or left, right, touchdown points and so on, why some of them got a little bit long, but that's because I was getting overloaded with the left, right, problem and the up, down, problem, kind of took second fiddle to that, so, as a result, several of them were quite long. Most of them, I think...everything was adequate with the exception of the heading error, at least with the left-hand crosswinds, and once I got adequate on that, maybe I could train myself a little, a little more with practice, but I have to just rate what I see with this experience level, and...so the lat-dir I would give in segment two is a 7 and the pitch...probably...I'm debating between the 5 or the 6, because they're almost all adequate and I was working a fair amount on trying to decide the difference between considerable and extensive, probably have to give that...I'll give it a 5, I'm probably being nice to it, I'll give it a 5 for adequate with considerable pilot compensation. The over riding problem was the lat-dir and so, it...that affected the performance more than just the longitudinal characteristics did. Okay, the segment one, 2, 2, and segment two was 7 for lat-dir and 5 for longitudinal.

#### Pilot D

Task 4095 Crosswind Landing - 35 kt 24 Jan 97; Run 8-10

Pretty high workload task, all three axis, pitch, roll and yaw. It really doesn't ... have to time share on these things almost in all ... just running out of time. Also I feel pretty marginal on the wing tip strike, with the steady state bank angle that it takes to hold this slip, I feel a little uncomfortable with that. Pilot ratings, for the approach, no different than before. I was

having to put in just a little bit of side slip so we could get the runway around on to the display from out behind the post. The landing, it's not ... I'm giving it a six and a six on pilot ratings. It's really not that bad. If I had my druthers I'd give it a 5 and a half. I don't think it's that much worse than the normal one. Normally I was giving 5's and 4's but It's a pretty high workload. Make it a six and six. (Okay and for the approach, the same as before?) Four and four.

Pilot E

Task 4095 Crosswind Landing - 35 kt 09 Jan 97; Runs 85-88

Okay, up and away for evaluation segment glideslope and localizer intercept, it's a fairly high work load just to keep the thing on localizer and glideslope, the... I've discussed this before about the things we can do to make this easier for the pilot, but as it stands right now the turbulence in the gradually tapering wind does cause both heading upsets of small nature which then tends to give you localizer deviations and the turbulence also causes glideslopes deviations that left to it's own devices would probably gradually diverge, so it does take input on that. For the actual precision landing, it's quite apparent that I do a better job with a right crosswind than with a left crosswind for what reasons I don't know, but it's a big difference in the performance from those two sides. I had three runs, four runs rather, three of which were mostly all desired. My X position always was desired on every approach. H dot was borderline desired/adequate, it was for all four landings. The lineup was very, very good with a right crosswind, in one approach inadequate with the left crosswind, but three of the four approaches... two were solid desired, and one was borderlined desired adequate and one was inadequate. That one I'm going to consider an outlier run 86, I'm going to rate based on runs 85, 87, and 88. For up and away glideslope and localizer intercept, the longitudinal Cooper Harper rating, it was controllable, adequate performance was obtained, satisfactory without improvement? No, minor but annoying deficiencies, basically the glideslope deviations... you did require moderate pilot compensation for a four (4). Lateral directional, same comments basically, except just the localizer tracking, controllable? Yes, adequate performance obtainable? Yes, satisfactory without improvement? No, also a Cooper Harper of 4. For the precision landing, for the... if I throw away that one outlier, the longitudinal performance is very good X position, it's almost right in the middle of the box each time, and H dots kind of marginal borderline desired adequate. I guess... considering the submission of all four runs, but really rating on the three, I would have to say my longitudinal performance was probably going to come into the high adequate range, borderline 4, 5. At any rate, it is controllable, adequate performance is obtainable, satisfactory without improvement? No, and I'm going to rate it a Cooper Harper of 5, and it's borderline 4, 5. I think there is certainly a learning curve here, I think if I did a few more of these they would all consistently get desired performance, but I think the work load is high enough where it would be kind of difficult to... certainly it would be difficult to make it level 1 and it would kind of always be borderline, I think desired adequate. For the lateral, similar comments, again there is some strange thing with me about making much better landings with the right crosswind. It is controllable, adequate performance is obtainable, satisfactory without improvement? No, I'm going to rate this one a 4, throwing out that one outlier, I would find it interesting if any other pilots experience a similar dichotomy of performance between the two crosswinds.

Pilot F

Task 4095 Crosswind Landing - 35 kt 22 Jan 97; Runs 61-64

First of all, two comments, one, I think that further investigation on these two items, I have two items, would be worth while, and the first is, is there's a perception to me that as we get out to larger sideslip angles, that the roll sensitivity and being able to pull the precise bank angle or set a precise bank angle maybe is more accurate, it becomes a little bit more difficult, the second issue is, with the higher crosswinds, I feel like I miss, my perception is, is that I'm missing some of the tactile feedback that I would get when using cross controls on a conventional airplane, and both of these things, well the tactile feedback, I think, let's just suffice it to say that I think both of these things deserve maybe some further consideration or a look at them. As far as the task goes, tracking the glide path is the same, and the localizer is the same, so I'm not going really comment, it's the same as before, and I think we said it was a 2 and 2 before. We'll just stay with that. As far as the landing task goes, again I feel like I'm really pushing the bank angle requirement below 50 ft, I'm wondering to hold a stabilized bank with 35 knot crosswind, I'd be interested in seeing what the exact bank angle requirement is for... to be able to align the heading on the runway, or the airplanes heading on the runway, and be able to execute this maneuver. I think the tendency is, is most pilots in a crosswind tend to put in a little bit more rudder, and hold a little bit more bank than they really need to, and I think that's probably because in most airplanes, I think it's easier to release a little bit of rudder than it is to put more rudder in if you find that you have an insufficient amount of rudder, and if the requirement to land the airplane at a 35 knot crosswind is say 3 1/2 degrees of bank and you're only giving the pilot a degree and a half to play with, I think that's kind of tight, or it might be kind of tight. Anyway, let's go on and rate it, it's definitely controllable, adequate performance obtainable, with a tolerable pilot work load, I think the answer is yes, is it satisfactory without improvement? and again I really have a hard time separating the pitch axis and the lateral axis. We did get desired performance or virtually desired performance on one of the runs, there... for me it was harder though to do the crosswind from the left than it is from the right, again it might be a function of the way the stick is in the cockpit. Again, I don't like really splitting up the ratings, but I guess I'd probably still go with a 3 on pitch, and a 4 on roll, on lateral directional. Again, the pitch I don't think is really anymore difficult than the normal landing except for... you can pay less attention to it, because you have to resolve the alignment problem, and again I do think that part of the part I already mentioned, being more difficult with crossroads from the left, I think maybe a function of the ergonomics and the way the stick is in the cockpit. Okay, that's it. This is just a note, we went back and reviewed the Cooper Harper ratings for the 25 knot crosswind, and we had given it a 4 and a 4, and we gave this one a 3 and a 4, I'm not going to go back and change the ratings, probably... the point is, is that the 35 knot crosswind is more difficult than a 25 knot crosswind. There is a definite learning curve, and we did the 35 knot crosswind after we did the decrab at 50 ft, and the decrab at 50 ft, definitely is more difficult than the 35 knot crosswind, with a decrab at 200 ft, but the point here is, this is an explanation of why there is a discrepancy in the ratings, and really the discrepancy occurred just because we saw the worst flying qualities case, in my opinion at least with a decrab at 50 ft, and between it, and also because of the learning curve. That's it, thanks.

## **Task 4110 Landing with Jammed Stabilizer**

Pilot A

Task 4110 Landing with Jammed Stabilizer 17 Jan 97; Runs 80-81

The approaches seemed to be perfectly normal, I think you can well make an approach, and you'd never know that you had a stabilizer jammed, it seemed perfectly benign, and so, we're getting adequate, I guess elevator wise, we're getting adequate, and even desired, high adequate, low desired type performance, longitudinally, I guess I don't recall those, I never did get the landing distance down, the sink rates were okay. Yeah, so, we're close to the... very close to the desired performance, adequate, so, I guess we'll give it a 4 on longitudinal, it is a 3 on the lateral directional.

Pilot B

Task 4110 Landing with Jammed Stabilizer 10 Jan 97; Runs 8-10

The only difference I noted, and I'm not positive this a result of the jammed control, but I did notice in the flare that there tend to be a very small tendency to oscillate a little bit. A little bit of rate limiting, I believe that also happened on the last run, to a lesser extent, than on the second run, it was particularly noticeable. On borderline adequate desired, sometimes get in desired, and sometimes get in adequate performance on the longitudinal task. The lateral directional task we're getting desired pretty consistently, so the HQR is longitudinal; it's controllable, adequate, deficiencies warrant improvement, and I'm going to say desired performance requires moderate pilot compensation, HQR4. Very similar to what I've seen before, the rate limiting was not pronounced, it didn't lead to full blown divergent PIO, but there were times when I felt like I had to back off a little bit to...to get the performance. I'm not willing to push it down into the lower category in level 2, though, so, let's call a HQR4, lateral directional; it's controllable, adequate, satisfactory, minimal pilot compensation, HQR3. So, in summary the CHR's are 4 and 3. That concludes my comments. That is for the...you want to do both phases, I'm sorry, what I just gave you was the precision landing phase, 4 and 3, okay. Glideslope and localizer intercept, these are fairly easy, and of the two the longitudinal is probably a little bit more difficult than lateral directional, but it's real close, longitudinal; controllable, adequate, satisfactory, minimal pilot compensation, HQR3. Lateral directional; controllable, adequate, sat., and pilot compensation largely not a factor, HQR2. So, for the glideslope and localizer intercept phase, the HQR's are at 3 and 2, and that concludes my comments.

Pilot C

Task 4110 Landing with Jammed Stabilizer 16 Jan 97; Runs 113-115

The first segment, the glideslope intercept and tracking, actually they're both going to be the same rating, I suspect. Adequate performance certainly satisfactory without improvement, certainly this is...I'm going to...no, I take that back, lat-dir I'm going to bring to a 3 this time, and the pitch to a 2, and I don't know why, but I had to make a lot of lat-dir heading changes and so on, to stay on it, that I don't remember doing before, and that's what used to make it a 2, it's just not as tight a control, and...you know, I have no idea, it doesn't have anything to do with your configuration, you're...that you're varying, I'm sure, but just something that I noticed, it took more pilot compensation to maintain the localizer on all runs today, more than it did on runs before. The longitudinal down to, what is it, probably 400 ft, that we're

doing this, maintaining...down to 200, okay, because that's about where the glideslope starts being very hard to follow. The pitch is...if you didn't tell me there was a failure, I wouldn't of known there was a failure, that's...oh yeah, let's make them both 3, lat-dir 3, and pitch 3. Both of them just very minor compensations necessary to intercept and continue to track the glideslope, and I was getting solid desired performance. Okay, now for the flare in the landing, we'll talk separately on this. The lat-dir was fine, once I was in close, I didn't have to try to track any localizer and all, as far as just maintaining bank angle, I didn't see any problem with that. Satisfactory without improvement, yes, and a 2 on the lat-dir for the segment two, the landing part, and in the pitch, again, boy I could hardly tell any difference, tell that it had failed, to tell you the truth, it was really quite pleasant. The pitch is just a lot trickier thing for me to handle apparently, and so I'd give that a 3 in this case. So, longitudinal 3, lat. dir. 2, for the landing. Did we get all that?

Pilot D

Task 4110 Landing with Jammed Stabilizer

Not performed by this pilot.

Pilot E

Task 4110 Landing with Jammed Stabilizer 10 Feb 97; Runs 38-39

Not a bad approach at all. I tried hard on the second approach which is why I got adequate performance on the glide slope. I was putting in some very significant pitch doublets, some rapid high amplitude, high frequency.. doing anything I could to see if there was a PIO. There was none. It flew very well longitudinally. A little bit sluggish in pitch rate which is one of the reasons I couldn't get it to do much. You couldn't really overcontrol it because it just very smoothly followed your inputs at a little bit slower rate. So there wasn't really a lag or a time delay but a slower pitch rate which just made it more stable as far as trying to excite any kind of modes. Laterally, no problems there either. The touchdowns were kind of like my nominal landings where if you don't play the dynamic ground effects just right, you just don't get a very good landing. I had a nice H dot on the second one but it was a little bit long and the first one I thought was a decent landing but just a little bit firm and just a teeny bit long. So for the longitudinal rating, for the approach. Was it controllable? Yes it was. Adequate performance? Yes. Satisfactory? Yes, a 3. For the lateral rating, controllable? Yes. Adequate? Yes. Satisfactory? Yes, a 3 also. Basically very good numbers and performance on the approach laterally and longitudinally. For the landing, longitudinally, controllable? Yes. Adequate? Yes. Satisfactory? No, it did mostly get adequate numbers. The Cooper Harper of 5. Adequate performance does require considerable compensation and basically that is the effect of dynamic ground effects. I felt very good with both flares and both touchdowns. It is just kind of rolling the dice to see whether you get a nice landing or not. But since you don't seem to have the control to get desired that probably is a good rating. For the lateral directional I met desired criteria on all of them. Controllable? Yes. Adequate? Yes. Satisfactory? Yes, a 3.

Pilot F

Task 4110 Landing with Jammed Stabilizer

Not performed by this pilot.



## **Task 4140 VFR Circling Approach**

Pilot A

Task 4140 VFR Circling Approach 16 Jan 97; Runs 91-93

Okay, the circling approach segment, Cooper Harper wise, give it a 3 for the lateral directional, and a 2 for the longitudinal, for the... where is this... where's that end... where's the circling end, and the... okay, beyond 200 ft down in the flare on landing into a 35 knot headwind, the Cooper Harper longitudinal has a split out on the, I mean the actual and the commanded gamma split out, somewhere in the last half of the flare, and we have seemed to get consistently a tendency to land long, and even though the thrust is brought back and the normal techniques are used, and so, I'm going to give it a 4, in longitudinal, and actually the landing had no particular problems with lateral directional, and that, and I'll give it a 3, for lateral directional, and I can't think of any other comments.

Pilot B

Task 4140 VFR Circling Approach 08 Jan 97; Runs 4-8

Okay card 30, let's see, rapidly maneuver in alternate runways in VFR techniques, yeah, that wasn't really a problem. Deviation for final approach air speed, I don't think is an issue here, or is appropriate because we have the auto throttle on and it is a little bit sloppy, minimum altitudes worked out okay, max bank angle is fine. No problems in anything relating to control in any of the circling approach phase and the precision landing phase, some of the same problems I'm seeing before, you are working hard to get a combination of sink rate and touchdown position in the box, and sometimes able to get desired and sometimes not, but you are working hard in any case. Okay, so for the circling approach phase longitude HQR; it's controllable, adequate, and satisfactory, call it minimal pilot compensation, HQR3, certainly level 1. Lateral directional, same thing, controllable, adequate, satisfactory, minimal pilot compensation, HQR3, again level 1. Longitudinal was primarily driven by the task, just the frequency of scan requirements to hold altitude in the turbulence, and lateral directional was some of the bank angle hold comments I've made in the past about just working to keep angle of bank under control. That is under control within a fairly tight tolerance. On the precision landing phase, longitude HQR; it's controllable, adequate, I think deficiencies warrant improvement and this is another one that's somewhere between a 4 and a 5, I'm going to give it a 4 and give it a benefit of the doubt, desired performance requires moderate pilot compensation, HQR4. Lateral directional, not really a problem in the landing with the lack of crosswind on final, it's controllable, adequate, and satisfactory, minimal pilot compensation, HQR3, basically the same bank angle comments I've made in the other phase. That concludes my comments.

Pilot C

Task 4140 VFR Circling Approach 14 Jan 97; Runs 121-122

Okay, for the circling approach, having that gamma dot system, it really makes circling approaches pretty nice, at least in holding altitude and so on. Okay, so to get to the circling approach, the rollins, rollouts, maintaining headings and all that, very easy, so for the circling approach, the lat-dir was satisfactory without improvement, as far as I'm concerned, and I don't know, that's as easy as it is going to get. I'd probably give that a 2 for the pitch in the circling, is it satisfactory without improvement, the circling part, again, I think I'd give that a

2, I don't know how to make that any much better. A good case could be made for, are those ones or not, but I'm going to be consistent and say things at that level are two, so both the longitudinal and lat-dir in the circling approach were 2's. I used 20 degrees of bank, it was all that was necessary, it seemed to be fine, the only thing that I could possibly add, would be next time try it with larger bank angles, but with the system set up the way it was, they certainly weren't needed, so, I'll stick with the 2's on that. For the...landing, where does the landing start, I mean where do you want to start. Oh well, in that case then, let me back up and just make some comments on the longitudinal, it's the usual problem of visibility with the ground sim and circling is not always easy, right about the time that you want to see something why it blanks out, so that little anomaly, of course is in there, not a big deal. I always ended up high on glideslope, which is not unusual, people tend to want to stay away from the ground until they've got everything under control, and to get down to the glideslope it was a HUD problem more than it was a controllability problem, because the VASI would end up right underneath some writing on the HUD, and so I'd have to kind of jiggle around a little bit to catch it, but it was not difficult to capture the glideslope, and ... nor was lineup much of a problem, the first time I had just a little bit of an overshoot and the next time I managed to roll out with hardly any, so, that was not a...not a problem. Okay now, from landing 200 ft on down, very, very interesting. Now of course, I do have 35 knots of headwind, which is certainly going to solve my floating problems that I saw on the regular runway without 35 knots of headwind, and as a result, it was much easier to put it in the box, that extra time and so on, that the headwind gave me, was enough to get things settled out, and I had a much better feel for when I thought the gear was going to touch, felt much more comfortable with this than the other one. The other thing that could very well be a factor, and before I finish this whole test, I want to go back and do some standard straight-ins to the other runway again, because there was one big difference this time, on this landing, there was no glideslope to watch go plummeting down or rocketing up, and to see if that peripheral cue was effecting what I was perceiving as far as heave and those kind of things, because to tell you the truth in this one, I did not see...I did not have the same feeling of the nose suddenly dropping and going high on glideslope, that I had when I was in the...on the other runway with the normal landings, so, I think that will be worth investigating. Now, to rate what I saw, let me go back here, adequate performance, yes, I was getting desired performance on that, satisfactory without improvement, I'd say kind of a qualified yes, that...I'll say yes on that, and 3 for the flare and touchdown would probably be fine, minimal pilot compensation and the biggest thing is I didn't have that feeling of things going on that I wasn't working with. Was there turbulence on that? There was turbulence, there wasn't very much turbulence on it, I don't think, if there was, it went right through me. I didn't have that feeling of the airplane doing something that I wasn't commanding, that I had on the previous landing test. So, lateral-directional, I didn't really have any complaints, I had plenty of authority, it felt good, the forces and thing, all those things were fine, and the lat- dir, I'll stick with 3 on that, so, 3 is for both things on the landing, and 2's on both things for the circling approach.

Pilot D

Task 4140 VFR Circling Approach

Not performed by this pilot.

Pilot E

Task 4140 VFR Circling Approach 09 Jan 97; Runs 104-105

Basically, the maneuverability of the aircraft at a low altitude structure circling approach down below a 1000 feet is not bad at all. One thing you notice when you make the bank angle, bank turns, 20 degrees angle bank turns, you get a lot of side forces in the cockpit and I guess that's due to the fact that we are so far above, or so far in front of the center of gravity and we're in a relatively high angle of attack relating to other transport category type aircraft, so it is kind of a little bit annoying thing there. The procedure worked out fine, it was an excellent procedure the more I think about it. Basically, for the evaluation segment of the circling approach at 1500 ft on final on runway 36, I believe it was to 200 ft on the landing runway 26, I met desired criteria in all the longitudinal and lateral directional categories or performance standards, and that was not a terribly difficult task. The turbulence makes altitude control plus or minus about 10 feet about the norm which is pretty tight considering a large aircraft like this. So, for the longitudinal rating, controllable? Yes, adequate? Yes, satisfactory without improvement, yes, Cooper Harper of 3 and mainly compensation is required due to the fact that there is dynamic maneuvering involved and yet turbulence upsetting you from your commanded track. Lateral directional, similarly, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, for 3 also. For the precision landing 200 ft on down to touchdown, a couple interesting things, landing with a 35 knot headwind Vs 0 headwind which we've landed on in all the previous tasks, gives you a much shallower glideslope and because you're ground speed is so much slower and therefore it makes it actually a little bit easier to perform the flare task. In all, I did two data runs and one practice run and all of which were desired in all categories. The last one was a tiny bit long and that's a little bit because you come in so shallow that you have to kind of guess just when to pull the power off to put it down in the box, but I think I met desired criteria for all of that. Certainly the headwind does help. For longitudinal, controllable? Yes, adequate? Yes, satisfactory without improvement? I'm going to say no, and say a 4, I met the desired criteria, but not really solemnly desired, still is a little bit of effort in the flare from the comments I've mentioned on previous landing tasks. For lateral directional, I met desired in all those runs, no problem with lineup whatsoever, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, for a 3. Task I think was a nice task, showed no potential problems.

Pilot F

Task 4140 VFR Circling Approach 22 Jan 97; Runs 102-104

Okay, basically I don't think the... I'll comment about the HUD display, I really have to get myself out of the design height, eye height, in order to fly a portion or a fairly... a couple portions of the circling approach, I guess, in order to see the display, because of where it is in the pilots field of view. The ILS approach portion, it's really no different than anything else we've flown, and we'll give it a 2 and a 2. The circling approach is actually pretty easy to fly with flight path vector up, and of course we're flying it kind of mechanically rather than appear visual maneuver, but the airplane is well controllable, and except for the display phenomena that I mentioned, you can basically do it real well. Is it controllable? Yes, is it adequate performance obtainable with a tolerable work load? Yes, is it satisfactory without improvement? I guess I have a hard time with this question because, certainly it is satisfactory without improvement as far as flying qualities go, and the control laws go, I don't like your... I don't like the way the field of view, and having to lean forward and come out of the design eye height, and that would actually I think, be unacceptable. I guess I'm going to kind of, I guess not put too much emphasis on that as far as your rating go, I guess if... when I really considered the display and how much I have to come out of the design eye to fly the display and to fly the circle and approach, I could very easily see making it like a 6 or something. I guess... I'm going to disregard the display on the circling portion of the

approach as far as rating this goes, and I'm going... I'll tell you what, I'm going to give you two Cooper Harper ratings, I think the circling approach, disregarding the display is probably, I would be between, two and a half, if we were giving half ratings, I would probably say the rating there would be a 2, and then if I include the display, I would probably say that it is between a 5 and a 6 because I consider, if I have to get myself out of design eye height, actually I would almost, almost put it into level 3 because of the display. I should not be put in a position where I have to get out of design eye height to fly the circle, in order to keep the airspeed parameters, and the altitude parameters in my field of view, so I guess if I was rating it with a display, I would probably, I don't know, I would probably say it was a 7 with the display, just simply because I... I don't know, yeah, why don't we... we'll rate it a 2, but why don't you in the comments just put that, forget a Cooper Harper for the display, we'll rate it a 2, not considering the display, and I think the display would be unacceptable. Anyway, going on to the landing, we get desired performance on everything, except for H dot, we flew the approach several times. You could actually maneuver fairly well to get on centerline, I don't think it's anymore difficult than the normal landing is, except for the fact that the learned flare response that I had does not work here, and my perception is, is that the flight path vector, if I have it below the horizon, which I should have a gamma, which should be independent of ground speed or winds, I did not get the same response. It would be interesting... I would be interested to look at landings with a... setting the gamma, say one diameter below the horizon, and seeing what kind of vertical velocity that you would get versus wind and no wind. Anyway, in order to get the other, all the other parameters in the desired range, everytime we had H dot in only adequate. So, going into rate it, it's controllable, adequate performance with tolerable pilot work load, is it satisfactory without improvement? And I would say no, I would come in, and we didn't get desired performance, so, it's not a 4. Adequate performance requires considerable pilot compensation. I don't think that I would really go that far to say that the compensation is considerable to get adequate performance. So, there is a big jump between a 4 and a 5 there, but I guess... I guess I'd probably give it a 5, because of the unpredictability of the flare, because it... again I'm not saying that this is true, but pilots perception, at least on my part, is that the commanded flight path vector, and I'm not getting a split so that I have to assume that that's actual flight path vector, put in the same place does not give me the same descent rate or the same gamma as it does no wind, that's kind of confusing to me. I think that's something that needs to be further investigated. I guess I'm going to leave it a 5 and a 5 for the touchdown, I don't really like to break up the Cooper Harper tasks, and it all impacts on, you know, making tradeoffs, and you know if I made other tradeoffs, I didn't try doing this, but if I made other tradeoffs in lateral control, I might have been able to get H dot within desired, but some other parameter would pop out. I guess I would have a tendency to rate the pitch axis in this case better than the... I mean worse than the lateral axis, but we'll just go with a 5 and a 5. Okay, change 415 I guess, no, I guess I'll rate... again I don't really like splitting the Cooper Harpers by axis, because there is overlap, and it is a tradeoff, but the pitch problem was significantly more difficult than the lineup problem was, even considering that it was a circling approach, we had to work on the lineup, and I will say for the crosswinds and all the approaches, I think it's harder to see lineup in the simulator than it is in the actual airplane, even with the aid in the flight path vector and the waterline, but I'm going to go ahead and change it, make the pitch rating a 5, and the lateral directional axis a 4 for this task.

## **Task 4220 Decelerating Approach**

Pilot A

Task 4220 Decelerating Approach 15 Jan 97; Runs 66-68

Okay, it appears as though using a slight amount of anticipation for the flap extension, if you're paying attention to the altitude, you can compensate for the little ballooning you get in the flap extension, the autothrottles seem to slow you down nicely, coming across the threshold, there once again, you've got to add thrust in the flare, a couple knob widths, a good hand full of thrust to, as you pull the nose up. The Cooper Harper ratings, I'd give it for the... down to 200 ft, I'd give it a... well, a 3 in longitudinal, and a 2 in lateral directional. In the flare, seemed to be able to achieve desired performance, and there is some slight compensation required, however, I'm not sure that it's anymore than any other airplane, or you have to figure out the technique that's applicable to this specific airplane. I guess, I'd give it a 3 in longitudinal, and a 2 in lateral directional for the flare.

Pilot B

Task 4220 Decelerating Approach 07 Jan 97; Runs 13-15

What I'm seeing on this, in the approach phase, prior to 200 ft it's fairly consistent. Pretty classic level 1. No problem with rapidly maneuvering and final approach. No problems in getting trim flight in holding less than half without an error. Pretty much solid level one. The flare in landing is a different story however, I'm still having problem with sink rate. I kinda settled in to somewhere between 4 and 5 feet per second..something around 1500 ft ...and I'm trying to drive it .. I'm trying to not drive it high, I should say, into the flare, I'm deliberately coming either on glide slope or a little bit low into the flare and correcting from there. What I'm seeing is fairly consistently spurts between the commanded and the actual gamma and an inability to quickly control sink rate just prior to touchdown. It seems that if the sink rate gets a little bit high and I try to correct for it, there isn't time to correct for it or I'll drive the main landing gear down and touch down prior to correcting for it. So, whereas, I felt like in the previous evaluations and other configurations in reference H I was able to control the sink rate just prior to touchdown, I'm not doing that successfully here. I am able to get adequate performance consistently but consistently unable to get desired performance longitudinally. Lateral directional not being a problem. Okay, Cooper/Hoppers for the approach phase. Longitudinal, controllable, adequate, satisfactory, no improvement required....and lets give it a 2. This is another case where I would like to give it a 2.5 but I'll give it a 2. Pilot compensation not a factor. For lateral directional, same thing, controllable, adequate, satisfactory, improvement not required, pilot compensation largely not a factor HQR2. Didn't have a problem with angle of bank control that I saw before. I think you're not flying enough ...there's not enough time to really make it a problem. Again, the landing phase, longitudinally it's controllable, adequate, however, deficiencies warrant improvement, adequate performance requires considerable pilot compensation HQR5. Lateral directional, not much of a problem there, its controllable, adequate, satisfactory, improvement not required, mildly unpleasant deficiencies, minimum pilot compensation HQR3. And I think the degradation here is just due to the gains and the task and workload requirements gets higher in the landing, so there's more lateral inputs required. That concludes my comments.

Pilot C

Task 4220 Decelerating Approach 13 Jan 97; Runs 100-103

Okay, I feel ever so much better about this, just overall, it was...everything was happening much slower, and much more naturally, I didn't have the feeling that something was going on that I didn't have control over this time. For the ILS part, much easier, satisfactory without improvement, I'd say yes on that one, improvement not required, and a 3. All the way down, just on one of them, did I get to the adequate just barely, because...but that was completely my laziness, not anything due to the handling qualities, and most of them were right there, with very...with just the minimal pilot compensation, that was fine. So, in longitudinal, ILS 3, and the lateral-directional 3, that was no problem at all, on either one on that. Okay, then down in the segment two, into the flare, once I learned the technique, which stomp, stomp, stomp, I needed to do, is it satisfactory without improvement, well, that's a tough question, that's very close to without improvement, and the thing that would keep me away from it, is it takes quite a...it took me quite a bit to learn how to do it, it wasn't the first time out of the box, I think I'm probably being very nice to it, by giving it, saying yes, it's satisfactory without improvement, but it definitely would not be higher than a 3. It was at least minimal pilot compensation, but I was consistently getting the desired and the deficiencies there were not so bad, it feels much more natural, and just feels more like I'm used to a airplane feeling close to the ground, and did not have to make those last minute quick corrections that were upsetting me so much with the...with the previous configuration. Okay...oh, and 3, 3 on both of them...of those...it's not a very good 3, a very solid 3, but a very...yes, yes, and I'm probably being nice to it on the...in the segment two, but it was so much better than the other one, you know, seeing them back to back like that, maybe made them look a little bit better, but that was much, much, improved over the first one.

Pilot D

Task 4220 Decelerating Approach

Not performed by this pilot.

Pilot E

Task 4220 Decelerating Approach 08 Jan 97; Runs 48-51

Okay, the thing you notice most with that approach is that without the feed forward compensation at 3 or 400 feet you do get some glide path deviations when the autoflaps are coming in as they are finishing their transition, and so the longitudinal task to hold glide slopes are a little bit more difficult. Also, when you get to the flare position since you are under powered relative to the nominal case, I found it a little bit harder to judge the proper place to make the power reduction in the flare, and so I think my touchdown performance suffered a little bit, I think this is something that could be taken care of with training and practice, but certainly that effect is there. Okay, for the glide slope intercept portion at 200 ft, longitudinal, controllable? Yes, adequate? Yes, satisfactory? No. I'll make it a level 2, give it a 4 and that's mainly for the... something that can be fixed the feed forward compensation during the autoflap transition, but that made the work load a little bit higher to maintain glideslope. The lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a 3 for that. The... for the precision landing, we are having some problems with my Y position. The first two were my fault where I thought we were a single throttle and was only pulling one throttle back and was getting a thrust asymmetry in the flare. When I started using both throttles I didn't do much better, so I did... interesting with the thrust asymmetry I erred to the left and when I realized I needed to pull both throttles back to the last four data runs, I erred to the right consistently, and we're going to look at the

more detailed data for that. At any rate the longitudinal performance was clearly adequate, both... if I had a good... I had one that was pretty much desired, run No. 49 and the two kind of most consistent runs were a little long and little firm so... but the overall performance would be adequate for that. So for the longitudinal, is it controllable? Yes, adequate performance? Yes, satisfactory without improvement? No. It would be a Cooper Harper of 5 due to the performance of the criteria. For lateral, we have some questions here, because it appears from the cockpit that we were not as far out of the lateral box, the desired box, as it showed on the score card, so this is a little bit of a tough rating to give. I'll go ahead for the present time and believe the score card and if we find as an error than I'll change this rating afterwards, but based on performance alone, controllable? Yes, adequate? Yes, satisfactory? No, be a Cooper Harper of 5 based on performance and that is consistently, slightly outside the desired lateral box. Of the 4 I did it was 11, 15, 7, and 14 ft, so 3 of the 4 were outside the box.

Pilot F

Task 4220 Decelerating Approach 21 Jan 97; Runs 95-96

Okay, basically, a couple of factors, and again, you know, some of these are somewhat display issues, and I don't really want to taint your evaluation on the control laws by display issues, but they are integrated here, and anyway, I'll just comment about the task, as we're seeing in the sim. Two things, first of all on the first of the data runs, I ended up, I hadn't done this on any of the practice runs, I hadn't done this on any of the runs before, but when I stuck... first of all, as we approached the runway, and I saw this on subsequent runs too, without any command, I get a split between the commanded and the actual flight path, at least that's my perception, and this is just before I start the nose up, so this is probably like around a 100 ft. On that first data run we did, I started the nose up, and there was... before I started the nose up, there was already a disparity between actual and commanded, and then as I pulled the nose up, that disparity got larger so, in the heat of the battle, I decided that I was going to pull the actual up to the horizon, and as I was doing that I realized how wrong that was, so I pushed the commanded back down to the horizon, and we ended up... (landing hard.)

## **Task 4225 Decelerating Approach/Manual Throttles**

Pilot A

Task 4225 Decelerating Approach/Manual Throttles 15 Jan 97; Runs 70-72

Landings with a decel, manual throttles that's a constant thrust setting during the reconfiguration and the ILS. I would give lateral directional during the... down to 200 ft is a 2, longitudinal would be a 2, and a during the flare, since we're not getting... you don't seem to be getting desired performance all across the board, I guess I'd have to rate it, just somewhere between a 3 and a 4. Because of the special techniques required, I think I'd give it a 4, because of the large amount of thrust required in the flare to get the sink rates down, which seems a little unusual and compensating factor. So, I'll give it a 4 longitudinally, and a 2 Cooper Harper in the landing phase, the flare phase. It looks as though, one of the things of note, for these approaches are that, if you have a very low thrust setting, as you begin the flare, you just about have to have a moderate amount of thrust on the airplane during the flare in order to get the gamma control law to respond properly. If you leave the thrust at idle, and do everything with the flare, it seems to... the bottom seems to drop out, and also the other factor is that the... you don't get the gamma that you command, and so I'm not sure why that is, maybe you should look at the control surfaces and see what they're doing, during one of those runs.

Pilot B

Task 4225 Decelerating Approach/Manual Throttles 07 Jan 97; Runs 20-22

We spent some time tuning the parameters, just a note here, it's important to note that when you push over, or when you start the run, I should say, right up through the pushover, not to adjust the throttles to maintain airspeed, to accept the acceleration as you push the throttles over. And make sure you start with the gear down except the accel. And then at 1400 ft, I wouldn't be in too much of a hurry to set 10%, we use 10% Vs 9%, and that seems to get us a fairly good speed on final and touchdown. Glideslope phases is pretty much what I've seen before, and so you're not adjusting the throttle, it's very much like an autothrottle approach--good solid level 1. No problems with the ability to maneuver and attaining trim flight with whether it be constraints of the technique. The landing is getting easier because I am accommodating to it, I think. There is no tendency to bobble or PIO in pitch and roll. There is a tendency to float due to sink rate control problems. There is no tendency to bounce or geometry strikes. Okay, in the approach phase, longitudinal HQR is controllable, adequate, satisfactory, improvement not required, negligible deficiencies HQR2. Lateral directional controllable, adequate, satisfactory, no improvement required, negligible deficiencies HQR2. In the landing phase, longitudinal HQR is controllable, adequate, however, I think deficiencies warrant improvement. There's a lot of work to get the sink rate under control. And I am going to give it an HQR4, this time....for moderate compensation for desired performance longitudinally. Lateral directional, it's controllable, adequate, and it is satisfactory, mildly unpleasant deficiencies, minimum pilot compensation and a higher workload HQR3. That concludes my comments.

Pilot C

Task 4225 Decelerating Approach/Manual Throttles 14 Jan 97; Runs 40-42



You want both longitudinal and lateral-directional, I assume, well, the lateral-directional is easy, is it satisfactory without improvement? I'd say yes, I'd give it a 3 on the lat-dir, this is a pretty well canned, you start out on the localizer and just kind of drive it in, so it would have to be pretty bad to not be satisfactory without improvement for that part of it. On longitudinally, is it satisfactory without improvement, I'd say no, it really requires improvement on this, I seem to have quite a spread, I was a little long, a little short, then one right in the middle, so I'd have to say adequate is the best performance I got, I think the one that was in the middle was...just happen to be...having to luck out on that one, so, I'm going to call it adequate performance for those, and as far as how much I had to work, I would say considerable pilot compensation would be the best description for it, so 5 for that. It does require improvement, you know the possibility of it working is there, but it needs to be refined maybe with the amount of throttle or a...either nominal throttle position be changed or maybe some learned amount of change in the flare or something. I never had a good solid feel, that I knew when it was going to touchdown, so, it wasn't a fine control on fore and aft touchdown point, that's for sure. And the only other thing that I noticed on this was the amount of time that it spent...the actual one stood...was away from the commanded flight path marker. I spent quite a bit of time, thus that of course, increased the compensation a little bit, you were switching really between ones that you were controlling from the commanded one to the actual one and so that bumped up the compensation a little bit also. Other than that, it feels quite normal as far as when I got down in close, all the motions I felt were ones that I was putting in. I had a little, little more feeling of being in control than I have on some of the earlier ones. That's it, you didn't need anything on the glideslope. The lat-dir on the glideslope would be...I would give that probably a 2, it really wasn't much going on there, and until I intentionally did a small duck under, just because the touchdown point is at the end of the interception of the ILS glideslope, if you don't duck under a little bit, you're throwing away a few hundred feet right there, so, I intentionally dropped down to like a half a, half a dot on the glideslope to have a better chance of getting it in the desired box, and so we kept reading a lot of adequates, or even occasionally I noticed the couple in there that got inadequate, but until I intentionally made this duck under, the glideslope control was actually quite easy, so I'm kind of stuck here on giving that a rating, and because it was intentional, it wasn't too bad, everything up and away, of course, it was canned and hardly a problem, probably give that a 2 even on the longitudinal until I intentionally ducked under and that's why I'm disregarding the fact that some of these came up adequate or okay, I think there was an inadequate in there some place, but for the main part of the glideslope, a 2 would do. It's really not doing anything, you know, you put it there, wait. On that one there was a little more just because of the splits, but in general that was not a big factor.

Pilot D

Task 4225 Decelerating Approach/Manual Throttles

Not performed by this pilot.

Pilot E

Task 4225 Decelerating Approach/Manual Throttles 08 Jan 97; Runs 54-56

Okay, there are several things on this, when we were trying to play around with the power a little bit to see which is the proper power setting, the first two data runs were at 9 percent and were clearly underpowered at the threshold landing short and firm and at very high attitudes trying to make it into the box. We adjusted the power from 9 percent, at 1400 ft to 10 percent, and the last landing we had enough power, and I thought I made a very good

save to make a nice touchdown, but ended up leveling out and not touching down, which would have been, I think a very nice landing, but then it leveled out about a foot, actually showed 4 ft on the radar altimeter and just continually decelerated and plunked down. Interestingly, when you get that situation when you kind of level off, if you drop the nose at all, you're gonna get a firm touchdown and if you hold it, you're gonna get a firm touchdown, so if you level off you're kind of in a mess. At any rate, the other thing that is interesting about the approach is that coming in on the deceleration all the way, it really does make the flare task problematic because on a swept wing jet aircraft decelerating approach is a very difficult approach to judge properly as far as in the touchdown zone. You don't have much power to play with as far as... if you have it overpowered in a normal approach, you can of course put power off a little bit sooner. When you already bet way back on the power and we're not suppose to be adding power for noise and we're kind of in a little bit of a mess there. So, it does have some problems associated with this approach. For the up and away glideslope intercept at 200 ft, longitudinal we met desired and all those criteria, we still have a little problem with the glideslope error around 3 or 400 ft because of the feed forward compensations lacking, and that's going to effect the rating. For longitudinal, it was controllable, adequate performance was obtainable, satisfactory without improvement, I'm going to say no, rate it a 4. That's do to work load on the glideslope. Lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a 3. Very similarly to the auto throttle approach. For precision landing the performance ended up being clearly adequate all the way, again when you didn't recognize it, we're using two different power settings, 9 percent for the first two and 10 percent on the stabilized power, it's 1400 ft for the third one. Included in the performance was a... the longitudinal was in the adequate range and lateral directional was probably desired except for that one... it had one kind of deviation on lateral placement, but the others were very, very good. So, for longitudinal, controllable? Yes, adequate? Yes, satisfactory without improvement? No, because I met the adequate performance rather than desired, it will come in as a Cooper Harper 5. For lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement, I'm going to say yes throughout that one, lateral anomaly and the other two which were very good. Use those as my rating runs and I'll give it a 3. Again the major concern with this approach is that you are coming in way back on the power as you approach the threshold and your margin for error is reduced and it's kind of depending on what your situation is at the threshold, it's gonna really drastically effect you're position in the touchdown, the pilot doesn't have a whole lot of control over that.

Pilot F

Task 4225 Decelerating Approach/Manual Throttles 21 Jan 97

Not rated.

## **Task 5010 Stall at Idle Power**

Pilot A

Task 5010 Stall at Idle Power 13 Jan 97; Runs 67-69

I'll give it a ... in pitch a 2, Cooper Harper and lateral directional a 2, and it's quite ... quite controllable and docile, and the forces for overriding the stick were ... didn't seem to be quite as great on that particular task, as the power on was. It looked like a matter of holding about 10 degree pitch attitude as you would decelerate at about 1 knot per second, and push over about 8/10 to 9/10 of a G, down to about 8 degrees pitch attitude below the horizon, and that gets you at 13 degrees of angle of attack. It would be nice if the speed would transfer to the bore sight ... airspeed, so you could see what the speed was at those high angles of attack, and I kind of prefer a, instead of a vertical tape, a round dial pointer for angle of attack, but some kind of marking also on the angle of attack indicator indicating the limits would be helpful. A color coded normal operating range, cautionary, and ... or maximum angle of attack limit indication on the scale would be ... would be helpful.

Pilot B

Task 5010 Stall at Idle Power 06 Jan 97; Runs 45-47

Performed as per the card. This time, max bank angle was within limits. I believe I want to look at this last one, yeah , I was within limits and I didn't notice any pronounced PIO tendencies. I think it has to do with the amount of pitch change and how aggressive you are with the recovery input. So, everything was fairly easy and performance was within limits . Its controllable longitudinally....it s controllable adequate satisfactory, and improvement not required. Level 1, mildly unpleasant deficiencies HQR3. Minimal pilot compensation required. Lateral directional was a little tougher than longitudinal but not enough to bump it into level 2, I think. Its controllable, adequate, satisfactory , and improvement not required, mildly unpleasant deficiencies, minimum pilot compensation HQR3. That concludes my comments.

Pilot C

Task 5010 Stall at Idle Power 15 Jan 97; Runs 97-99

A little more work and pitch, tend to overshoot a little bit, that's not what we're measuring, however, and to recover, it took a little push force this, and the last time I could just kind of come off the backpressure, and drop...the nose dropped, at a nice rate by itself, but anyway, for lat-dir, satisfactory without improvement, yeah, and I'd say a 3, minimal compensation to keep the wings within desired, and for pitch, same kind of thing, it's...I'd still call it a 3, that's I think, a good description of it.

Pilot D

Task 5010 Stall at Idle Power 22 Jan 97; Runs 12-13

It's really no problem, straight ahead stall, and the only real problem I saw was just a tendency to bobble in pitch and roll a little bit, and as you approach the stall, the stall protection comes in and it keeps taking an increasing force, which is good, but it does increase the workload to get it up to stall. As far as the actual stall recovery goes, there's no

problem, we have plenty of pitch authority. There is a tendency to sit there and oscillate in roll and pitch just a little bit, but no problem, very good. Pilot rating longitudinal 4, lateral 3.

Pilot E

Task 5010 Stall at Idle Power 07 Jan 97; Runs 98-100

There's nothing really common that this one, no PIO tendencies Pitch or Roll. I made basically the first one... I fairly aggressively pushed the side arm controller to slightly forward of neutral point, I got a rate limit on the elevator, about 30 degrees momentarily and recovered very nicely. The next two I did very aggressively to the forward stop and held it there and tried to get a max Q and it did not seem to be that much greater than pushing slightly forward of neutral. That Q that I got was minus 2.74, the last one which made a very aggressive push forward to the forward stop, no that was the second one. No problems through recovery, and we had no PIO noted or tendencies of not wanting to recover. I felt like I had, even though I saturated in the elevator, I felt like the control authority was efficient. The evaluation segment longitudinal 2 Cooper Harper controllable? Yes, adequate? Yes, satisfactory, yes, a 3. Basically I almost think though that if I just released the stick, the stick protection features would give me almost the same recovery, maybe not quite as quickly as by actually staying in the loop. The lateral directional, controllable? Yes, adequate? Yes, satisfactory, yes, a 3 also. It takes a certain, you just got to be aware the fact though to maintain wings level, but its not a real PIO problem.

Pilot F

Task 5010 Stall at Idle Power 23 Jan 97; Runs 16-17

I guess I would note that the transition at 15 degrees with the envelope protection on the stall entries, probably not a big deal. On the stall recovery, I do notice it, and that there is a tendency for me to stagnate at 15 degrees. I have to pick up a push to go through that, it's not a big deal, but it's just something to note. I would assume that 15 degrees is probably an angle of attack where the airplanes just trying to fly, if it's not, I would probably try to bump that transition so that it is at a point where the airplane is acceptable to fly, and have to be great flying there, but my point is, I could see a tendency, especially if it was an inadvertent stall, get into envelope protection, not at stall. These are really only, well, anyway, I could see a tendency for the pilot to stagnate at that point, because it's... the nose is dropping, and giving him the normal feedback, that a normal airplane, and a stall does, with kind of a g rate kind of thing, and then he has to go to the push to get through that 15 degrees. Like I said, I don't think that's a big deal, I think the requirement was no tendency to PIO for desired or adequate, is that correct. Okay, I don't think that I would call what I did a PIO, although two things, first of all, in putting the inputs in, I think it's a ergonomic issue, but I am having the tendency to split the pitch inputs to put in a roll input. The other thing is, is basically, when I pushed over, if I tried to tightly control the bank angle, I have a tendency to maybe overcontrol slightly, and I could see getting in, I think if we looked at the strips, we'd see a couple oscillations are going left and right on bank angle, and you know, the line between just an overcontrol and a PIO, is very thin. It was something that I could control, and so, I guess I won't characterize it as a PIO, although, I would say that it's mildly unpleasant deficiency, certainly. I'd almost say it was a annoying deficiency, in fact, let me turn the tape off, and let's do one more data run, if you don't mind.

We did another data run in between the comments here, and what I wanted to do was look at the tendency for a lateral PIO, and I think that when I come into the Cooper Harper, I'd say

it's controllable, adequate performance is obtainable with a tolerable pilot work load, is it satisfactory without improvement? And that's really what I was trying to answer. Was there any tendency to PIO or not, I still think this is a hard question, I'm going to answer yes, and the reason I am is, I think that there could be a tendency to couple up if you tried to use real tight control, because I think what you're going to do is end up overcontrolling in the ailerons. As long as I'm very patient with the airplane, you know that's kind of been an underlying theme, that I have to be patient with the airplane, and that the control is not always real crisp. As long as I'm patient with airplane, and consistent with how I fly the airplane throughout the rest of the envelope, I don't really think there's a tendency to PIO. I think there is a tendency to overcontrol though. I guess... I guess I still think, in my mind this is a hard question to answer, I think it's a hard question between a 3 and a 4, and I think it's definitely mildly unpleasant deficiency, it's almost to the point where it's annoying, and minimal pilot compensation is required for performance, and that's what was really the tie breaker for me, is I do think it's minimal compensation required to get desired performance, although, it's on the borderline between what I would consider minimal and moderate, not because of the work load issue, but because at least in my mind, when I look at compensation, I look at how likely I am, how easy it is for me to accept that compensation, and certainly if I was looking at other tasks in the cockpit at the same time, one of the things that I would drop out is, being patient about the roll. I think I'd stay well within adequate, but I could see pushing on the side of the desired because of that, so anyway. I'm sorry, for longitudinal and lateral, I'm not going to split them this time, well, we can split them there, but I'm going to say it's a 3 for both, and you know the pitch really isn't bad at all, like I said there is that tendency to try to stagnate when your transition for releasing back pressure to pushing, but you know, the pitch really is pretty good, and I'd almost be tempted to go with a 2, but we'll just leave it 3 and 3.

## **Task 5020 Stall at Max Takeoff Power**

Pilot A

Task 5020 Stall at Max Takeoff Power 13 Jan 97; Runs 64-66

Recovery from Limit Flight Envelope; Cooper Harper ratings, longitudinal, is it controllable? yes, is adequate performance obtainable with tolerable pilot work load, yes, satisfactory without improvement, I think it probably is, improvement not required, level one, and we'll ..., looks like a Cooper Harper rating of ... the only unpleasant deficiencies I might note is the one you're holding the force on that, I'm trying to hold a constant decel rate, the force you're holding is fairly high, and I noticed in the stick there was a few discontinuities, where you seem to be going through a...one region to another, or something. Yeah, you've got up to a certain ... certain speed down to a certain speed when there is slight glitch in the stick, but other than that, it was pretty good, I ... it's either a 3 or a 2, I would ... I'd think I'd give it a 3 in longi ... and pitch, and for lateral directional, the only thing that seems to be a minor annoyance is the ... when you're holding that very large force in pitch, and you're trying ... you're holding very small forces in roll, then any minor angle that you're pulling on ... on the stick, if your off slightly on the angle that you're pulling, you'll get some roll in there, with the high forces in pitch, and the very light forces in roll, the small angle changes in the... it seemed like there's difficulty to control it to plus or minus one, although, so, I'll give it a 3 in lateral directional also.

Pilot B

Task 5020 Stall at Max Takeoff Power 06 Jan 97; Runs 41-43

...Lets see, summary performance standards max bank angle desired was relatively easily obtainable. However, there is some pilot induced oscillations in the lateral axis. I noticed a very pronounced tendency for small amplitude roll oscillations on the order of plus or minus..oh , a degree to 2 degrees....in conjunction with large longitudinal inputs and it was strictly in conjunctions with those large inputs but I was definitely driving it and I was out of phase with it. So you can't say there were no PIO tendencies there, there was in the lateral directional axis, although, it was not divergent. And it was small amplitude. There is no task for the longitudinal axis. I'm going to assume that that refers to desired longitudinal control. I can put the nose where I need to in terms of the decel rate....and I'll give it a tolerance something along the line of what we saw before, plus or minus a degree and it was easily doable to that extent. As for longitudinal, its controllable , adequate, satisfactory, improvements not required , mildly unpleasant deficiencies, minimum pilot compensation HQR3. Lateral directional, I'm not going to penalize it in terms of control because I don't feel like the amplitude of the PIO is large enough to penalize it to that extent. But I can't say that I could get desired performance there either 'cause I did get some PIO. Nondivergent PIO. So its controllable , its adequate, however, not satisfactory without improvement, deficiencies warrant an improvement and we'll say that since I couldn't get desired performance, that moderately objectionable deficiencies adequate performance requires considerable pilot compensation HQR 5. This is another one where if I could give it , I would give it a 4.5. Because I can't say that I was using considerable compensation to get adequate, but on the other hand, I couldn't get desired. So, that concludes my comments for card 11.

Pilot C

#### Task 5020 Stall at Max Takeoff Power 15 Jan 97; Runs 94-96

Okay, for what I did, which was just keep it wings level, and my task was to keep it as near wings level as possible, it was satisfactory without improvement, and in pitch it took a...it took some compensation to keep at it, because it's...you have to...it's real goosey, and just a little bit of input goes a long way, so, the best I could do would be a 3 on that, and I kept it within desired in roll, and again, just keeping it on wings level, even the lat. dir., I'd leave it at 3. I never got it very far off, and tried to come back and catch it, but that's a different task, but to just keep it on wings level, just a minimal compensation will do it.

#### Pilot D

#### Task 5020 Stall at Max Takeoff Power 22 Jan 97; Run 23

Very similar to the OEI's that we just did, we don't have the additional task of controlling beta as much. I'm just going to give it a ditto, although it did feel like the force buildup was a little higher to get it up to 21 degrees in this case, which I think is good. Not sure quite why, maybe it's my imagination. Pilot rating must give it the same. The longitudinal and the lateral, both 4/3.

#### Pilot E

#### Task 5020 Stall at Max Takeoff Power 07 Jan 97; Runs 94-97

We did 4 runs on this at progressively increasing aggressiveness for the recovery. The first one I very, very gently recovered probably somewhat in the order of maybe a degree to 2 degrees per second cue to recovery. The second one was a little bit more higher Q, as far as pitch rate is concerned, and the third one is a little bit higher still, although the Q dot for that third one was less than the Q dot for the second one, but I think I maintain the command to get a higher Q, a higher pitch rate, than on the second one. On the fourth run I was very aggressive with a acceleration of Q dot of minus 5.52. The first two I noticed a roll PIO going through about 17 degrees alpha, it was about 2 hertz and plus or minus a degree or so, and I just felt like I was at 180 at a phase with the vehicle. I did not notice the roll PIO with the faster of pitch rates, and I was totally absent. At the last one I went the highest pitch rate... was just very, very aggressive. Any rate it is possible to recover using all those techniques but very gentle through very aggressive. Cooper Harper longitudinal for the steady fight wings level. This goes through the entire evaluation, so longitudinal, was it controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, using all the techniques basically mildly to aggressive. I would rate that a 3, minimal pilot compensation is required. There is no pitch up tendencies in the stall. In fact you have to hold a lot of back stick to keep it up there. I guess you have all the Boeing stick protection features on, is that correct? (Correct) So you've got to fight the actual soft stops and all that, so I think if you let go of it, it's going to tend to want to recover more aggressively than the first two or three ways that I recovered it. For lateral, controllable? Yes, adequate? Yes, satisfactory? No, I'm going to rate the lateral a 4 based on the PIO I experienced on the first two runs. So there appears to be some kind of a propensity to get into a lateral PIO if you make a very general recovery, and such would put the compensation up there. I think that may be something worthy of note. Knowing that now I would tend to recover more aggressively than I initially started just to avoid that PIO, but obviously you need to do more than 4 runs coming up with that. We'll see a 3 and a 4.

#### Pilot F

## Task 5020 Stall at Max Takeoff Power 23 Jan 97; Runs 22-24

Basically, exactly the same comments as the previous stall, I don't really see much of a difference, we just had a discussion about the  $Q$  dot parameter, we were seeing a 2.05 squared, degrees per second squared, I guess, for the acceleration with pitch rate, and I guess, you know sitting here doing the stall, and we know what we're doing, especially considering the fact that, you know, repeatedly, at least my comment has been that I'd like the airplane to be just a little bit crisper. I'd rather for ride quality, I'd rather back off on my inputs, but still have the airplane respond crisply when I need to, I guess it would be okay for me, if the nose came down a little bit faster. I think one of the reasons why we're seeing a lowered  $Q$  dot, than what you were saying Lou, was that in the Milspec is... you know, basically I'm just releasing back pressure here on the stall, and I'm trying to control the bank angle very precisely, and that's taken a fair amount of my attention, and I think in part the reason why maybe, you know... I could bump forward on the stick, I think I could release more back pressure, and in fact after we get done rating this, let's just go take a look at... If I just release it. But I'm wondering if people aren't just very ginger about releasing the back pressure, simply because of the bank angle control, and it's taking a lot of their work load, and a lot of their attention. Anyway, to rate this, it's controllable, adequate performance is obtainable with a tolerable pilot work load, and again, I'm in the same quandary between the 3 and the 4, for all the same reasons. I really saw nothing unique about this particular stall. I'm going to go ahead again, and say that I think, you know, it's minimal pilot compensation, because I have to reduce the gain, and I'm going to, I guess, go along with what I've done in the past and be consistent, and give it a 3 and a 3. One thing that I will note, though, is you know, if consistently pilots are tending to not drop, you know, pilots being creatures of, I don't know, kind of like Pavlov's dog, they want to get the performance. You know, if this  $Q$  dot's not a parameter, my tendency is going to be control to what is the most difficult, and make those tradeoffs. Yeah, I don't think that, at least from what I've seen in this limited look, that there's a doubt in my mind that the airplanes recovering, but we'll take a look at it again, I'm wondering if people are just very gingerly about releasing the back stick, because of the recovery, because of the roll stop. Anyway, we'll take a look at that.



## **Task 5040 Turning Stall at Idle Power**

Pilot A

Task 5040 Turning Stall at Idle Power 13 Jan 97; Runs 70-72

Once again the forces to override the low speed envelope protection are high in pitch and they still retain very light aileron forces, so the bank angle control is somewhat touchy at the very low speeds. It would be helpful to have ... would be helpful to have a ... like I said, color coding on the angle of attack indicator, and also a stick shaker, to give some feeling for when ... when you are getting up to 21 degrees, watching the bank angle and the pitch attitude, and the angle of attack indicator are quite spread out on the display, so we seemed to get surprised by the angle of attack as it increases, but other than that, the recover is very docile, and roll wings level lower the nose, and it's very straight forward in that respect, and I would give it a 3 on lateral directional, and a 2 on pitch control.

Pilot B

Task 5040 Turning Stall at Idle Power 06 Jan 97; Runs 48-50

Card was not performed as per the instructions, except that recovered both lateral directionally and longitudinal at the same time... didn't really, I can't really say directionally, I didn't really put any rudder inputs but I did roll the wing level and lower the nose at the same time, in the past that caused problems, this time it did not. I was able to maintain performance standards within the desired range in both axis. Working a little bit in lateral directional, not quite so much longitudinally, although I was working a bit to maintain the pitch attitude I wanted to to get the deceleration rate so, I'm not quite, not quite ready to say that lateral directional is.....results in a higher workload than the longitudinal system. So, lets go with the longitudinal HQR, it's controllable, adequate, satisfactory, with mildly unpleasant deficiencies, minimum pilot compensation HQR3. Lateral directional, controllable, adequate, satisfactory, with again, mildly unpleasant deficiencies, minimum pilot compensation, HQR3. The longitudinal task, the workload that resulted in the 3 was associated with maintaining pitch attitude in the entry to the stall and the lateral directional degradation to HQR3 was as a result of workload requirements and the recovery from the stall. That concludes my comments.

Pilot C

Task 5040 Turning Stall at Idle Power 15 Jan 97; Runs 101-103

Both the pitch and the roll were satisfactory without improvement, so we're up in there, and again, minimal pilot compensation, it's fairly easy to get desired, there wasn't wasn't any question, it was behaving quite nicely in the recovery, I had no anxiety over whether it was going to recover or not, it all looked fine, and it was quite controllable, so a 3 for both the longitudinal and the lat-dir

Pilot D

Task 5040 Turning Stall at Idle Power 22 Jan 97; Runs 15-16

It's pretty much ditto, 5010. We do have the additional task of the roll which really doesn't add to it. I did notice that the... this is the first time and really all the work I've done here so

far that I've had to use the lateral axis, and it seems like it might be just a little bit jerky on the lateral control inputs, but for this task I'm going to give it the same ratings, longitudinal 4, lateral 3.

Pilot E

Task 5040 Turning Stall at Idle Power 07 Jan 97; Runs 101-103

No problems on this one. If I make an aggressive, what I was doing was recovering in pitch first and I was pushing over with the side stick and keeping the roll attitude constant. Once I got the flight path marker below the horizon, I'm sorry when I got the waterline reference of longitudinal axis, body angle below the horizon, I would go ahead and recover. If I did recover laterally... if I did a very aggressive wings level recovery, I could get a little tiny bit of roll PIO, but if I was just a little bit less than aggressive, it worked out very nicely. So I say overall no problems with the recovery at all. In the rolling into the 30 degrees angle of bank, I noticed that I had to put in a rudder to keep the side slip centered, so the control law is sufficient in that regard. I shouldn't have to be working the rudders to maintain zero side slip on a simple angle of bank capture. For the task though, for the evaluation segment, longitudinal Cooper Harper; for the longitudinal task, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, Cooper Harper of 3. Basically you have to... actually just release the stick, it probably would recover on it's own, but I am putting in compensation therefore a 3, but it does not require much effort at all on the part of the pilots, so it's kind of a borderline 2, 3. For the lateral directional Cooper Harper, controllable? Yes, adequate? Yes, satisfactory, yes, I'll rate it a 3 also. There are places in the envelope we could get a slight roll PIO, and it is a little bit difficult to hold 30 degrees angle of bank. It does not, you can't really command that angle of bank and have it hold it so I think that the control law is sufficient there also, and have to put in the rudder to maintain the zero side slip when you command that 30 degrees angle of bank either left or right. So upon further reflection, I am going to change my ratings say it's not satisfactory without improvement. In fact it needs to be improved in the lateral axis. I'm going to rate it a 4, and that desired criteria, that we need to have an aileron/rudder interconnect feature that will zero out the beta when you roll into the angle of bank, and also the control law needs to more easily hold an angle of bank that's commanded.

Pilot F

Task 5040 Turning Stall at Idle Power

Not performed by this pilot.

## **Task 5050 Turning Stall at Thrust for Level Flight**

Pilot A

Task 5050 Turning Stall at Thrust for Level Flight 13 Jan 97; Runs 73-75

The pitch attitude required is about 12 degrees, kind of a constant pitch attitude while it decelerates, good control, same problem, or same notation anomaly as before, heavy elevator forces and light, aileron forces, and it takes a little special effort to avoid a bit of a PIO, trying to hold 30 degrees of bank angle, the little lack of control system harmony, by design I guess, and however, there wasn't any trouble holding the tolerances during the stall entry and the recovery, it's quite straight forward on the recovery, roll wings level, lower the nose, and no problem at all, I'll have to give it a 2 for the pitch, and a 3 for the lateral directional.

Pilot B

Task 5050 Turning Stall at Thrust for Level Flight 06 Jan 97; Runs 52-54

In summary, the performance standards were met. A very small tendency, very, very light tendency for pilot induce oscillations in the lateral directional axis. I'm not going to penalize it for it. I don't think I really got any full-blown PIO but there's a very mild tendency towards that. Yeah, that's really the whole thing, I saw it anytime there were large inputs that time. Again, very mild but its there. Longitudinal its just a matter of chasing that carrot, its the workload that primarily the problem..obviously in the entry since there's no task in the recovery. And again the criteria I'm using for desired is plus or minus a degree, for adequate, plus or minus 2 degrees, longitudinally and that was easily doable in the desired range. So longitudinal CHR, it's controllable, adequate, and satisfactory, mildly unpleasant deficiencies HQR3. Lateral directional, controllable , adequate, satisfactory, mildly unpleasant deficiencies and minimum compensations HQR3 as well, with the comments as noted. And that concludes my comments.

Pilot C

Task 5050 Turning Stall at Thrust for Level Flight 15 Jan 97; Runs 104-106

I couldn't see any difference between the two and required work order performance, so a 3 and 3 for longitudinal and lateral-directional.

Pilot D

Task 5050 Turning Stall at Thrust for Level Flight 22 Jan 97; Runs 18-19

Pretty much ditto, the previous two. I did notice that the force buildup is really a pretty good warning that you're getting close to stall. It actually might... we might make it a little bit higher for... to give just a little bit more warning, and of course, does increase the work load for doing the task here, but I think operationally a little bit more buildup might be desirable. I'm going to give it the same pilot ratings, longitudinal 4, lateral 3.

Pilot E

Task 5050 Turning Stall at Thrust for Level Flight 07 Jan 97; Runs 104-106

General comments, it seemed like it was just slightly harder to hold the angle of bank and get the deceleration with the level flight thrust and idle power, it's just a little bit higher work load, as opposed to task #5040. The task was straight forward, I noticed every once in a while a slight roll PIO on the recovery, especially if I aggressively rolled to capture wings level. The more aggressive you are, the more likelihood of creating a very slight roll PIO and it's pretty easy to recover from just by getting on the loop just briefly. No problems in the recovery, it's almost... it's hard to hold it up there if you just relax you're back stick you're going to recover pretty quickly. So actually you have to work to keep it in the stall, with all of the protection we have. As far as longitudinal Cooper Harper, I think I met all of the desired criteria for the longitudinal and lateral directional. And basically no PIO, so controllable? Yes, adequate? Yes, satisfactory, yes, I'm going to rate that a 3. Basically I think if I did nothing it would recover also. So the recovery would probably be a 2, but since the start segment is 30 degree bank turn, you would actually have to work to keep it into the deceleration mode, there is compensation required, so that gives it a 3. Lateral directional, controllable? Yes, adequate? Yes, satisfactory, yes, I'm going to say a 3 also, even though I think at times you could get a very slight roll PIO, but it was very, very slight and not always pleasant.

Pilot F

Task 5050 Turning Stall at Thrust for Level Flight 23 Jan 97; Run 18

Really no big deal, actually the entry is almost easier at 30 degrees. There is, again, I have to pay attention to the pitch inputs, because I have a tendency to couple up in roll, but it's not too bad. Again, capturing and holding a bank angle, if I'm trying to do a real tight tracking of bank angle task, I have to be patient with it, I have to catch the deviations early, and make small gradual inputs, so that the predictability remains good. If I start making more abrupt, tighter control inputs, I have to actually reverse the stick to get the roll rate to stop, or the roll rate just kind of trails off, or coast to a stop, and it's hard to predict where it's going to stop. When I reverse the stick to stop the roll rate, it can be... you're not getting roll rate ratcheting, but it can kind of be ratchety, kind of bouncy, kind of control. Anyway, this comment is exactly the same as we saw before. When I went to... because of this, when I went to capture the bank angle, I used a fairly moderate roll rate back to wings level, but when I was within 8 or 5 degrees of wings level, I slowed the roll rate down significantly, so that I could coast in and capture zero degrees of bank fairly precisely. Even on the pushover there was a tendency to have to really pay attention to the bank angle control. Still the tendency of going through 15 degrees, you have to transition from the back pressure, releasing back pressure to a slight push, but it's not a real big deal. I'd go in for the Cooper Harper, it's controllable, adequate performance is obtainable with a pilot work load, is it satisfactory without improvement? The same exact comment from the last stall as far as, I'm going to say that it's mildly unpleasant, and minimal pilot compensation, although... and I think it's more of a function of over controlling, than it is really coupling, but I guess I could see if somebody really tried to tightly control this, that they could maybe induce a slight PIO. Anyway, so I'm going to say yes, and I'm going to go, and I'm going to rate it for all the same reasons as I did on the last stall, a 3 and a 3.

## **Task 5060 Diving Pull-out**

Pilot A

Task 5060 Diving Pull-out 14 Jan 97; Runs 26-29

Cooper Harper rating for the pitch, I would give it a 2, and you rating the lateral directional on this? I'll give it a 3. The unstart circles are pretty effective in keeping the airplane free of an unstart during the pushover, there seems to be a slight non-linearity in terms of the response of the airplane to a constant pull-up force when you first start to pull out. There's a rapid onset of G's, and it kind of overshoots and drops off, and finally stabilizes out. If you pull a constant force, maybe the combination of the thrust coming up and the control system reacting to your commands. There's barely... fairly docile, it took a...it almost didn't get down to 7 1/2 degrees of nose down before we got to 2.5 Mach, and the pull out was quite easy, no particular problem there. The ability to hold G's was reasonably good, a little more expanded G meter might be helpful.

Pilot B

Task 5060 Diving Pull-out 08 Jan 97; Runs 73-75

The card was accomplished as per the instructions, maneuver is possible without exceptional pilot strength or skill, you are pushing forward to keep the nose down, because the over Mach protection is trying to fight you, without exceeding VMDE, that's an old criteria. Okay, no control reverses or PIO, that's true. Maximum bank angle and load factor we are able to keep within desired. Fighting a little bit to keep the engines from unstating in longitudinal and to maintain bank angle within a reasonable value, that being 5 degrees on the recovery. Both Cooper Harpers are the same, it's controllable, adequate, satisfactory, and minimal pilot compensation in both cases, HQR3, both longitudinally and lateral directionally. That concludes my comments.

Pilot C

Task 5060 Diving Pull-out 15 Jan 97; Runs 115-117

For the...well, let's do pitch first, satisfactory without improvement, well, the problem is keeping from the unstart on the push, on the pull, without any motion seat of the pants, it's a lot harder to try to hold a G, it was very right on the border of desired and adequate, so I'm going to say it's not satisfactory without improvement, that's a tough one. Deficiencies require improvement, and it's one of those that...it's easy...it's fairly easy in pitch to get adequate, and it's difficult to get desired, and so that makes it tough to rate, I would have to give it a very poor 4, however, we're right on the border of desired and adequate, and it was a lot of work, and it was at least moderate, and maybe just a smidgen more to get that desired performance. So, 4 for pitch. Roll, satisfactory without improvement, it didn't take a lot of work, because it's just a straight up and back, I did see a little bit of coupling and the nose over, and a little bit coming up at no more than a degree or two, maybe something, and...most of my concentration was on pitch, and lat-dir kind of took care of itself. So, I'm going to say it's satisfactory without improvement, a 3 for lat-dir, 4 for pitch.

Pilot D

Task 5060 Diving Pull-out 22 Jan 97; Run 34

This is the diving pull-out initiated from a minus 7 1/2 degrees, and Mach 2.5, and trying to recover at 1.5 G's. A little bit of a task longitudinally, initially you have to kind of pull the thing up to 1 1/2 G's, and then as the envelope protection takes over, you kind have to push to keep it from pulling up more, and particularly when you're trying to level out the aircraft at gamma equals zero, and by this time we're going a little over a Mach 2 1/2. The alpha goes down to 1.9 and we get... the unstart envelope gets very small, it's almost impossible to keep from having unstarts. Laterally, I got up to 6 degrees on the pushover, which I think was just inadvertent, that was really, if I paid more attention, that wouldn't have been a factor. I'm not going downgrade on the account of that, but there still is that PIO and roll that's been existing here all along. Pilot rating, let's still give it the 4 and 4. Pilot D on 5060, we made two runs for data there. The first one we didn't do correctly, we didn't retard the throttles to idle, so we got into a little bit of a problem, that ended that problem, where we were have to pull up at 1 1/2 G's and then push over as the envelope protection tried to take it, and also we were getting the unstarts, because the unstart envelope had gone to zero, at the level flight condition. With the throttles at idle, the task was a little bit easier, you still have the lag in G as you do the pull-up, but it was a constant, not a constant, but a monotonic at least, well excuse me, what's the word, it was always a pull to hold 1 1/2 G's up to level flight, and at level flight we had a reasonable unstart envelope this time, but still it's, because of the lag in the G, and the tendency to PIO in roll, let's still give it longitudinal and lateral ratings of 4 and 4.

Pilot E

Task 5060 Diving Pull-out 10 Jan 97; Runs 50-53

This is fairly a simple task, not much involved, a little bit of coupling in the lateral axis on the pull, which I've seen before, you get a little plus or minus one or two degree phi, slight roll PIO on the recovery, and it's just kind of a nuisance rather than anything significant, but it's something that should be corrected. No problems on the recovery, there's a slight tendency to get a lag in your... if you close on G in the recovery, in other words you use a G tape and pull-up to try at 1.5, you have to anticipate that because there is a delay between an input from the sidarm controller and the G response, probably a TPA2 effect, but at any rate you can over... if you don't anticipate that, you can get a slight G exceedence. I stayed within plus minus .2 G's the whole time, but hit about 1.67 on one time when I tried to close right on 1.5. Once you get the attitude or the pitch rate about where you want it, it's pretty easy to maintain plus minus .05 G's once you can stay within that first overshoot. Okay, for the performance standards for the diving pullout bank angle, I met the desired and maximum load factor, met the desired, so, for longitudinal Cooper Harper rating, controllable? Yes, adequate? Yes, satisfactory? Yes, Cooper Harper of 3, for work load, and for lateral Cooper Harper rating, controllable? Yes, adequate? Yes, satisfactory? No, I'm going to say a 4 for this little nuisance roll PIO about 0 degrees speed. I'm going to call that a minor, but annoying deficiency, and that would bring it in as a Cooper Harper 4.

Pilot F

Task 5060 Diving Pull-out 21 Jan 97; Run 42

Basically, the airplane is well controllable here. I'm getting a little bit more use to the side stick controller in the way it is in this simulator, and really... less... I can notice a noticeable difference, I don't have to pay as much attention to keeping the wings level as I did at the beginning of the period here, it's becoming easier for me not to couple pitch inputs with roll

inputs on the stick. Predictability is an issue here for two factors, one is the fact that in and out of envelope protection, does cause a predictability, because as far as the force gradient goes, well I don't want to say a force gradient, the airplanes pitching up when you go into the envelope protection, and then you have to adjust your back pressure or sometimes even apply a little bit of forward pressure in order to control the airplane when you're in the envelope protection, but then when you move below 2.5, that envelope protection is ramped out, and it seems to be fairly rapidly, and you have to transition to control the airplane, and when you're trying to do this fine G tracking task, that hurts predictability. The other predictability problem is the fact that the airplane is not real crisp, it kind of coasts to a stop, when you release pressure on the stick. What I noticed was, on my maneuver is, when I initially started to pull, I was pretty aggressive as far as getting into the maneuver goes. Envelope protection was there, we went to about 1.63 G's, or 62 G's, or maybe a little bit more than that. Anyway, as we got into the 1.6 range, I think I actually bunted on the stick, you can look at the data to see for sure, to stop the G from increasing, and again, I think that was a function of we were just going in and out of the envelope protection and plus the airplane coasting to a stop, and then I'm not sure exactly where that transition occurred, but anyway I kind of got it under control, and I over compensated, we shot back down to the 1.3 something G range, and again, by this time, I think the envelope protection was gone for sure, but then I had to increase the stick force, and we were within a couple degrees of the horizon before I really got stabilized to around 1.5 G's. So anyway, I do think there is a predictability problem there. As far as the task goes, it is controllable, you did get adequate performance obtainable with tolerable pilot work load, in fact I think we've got desired. Is it satisfactory without improvement, there's a couple issues that enter into this question. First of all, as far as envelope production and G tracking tasks and everything else, it hurts the G tracking task, I guess if I was looking at just purely a G tracking task with no operational suitability in mind for this, this would be a very hard question for me to answer because as far as tracking G, if I forget about envelope protection lines there, what's going to be happening, or why the pilot would be doing this maneuver, I could very easily answer that question no, because it's, I guess the reason I would is not so much because you can't get the desired performance, well let me back pedal on this, I guess. I guess I'd have to answer it yes, because you're getting desired performance, and the pilot compensation and work load required to get the desired performance, probably doesn't lend itself to answering no, but if I was just looking at this purely as a G tracking task, I would say that it's got a very objectionable characteristic in it that I don't really... for just a pure G tracking task, really wouldn't want to have to live with on a day in and day out basis, and that's why, I guess, I was kind of hedging on this question. Anyway, I'm going to answer it yes, we did get desired performance, and it's not with... I don't think it requires, oh boy, you know I'm having a hard time with this question. I guess in my mind, I'm going to have to decide rather if I think it's minimal compensation, or moderate compensation, and this is the real question between the yes and a no to differentiate between level 1 and level 2. I guess ultimately, I'm going to say I don't think it's all that bad, and I'm going to answer it yes, and say minimal compensation required for desired performance, and I'm going to give it a 3 in both axis. Just to... I guess... just an additional comment about this is, this is one of those times in the Cooper Harper where I really have to make a decision between the two blocks, yeah, I guess minimal performance is the right way to go, we'll go with a 3, although, I guess I would just note that the predictability problem in and out of envelope protection was a issue for me in making that final... answering that final question yes or no, about is it satisfactory without improvement.

## **Task 5070 Emergency Descent**

Pilot A

Task 5070 Emergency Descent 14 Jan 97; Runs 23-24

With and without added drag, without the added 60 counts of drag, we're unable to get down without exceeding the time above cabin altitude of 25,000. With the added drag we can get down in the allotted time, the display of airspeed and altitude limits is perhaps helpful, but a good airspeed indicator with a redline on it that changes with altitude, would also be quite helpful, and knowing ahead of time the way the airspeed changes, that could be worked probably as easily as a graph. I think perhaps that would be one thing to evaluate. As far as lateral directional Cooper Harper rating, we're in the adequate...adequate, but not desired range, is that true. Really, there's no lateral Cooper Harper performance. So, what is it longitudinal, or what is it. Just a general Cooper Harper for the whole thing. Perform the maneuver smoothly with no tendency to oscillate or hunt. Okay, so...yeah, the...are we in level, are we adequate there, level 2. We don't have a good performance standard, and if you want to you can skip the Cooper Harper rating. Longitudinally, it's reasonably easy to adjust the flight path vector and adjust airspeed accordingly, it would be much easier without the 45 degree bank, since...in override, and having to hold a very, very heavy force, in order to hold some unusual roll attitude, while you're descending, and if... it would be highly desirable not to have to use a 45 degree bank, and spend the whole time in roll, with overriding the roll protection, but the heavy force that it requires, especially going in left turns, and the display of redline versus altitude, was somewhat helpful, although, I'd like to see the...like to see just the basic normal airspeed indicator, see what problems that creates, I think with the knowledge of where the knees are, and just a basic airspeed indicator, you could easily maintain the redline on the descents. Longitudinal Cooper Harper, I guess we had some overspeeds, so, I guess we would have, I'd give it a 4, I guess.

Pilot B

Task 5070 Emergency Descent 08 Jan 97; Runs 67-71

Task was evaluate handling qualities during rapid maximum speed descent from cruise. Perform maneuver smoothly with no tendency to oscillate or hunt for pitch attitude or speed through the maneuver. Well, there is a tendency oscillate or hunt, but it's not...it's just a matter of control. If you're not overshooting, you're probably not trying hard enough, to some extent. My task was basically self-generated in terms of the tolerance, because the tolerance is here; normal acceleration and air speed above VMO, 25 knots is pretty loose from what I saw. So, I'm trying to keep it within about a circles width on that indicator which is probably something on the order of 5 knots, 5 to 6 knots within the, or close to the red line that is, and keep the angle of bank something between 40 and 45 degrees throughout the maneuver as far as the lateral directional stuff. And that was do-able, I was working a little bit to do it, but not a whole lot, so I'm gonna give it Level 1 HQR's. Both longitudinal and lateral directional is controllable, adequate, satisfactory, mildly unpleasant deficiencies, minimal pilot compensation, HQR3's on both. That concludes my comments.

Pilot C

Task 5070 Emergency Descent 15 Jan 97; Run 121



This is a real challenge, and the best I could do on most things was get adequate, and a couple of things sneaked out. This is something that's going to have to be practiced a lot in this procedure, if somebody can get it to work, and this is what you want to do, it's going to take a lot of training to get that. The...as it was, I went out of adequate by...no, I didn't go out adequate on that did I, adequate was what I had on speed, but it was close, and very, very, tough to maintain. The display, actually, after I've worked with it just a little bit, it did help, the predictor there makes all the difference in the world, and initially it's a very open loop thing, I would pull the things, pull the throttles back, open the speed brakes, and go to the 40-45 degrees, and then after I got my speed settled, then I would just put the left tip on the horizon, and then wait and see what I got, and then vary the predictor with my left hand, just by how hard I pulled and pushed, and as I said, that was...it didn't take very long, and I understood the relationship there, and it was worth while, however the ability to maintain the speed, is not there, and unless this is practiced an awful lot, it's going to take a lot of pilot compensation just to keep from exceeding the limitation of the airplane, in Mach or EAS. So, is adequate performance obtainable with a tolerable pilot work load, I'm going to say no, it really requires improvement, there's something considerably more going to have to be done, especially since we didn't get the major goal of getting down in time, so, I'm going to give that...I'd say 9, that was intense pilot compensation to retain control to keep it from going past a speed limit in particular, and even G, you could get up there real quick, so, I'll give it a 9.

Pilot D

Task 5070 Emergency Descent

Not performed by this pilot.

Pilot E

Task 5070 Emergency Descent 10 Jan 97; Runs 45-48

A lot of things on this one that kind of didn't work just like we expected, as we increase the drag, the times went up progressively from a 195 seconds with delta CD of 0 to about 205 with .02 to 228 at .04, so, something very odd is going on. Also, we noticed a real cliff about 46 to 47 degrees phi, the thing would depart, therefore the last run I held it about 38 to 40 degrees angle of bank to stay away from that. When you're really trying to tightly control the energy to maintain it within the VMO balance, it is very easy to, since the lateral control law does not do a good job holding bank, because of all the protection you've got to hold right stick in, and depending on how much you hold you can easily exceed the 45 degree threshold and depart, so, I tended to give myself a little bit of pad. Some suggestions, if you're going to have to hold, if you can't just send a bank angle and take your hands off of it, you've got to hold that sidearm controller in to the right to maintain the right bank, then there should be some kind of envelope protection to keep you from exceeding the cliff where you depart, so, we're actually hurting the pilot here, you've got to hold the stick in to maintain the angle of bank, but at the same time you can easily overexceed the departure point to depart, so, that's something that's got to be worked out. The other thing to figure out is why the drag increases caused a worse performance. Are there any Cooper Harpers on this Bruce? Okay, Bruce informs me I met the adequate criteria for both performance standards. Okay, so for longitudinal rating, is it controllable? Yes, is it adequate performance obtainable? Yes it is, however, I'm going to rate it a 6, and I think adequate performance requiring extensive pilot compensation is very appropriate here, in order to fly that VMO curve, it is really a very high work load task, with very, very, subtle changes in the pitch input

causing dramatic changes on the VMO curve following. Laterally, I also don't like it because of the comments I mentioned where you have a cliff at about 46, 47 degrees phi, and you have no way to prevent the pilot from exceeding that cliff, you've got to either put a bank angle eliminator in there at 45, or take out the protection that wants to hold you less than 35 degrees phi, I believe it is, so, you don't have to continually hold in right stick, and can easily overexceed the bank. So, for lateral, controllable? Yes, adequate? I'm going to say yes, based on the changing of a technique to fly about 35-40 degrees phi, I'll rate this a 6 also for the numerous comments I've made about setting the envelope protection properly, so, a 6 and a 6. One final comment on the emergency descent, I think this a real good candidate for the automated procedure, it's very difficult to fly the VMO profile very, very, tightly, and I think an automated procedure could do it better than a pilot in this case, being able to pick up the accelerations much more quickly than a pilot could.

Pilot F

Task 5070 Emergency Descent 21 Jan 97; Run 39

All right, you know, one thing that is useful if you know, you're using the bank angle to give you an elevator G to increase the drag to do the descent, the one thing that's useful in that is, I can pretty much control the acceleration, D acceleration with the bank angle, with the gamma control, if I set a pitch attitude that will hold about 40... about the airspeed that I want, or the decel or accel rate, depending on where I am on the VN diagram, or actually airspeed versus altitude diagram here, I can increase or decrease the acceleration just by rolling in bank, and the flight path, the gamma, will stay fixed. So, that's a good characteristic for doing this task. If you were going to use something like this operationally, again, I think there's a lot of issues as far as the display goes, that would have to be refined, or looked at in detail. Actually, for just having seen this, I thought the display works kind of neat. Anyway, just doing the Cooper Harper tasks, it's definitely controllable, you get adequate performance with a tolerable work load. Is it satisfactory without improvement? As far as the task definition of being able to hold those parameters and fly that, I think the answer is yes, although, there are other issues as far as performance goes, that have to be addressed. Basically, my scheme was to hold in the neighborhood of 40 degrees of bank to give myself a little bit of leeway within the desired zone, and 40 to 45, I could get stable at 45 every now and then. It would take me a while to kind get stabilized out there. Like I said, one of the techniques that I used was to use the bank since gamma would stay fixed. If I got a gamma that was close to holding the rate that I wanted, I would just use the bank to control the small accel or decels. Obviously, there'd be other techniques, the reason I did that is that it was easier to get, I think this goes back to predictability issue, is easier to get small increments in G very precisely and very controllable, by the letting the airplane hold gamma in using the bank than it was to try to pump the stick forward and back. And again, I think it's the predictability thing, although, you're making such small inputs once you get stabilized here, that predictability is really not a factor. Anyway, I think it's satisfactory without improvement, and pilot compensation not a factor for desired performance, or minimal pilot compensation required for desired performance, I think the choice here is between a 2 and a 3, and I would say for this task, it's probably good with negligible deficiencies, so, I'd go with a 2, both in the lateral and longitudinal axis.

## **Task 6050 Inadvertent Speed Increase, high speed**

Pilot A

Task 6050 Inadvertent Speed Increase, high speed 14 Jan 97; Runs 9-11

Pushover inadvertent speed increase, and pull out at Mach 2.4, appears to be quite docile, I'd give it a 2 in longitudinal and lateral Cooper Harper wise, and the circle seemed to be quite useful, when you push over, you can simply close up those circles to bring them into the wing tips on the flight path vector symbol, and that gives you about seven tenths of a G on the pushover, and the pull-up is quite benign and straight forward, no excessive forces, seems to be quite pleasant forces, no particular problems, no unstarts, and it looks real good. The breakout on these maneuvers, breakout of the actual flight path vector from the commanded flight path vector is...occurs at seven tenths of a G pushover or so, when you hold it for extensive period of time, and that is perhaps somewhat helpful in preventing unstarts, because it's the actual flight path vector that causes the unstarts.

Pilot B

Task 6050 Inadvertent Speed Increase, high speed 08 Jan 97; Runs 31-33

I didn't see what the maximum amounts were, I don't know if you saw that, but I'm sure it was well under 2.6 and max load factor was well under 1.57 and well above 1.53. Max bank angles not a problem, good solid level 1 performance, not really a problem to do this stuff, you've got to be real careful with the pitch though, at the forces are fairly low to get that unstart, so the envelope protection symbols up there are really, really helpful in this maneuver. Okay, longitudinal; it's controllable, adequate, satisfactory, minimal pilot compensation, HQR3, and that consists of just watching out for the unstart. Lateral directional, controllable, adequate, satisfactory, with pilot compensation largely not a factor, you can pretty much ignore the lat-dir axis, HQR2. That concludes my comments.

Pilot C

Task 6050 Inadvertent Speed Increase, high speed 13 Jan 97; Runs 38-40

Satisfactory without improvement, the...it's a minimal problem, I mean there's hardly anything on that, it was pretty straight forward, in fact given such a small perturbation change in pitch attitude, the timing just not get to 1 1/2 was a bigger concern than the tendency to overshoot, or not pull hard enough, I wanted to get the 1 1/2, and by the time I got there I was...it was ready to come back off it with a larger perturbation, it would have been able to sample it a little bit better, but with what I had here, good negligible deficiencies, I didn't think pilot compensation was a factor, I'd say a Cooper Harper of two, and laterally the same thing, my gosh, there might have been a slight tendency to go right, but it was very natural to keep the wings level, it wasn't a big problem, and I don't know, it's possible with a sidestick, the fact that when you pull back, you tend to rotate your hand in, might have been where the rolling came in, so I can't say whether it's a aerody...or a gyroscopic thing as you pull G or whether it was due to the feel system and the fact that it's a side stick, and when you rotate back you tend to pull in a little bit, I don't know, could be either one, I have no way of telling right now, but in any case there was just a very slight tendency to roll right as I pulled up, but again that's another 2, I can't see any reason to change them.

Pilot D

Task 6050 Inadvertent Speed Increase, high speed 22 Jan 97; Run 29

This was a .7 G pushover for 5 seconds pulling up at 1.5 G's back to level flight. Little bit of a task longitudinally, there's a lag in the G response, I guess due to the heave response of the airplane, that causes you to have to compensate a little bit, and we have our PIO tendency in roll still. So, I'm going to give it a 4 and a 4.

Pilot E

Task 6050 Inadvertent Speed Increase, high speed 10 Jan 97; Runs 23-25

It's a fairly simple straight forward task, pushover to seven tenths g. Because your using the G tape, it's fairly straight forward, the recovery at 1 1/2 G's is also very easy to accomplish, mostly though by the time I was gaining 1 1/2, we just about recovered, we did on the last time, wait and count the five seconds after I've established the .7 G's, and that worked out better to give you more time to recover, and I suggest we make that a practice for the remainder of the evaluations, as far as evaluation segment, inadvertent speed increase, longitudinal Cooper Harper, I met all of the desired criteria, is it controllable? Yes, adequate performance? Yes, satisfactory without improvement? Yes, Cooper Harper of 3, minimal pilot compensation is required. For lateral directional, on the last we noticed a slight coupling with the roll axis, and just a very slight plus or minus half a degree angle of bank kind of oscillation. Didn't notice that on the others, but I was a little more aggressive on the last one, but nevertheless lateral is not much of a player there, however, that little oscillation is to indicate that you do need to be consonant of getting... coupling into the lateral axis, with that in mind, it's controllable, adequate? Yes, satisfactory without improvement? Yes, a 3 also.

Pilot F

Task 6050 Inadvertent Speed Increase, high speed 21 Jan 97; Runs 26-28

I guess my comment that I'll start out with is the airplane is not real crisp and I don't know that I necessarily would expect it to be crisp, but it may be desirable for ride control and for then overcontrolling at altitude, to make sure the airplane is controllable, I guess the bottom line is, my preference would be to have a little bit crisper control of the airplane. This is okay, and it works out, it leaves me to be a little bit more patient and little bit slower with my inputs, where, that's what I would try to do, you know, if I was flying in revenue service anyway, and from that perspective it probably makes it easier for the pilot to do that in some regards. I think my preference would be to have a little bit crisper control of the airplane, and have maybe the stick dynamics tuned a little bit better to help me, or make it easier for me not to overcontrol, I guess. I don't think there's any tendency to overcontrol with the flight control law here, there is a tendency, and I think it's a ergometric issue, when I go to push or pull on the stick, it took me a little bit of time to get used to how to a purely pitch input in without ergometrically coupling into roll with the stick. I think we got desired on all of the parameters for this task, and I'm not really going to... this is mostly a pitch task, I'll go through here for the Cooper Harper for the entire task, and I think the ratings will be roughly the same. The tendency to... for me to couple and roll a little bit effects both the pitch and the roll task, but I think it's roughly a tradeoff, besides I think... as far as I'm concerned they'll be the same rating for this task, in longitudinal and lateral directional. It's obviously controllable, and you get adequate performance with a tolerable pilot work load. Is it satisfactory without improvement, like I said, from my particular taste, I'd like it to be a

little bit crisper, and when I say crisper, I mean not coast to a stop, in other words, when I accept the G, when I reduce force on the stick, I'd like to see a immediate response in... when I'm trying to control in this case, G, and I don't. When I release force, I have to anticipate it and release it before I really get to the point, 1.5 G, and then it will kind of coast to 1.5 G, so, once I release the force, the G continues to increase for a period of time, and to stop on the last one, I was a little bit more aggressive and to really stop the flight path on the horizon, I actually ended up having to bump forward a little bit, where generally I would just expect to probably release pressure on the stick. Anyway, it is satisfactory without improvement, so, that will put us into level 1. In this one... I would... if we were giving half ratings I would tend to go towards the 2 1/2 range just because, and again I think that's... you're going to see some pilot preference in this one as far as the crispness of control, but I would probably, given the latitude to do halves, I'd probably go 2 1/2, just because I'd like it to be crisper, and the crispness relates to predictability, and I think you suffer just a little bit in predictability here. I guess if I have to choose between a 2 or a 3, I guess I'd probably go with a 3. Again, it's a hard choice, given half ratings, I'd go 2 1/2. I have a hard time saying that it's mildly unpleasant deficiencies. Let me think about this for a second, but I do think that there is minimal pilot compensation required for desired performance because of the predictability, yeah, I'll go with a 3.

## **Task 6060 Simulated 2-axis Gust Upset, high speed**

Pilot A

Task 6060 Simulated 2-axis Gust Upset, high speed 14 Jan 97; Runs 13-15

I'd have to give it a 2 in lateral directional, and actually let me give it a 3 in lateral directional, and a 2 in longitudinal. It would be helpful if we had track hold for the lateral bank angle control, around zero. We...the maneuver is easily performed. It's quite easy to pitch over and prevent an unstart with the display, and is very good for situation awareness as far as the inlets are concerned, and maneuvering capability. The ability to maintain G level at the recovery point is quite easy once you do one or two of these, and the pushover is quite easy to do without an unstart, so it's a fairly docile and straight forward maneuver.

Pilot B

Task 6060 Simulated 2-axis Gust Upset, high speed 08 Jan 97; Runs 58-60

The maneuver is possible, no exceptional strength or skill required, didn't exceed MD and met all the desired parameters. I'm working a little bit on that, but not enough that degrades performance any significant amount. Longitudinal CHR controllable, adequate, sat, no improvement required, minimal pilot compensation, HQR3. Lateral directional; it's controllable, adequate, sat, improvement not required, and again minimum pilot compensation, HQR3. And the compensation was just due to the task, I didn't feel like I was fighting the control laws at all, just the task. That concludes my comments.

Pilot C

Task 6060 Simulated 2-axis Gust Upset, high speed 13 Jan 97; Runs 44-46

Okay, again, it's satisfactory without improvement, certainly no big problem, fairly easy to get the desired performance, and I'd have to say minimal pilot compensation required this time, after really hawk, is it would be pretty easy to overshoot, you just kind of have to concentrate. The compensation is to really concentrate on not pulling in a whole bunch because of the delay between your putting the input in, and having it get to the Mach, or to the G rather, so, I'm going to say that's certainly not a problem, but then I would give it a 3 in that case. Some mildly unpleasant deficiencies takes a little extra compensation than might in some. I did notice a difference on the recovery, whether I was rolling right or left, it was probably easier, I tended...I suspected do it a little bit faster when my recovery roll was to the right, than it was to the left, and it's just because my hand is easier, you know, the forces I can put on the stick are a little bit easier to do going inboard than outboard with the sidestick, I suspect is the reason for that, but in any case, no big problem, the gradients and so on with the sidestick feel fine to me. They seem to be well matched, their harmony is good, when I'm sitting still I feel the breakout because I'm looking for it, but when I'm flying I really don't think much about it, and it doesn't seem to be a problem, so, apparently that's certainly usable, and if I looked at it a few more times, I could probably make a little finer comments, but my first cut at it was...felt pretty good. HQR3, thanks.

Pilot D

Task 6060 Simulated 2-axis Gust Upset, high speed 22 Jan 97; Run 31

This was the 2-axis upset we fly the aircraft into a minus 6 degree gamma, phi of 15 degrees, and then recover at 1 1/2 G's, and really it's a pretty easy task, we do have the lag in the G response to commanded gamma, so it takes a little bit of compensation there, we still have our slight tendency to roll PIO because of the slightly, I believe, partially due a loose roll mode. Give it a pilot ratings of longitudinal 4, and lateral 4, again.

Pilot E

Task 6060 Simulated 2-axis Gust Upset, high speed 10 Jan 97; Runs 27-28

Kind of a little bit of a complicated task, but fairly simple rating procedure. Setting up the 2-axis upset requires a little bit of time, obviously, if you are very smooth so you don't get any unstarts from a pushover to a minus six degrees gamma. The recovery from 15 degrees angle of bank to straight and level is not really a problem, however, there is a slight tendency for very, very, slight roll PIO in capturing the zero degrees of the wings level, and we noticed this in the checkout last fall, also on the recovery, when you put in a 1 1/2 G recovery, there... most times you had a very, very, slight roll PIO about wings level, and this is another little nuisance mode that probably needs to be corrected. Other than that, maintaining 1 1/2 G's is fairly straight forward, and recovery is very straight forward, and with no real problems noted. For longitudinal Cooper Harper, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, Cooper Harper of 3, there's a certain amount of compensation required to maintain that one and half G pull, that gives it a 3 Cooper Harper. For the lateral directional, controllable? Yes, adequate? Yes, satisfactory? Yes, and I also rate that a 3 with the aircraft characteristics portion of the descriptor fair, some mildly unpleasant deficiencies, being quite appropriate and the unpleasant deficiency is the oscillation about wings level in the lateral control law, so a 3 and a 3.

Pilot F

Task 6060 Simulated 2-axis Gust Upset, high speed 21 Jan 97; Run 31

For this particular task the... I guess the predictability things that I talked about on the last card that we did, really show up here fairly strongly. I found myself in... and again I think part of this is issue with ergonomics of the stick and part of this is a predictability problem, I found myself making very slow deliberate inputs to the stick, and then when I am either trying set the G or set a bank angle, I start making the input slowly, get the rate going, and then I start backing off on the rate to coast to a stop, or to get to a stop early on, and the reason that I start, I guess the... I guess really what I'm talking about is the fine acquisition when I get to the end game of acquiring the bank angle or acquiring the G, I start compensating by slowing the rate that I approach that down earlier than I normally would because of the predictability problem. I don't want to say problem, because the predictability not as good as I'd like it to be, and the airplane is not as crisp as I would like it to be. To stop from coupling with the stick, I have a tendency to try grip the stick actually a little bit different. Like once I get the bank angle, I will kind of rotate my wrist a little bit, so that I can kind of freeze the bank angle, and make sure that I don't put any inputs into the bank angle. Things that do help refine this task real well, are the fact that when I pull the throttles back, or once I set a pitch attitude or a bank angle, if I don't touch the stick, it will hold that, and so on the setup, when I pushover, and I get the 60 degree... 6 degree nose down, or flight path down, and when I get the 15 degrees of bank, I basically release the stick and it will just stay there until we count for the 3 seconds and then do the recovery, and I don't want to really say release it, I guard the stick, but then I grab hold of the stick again, and start putting pressure on it. Okay, for the Cooper Harper rating, I think the... I didn't see a

big difference in either one of the axis as far as controllability or as far as anything that would effect a Cooper Harper task. The bank angle is the same way that I talked about the flight path being. It kind of... or the G... it kind of coast to a stop, and anyway, in the task it's obviously controllable. I believe that we got desired performance the entire time, so, it's adequate performance, it's certainly obtainable with a tolerable pilot work load. Is it satisfactory without improvement, I'm going to say yes to this, the reason I'm hedging here a little bit is, again particularly in this task when you're blending two axis together, I'd really prefer a little bit crisper response, and when I say crisper, I don't mean necessarily in magnitude, I would just like to be able to not have to anticipate and lead setting the G or stopping the bank angle somewhere as much. I'd like to pay less attention to having to get the fine acquisition, and just to clarify the way I look at these tasks is, it's an acquisition in fine tracking, and there's really two phases to the acquisition, there's an initial input to get myself close, like if I'm going to set 1 1/2 G's, I make an input to get somewhere in the ballpark of 1 1/2 G's, and then I refine that as I get there, and it's refining it, or that transition from gross acquisition to fine acquisition that the predictability problem or predictability issue is apparent to me, and I would just like to be able to not have to spend as much time transitioning from gross to fine acquisition. So anyway, I'm going to go into the level 1, and again, here I'd think I would go with a 3 because of the predictability, I don't think I'd be tempted to even go with a 2 1/2 if we were doing half ratings. Just another point of clarification and answering, is it satisfactory without improvement, one of the things that I helped to make that decision is looking at the descriptors for a 3. Minimal pilot compensation required for desired performance, and desired performance requires moderate pilot compensation. I definitely don't think we're in the moderate range, but I do think that minimal pilot compensation is required for the desired performance... for both axis.



## **Task 7030 VMCG demonstration**

Pilot A

Task 7030 VMCG demonstration 13 Jan 97; Runs 60 & 61

Not rated.

Pilot B

Task 7030 VMCG demonstration 06 Jan 97

Not rated.

Pilot C

Task 7030 VMCG demonstration 15 Jan 97

Not rated.

Pilot D

Task 7030 VMCG demonstration 24 Jan 97

Not rated.

Pilot E

Task 7030 VMCG demonstration 07 Jan 97 R 10

Not rated.

Pilot F

Task 7030 VMCG demonstration

Not performed by this pilot.

## **Task 7035 One Engine Out Takeoff**

Pilot A

Task 7035 One Engine Out Takeoff 13 Jan 97 R; Runs 24-26

I felt that the amount of rudder was rather small and easily controlled, however, the deviation to the right of...from centerline after rotation, seemed to be as ... hard to get desired performance, I'm not sure what you'd have to do to get that, because you can't bank unless you over... provide additional rudder more ... maybe I just wasn't applying enough rudder, I though I would stand fairly close to centerline. There maybe some effect, due to the fact the cockpit might be over the centerline, and the CG is off to one side to some degree. We're going to call this desired Cooper Harper wise, I've been trying to give it a 2, I don't think it has any serious deficiencies. Are we breaking this out into two segments on this one, okay, so, longitudinally...are we...or is that...adequate...we'll have to call it a 4 for...or level 2...for pitch, because of the pitch rate, okay, I'll give it a 4, because of the difficulty of holding the pitch rate, I don't know whether it's the, there seems to be a pilot PIO or a difficulty in holding that rate for some reason, and a slight difficulty in holding the centerline. Is that adequate performance, or desired, so I'll give it a 4 on lateral directional.

Pilot B

Task 7035 One Engine Out Takeoff 06 Jan 97; Runs 32-34

Card was accomplished as per the instructions. Performance pretty much desired everything except for 2 areas. One was the pitch control..pitch rate control I should say on rotation. I was able to meet adequate pretty much all of the time, but not desired. The lateral deviation on the runway...which runway centerline deviation I was able to meet adequate but not desired, also. So, lets give it HQR's it felt like a pretty solid level 2 configuration. In general, relatively high workload but certainly manageable. And given the nature of the emergency, about as expected. For longitudinal, it's controllable, and adequate, however, I don't think it's fair to call this level 1. So, it's not satisfactory without improvement deficiencies require improvement. And, lets say adequate performance requires considerate pilot compensation HQR5. Lateral directional , again, the weak link error was on center-line deviation after initiation of rotation but prior to liftoff was the primary phase . HQR, it's controllable and adequate performance is obtainable with tolerable workload, however, not without a considerable amount. So, I'm going to call it level 2 again deficiencies require improvement. Adequate performance requires considerable pilot compensation HQR5. That concludes my comments.

Pilot C

Task 7035 One Engine Out Takeoff 15 Jan 97; Runs 52-54

For the longitudinal, is it satisfactory without improvement, yeah, no question on that, that's...once you learn how to...the rates to rotate and so on, that comes along very nicely, so, nothing needs improvement on that, a 3 on that minimal pilot compensation required for desired performance. lateral-directional, depends on how much stress you want to put on the ability to keep the centerline, that's usually pretty important, and 2 out of 3 times I only got adequate, and considering I'm not using any surprise factor in here, no delay or anything, I'd be hard pressed to keep that in 10 ft. on a surprised one, I'm sure, and even when I knew it was coming, 2 out of 3 times, I only got adequate, so, I think I'll have to, you know, given the

constraints we had here, which we're using for the limits, I'm going to have to say it's not satisfactory without improvement, and it would be a 5, the...getting adequate was no more than considerable pilot compensation considering it's a tough task, even no matter how good it is, I'm looking at how much did the handling qualities, and so on, so I'd give it a 5, lateral-directional for that, and no special comments, the only thing that...the amount of rudder that you need on the runway vs. what you need climbing out, there's a little, you know, that's sizable, and that increases the work load a fair amount at a very critical time, right after lift off, but it would be a good trick if you can find a way around that one.

#### Pilot D

Task 7035 One Engine Out Takeoff 21 Jan 97; Runs 60-62

We failed the engine just above V1, we failed at 171 knots. The takeoff procedure is like 2011, but we don't do a cutback. The task is really not too bad, but again I've been practicing these engine outs now for all afternoon, so, it's tending to be just a little bit rote. I think really the only problem I had was a little bit of a tendency to drift right on the takeoff roll after the engine failure, but it was on the order of 10 or 15 ft and more than adequate from a safety standpoint. Also, I was in and out of the adequate desired on the takeoff rotation as I have been all day, so, pilot rating longitudinal has got to be a 5, lateral directional because of the drift has got to be a 5, although the work load in both these tasks, particularly lateral directional, really isn't too high.

#### Pilot E

Task 7035 One Engine Out Takeoff 07 Jan 97; Runs 49-51

Just for the record I did three of them for data, the second one was the only one I didn't completely right, the other two I tended to for some reason get at engine failure I tended to want to rotate, a little brain dump there, but any rate... even those still came out pretty good data so overall I think I met the desired criteria on everything. So for the combined rating or for the longitudinal Cooper Harper on the takeoff roll, rotation, climbout controllable? Yes, adequate? Yes, satisfactory, yes, I would rate it a 3. Longitudinally not too much more difficult than a normal takeoff. The climb out after gear up is a little bit... obviously a lower gradient, but I didn't see a whole lot difference in work load. For the lateral directional, controllable? Yes, adequate? Yes, satisfactory, .... no, I'm going to make that a 4, the reason being, is there is a lot more work load for lateral directional especially if you combine that one rating, you're on the rudders all the time and also it is harder to track the heading of the lateral guidance circle. The overall task is harder so it's kind of borderline, level 1, level 2. I am going to rate it a 4 just for work load, but it's still meeting the desired criteria for the most part.

#### Pilot F

Task 7035 One Engine Out Takeoff 23 Jan 97; Runs 9-10

With the engine loss on the runway, it's pretty controllable, you see the deviation with the combination of the waterline out there tracking the centerline, and also the DME symbol just underneath it, really gives you a good cue to put on the centerline to help you track straight down the runway. In lower vis, you might not be able to see the centerline as well, and tracking might be more difficult, because you're looking closer in, to look at the centerline. That's just a side comment, anyway, with the engine failure, it doesn't take a whole lot of

rudder to correct back to centerline, the airplane corrects back to centerline very nicely. At the rotation, we got 89.5 percent in the desired range, almost 90 percent. I do think that the rotation tracking is somewhat hit or miss, but I do think that it's a learned task, I still think that if the airplane was a little bit crisper, you might be able to track a little bit better, but actually for, I'd be more concerned about being very smooth on the rotation, and really tracking something that precisely, so anyway, I think you could do the task better with a crisper flight control system, I don't know that you really need it to do the takeoff task in itself, and I think the compensation, only compensation that I really can use for the rotation rate is to just kind of see it a few time, and learn the rate at which the brackets go up. Anyway, airborne, you input the rudder on the runway, during the rotation the requirement for rudder is reduced slightly, or... I'm sorry, let me back up. Once your airborne as you're accelerating the requirement for rudders reduced, which you would expect, during the rotation, at least my perception is, is as the nose wheel comes up, there's really not much need for increased rudder, and that might be a function, because the airspeeds accelerating. Most airplanes, at least from my experience, is if you lose the engine on the runway as you rotate, when the nose wheel comes up off the ground, generally I need to kick in a little bit extra rudder, and I didn't really, at least my perception was, and you can go back and look at the tapes, I didn't really see quite as much a need for that, or that wasn't quite as obvious to me in this airplane, or in this simulator. Anyway, once you're airborne, and get the rudder squared away, after you stabilize it 212 knots or thereabouts, the rudder requirements are pretty minimal, and pretty easy to hold, or keep the airplane coordinated while climbing out, the flight director is pretty easy to follow. There didn't appear to me to be a whole lot of rolling tendency with the engine. It's pretty much just a rudder requirement, and that's good and bad, in that it simplifies the controls, the rudder requirements aren't that great. I don't know that your recognition is going to be quite as quick either, anyway, it's a very controllable maneuver, and I thought it all worked out well. By no means am I suggesting you need to have a roll off with a engine failure, it's just a comment, it is pretty, pretty controllable, pretty... it's not as exciting as it is, I guess, in some airplanes, which is good. It's definitely controllable, adequate performance is obtainable with a tolerable pilot workload. Is it satisfactory without improvement? And... boy, I would really like to answer yes to that, because this is for this task, the airplane is pretty well mannered. I'm almost tempted to... here's what I'm going to do, I'm going to say that, again, I don't really like splitting up the axis, but I'm going to go ahead and say it's a 2, well... I'm going to say it's a 2 for lateral. It really is quite good for the lateral task, it's really not bad at all. For the pitch, we only got adequate performance, which really would constrain me to a 5, although, we were so close to desired on that one run, I don't know, again, the big problem that I have is, you know, if you read the descriptor for 4, it says minor, but annoying deficiencies, 5 is moderately objectionable deficiencies, and if you read the demand on the pilot section, it's desired performance requires moderate pilot compensation for 4, and adequate performance requires considerable pilot compensation for 5, and to me there always has been a big jump between a 4 and a 5, because of the way the wording is there, and I really wouldn't say that there is considerable pilot performance required for a... to get adequate performance, and I wouldn't of on any of the other runs either, I guess. I'm going to go ahead and give it a 4, I guess. You know, in retrospect, thinking back to the other runs, I really have a hard time with adequate performance requires considerable pilot compensation, because to get adequate performance, it does not require considerable compensation. Anyway, se la vi, whatever we've rated it, we've rated it, but... so, let's see, that would be a 4, a 2, and a 2 and a 2.

## **Task 7036 One Engine Out Takeoff - 35 kt x-wind**

Pilot A

Task 7036 One Engine Out Takeoff - 35 kt x-wind 13 Jan 97; Runs 56-59

Is it controllable? yes, adequate performance obtainable with tolerable pilot work load, yes, satisfactory without improvement, I guess I would have to say that... what was it that was lacking, it was the lateral deviations, and I have to give it a... I would say a lateral directional of 5, Cooper Harper, for the first phase of takeoff, and for the longitudinal I'll give it a 4, and after, what is it ... after ... where's the dividing line, this is just one rating, okay, but if you... if you, put your inputs in correctly so that you're right down the centerline and you require no corrections, you did it right the first time. It works pretty good, but if you get off a bit, you try to correct back, you can't really bank, if you put in a lot of rudder, than that gets you to correct back in, at any rate, that increases the drag, increases the time that you spend in this never, never, land, and this transition area, and it aggravates the problem, so, it's...if you're able to get the rudder in just right, it's not a particularly bad problem considering the circumstances with the crosswind and the engine out, it's not all that bad. Seen 737 simulators that were a lot worse than this, it was the simulator, not the airplane. Okay, I guess that's it.

Pilot B

Task 7036 One Engine Out Takeoff - 35 kt x-wind 06 Jan 97; Runs 36-38

Card was accomplished as per the instructions. In summary desired performance for runway centerline deviation was achievable but relatively difficult and it require me.. kinda getting the feeling for the maneuver , I'm sure with further exposure to this that I would continue to get better at it . You can characterize it as doable but with a lot of workload. Desirable performance in terms of rotation pitch rate control was not achievable. I was pretty much consistently off every time. I was able to get adequate. In every other respect the desired performance was obtainable and relatively straight-forward. I won't call it easy because the work load was high, but at least it was doable. Okay, longitudinal CHR, was controllable and adequate, not satisfactory that improvement. Deficiencies require improvement. And this is adequate performance requires considerable pilot compensation HQR5. Lateral directional, it's controllable, adequate, not satisfactory, deficiencies require improvement level 2 performance. Minor but annoying deficiencies desired performance requires moderate pilot compensation HQR4. And as a caveat, if I can give it 1/2 ratings, this one will probably be a 4.5....for lateral. Just because desired performance requires more than moderate pilot compensation requires intense pilot compensation . That concludes my comments.

Pilot C

Task 7036 One Engine Out Takeoff - 35 kt x-wind 15 Jan 97; Runs 86-88

What a treat, okay, and I assume it's one rating for longitudinal, one for lat-dir, the whole thing, okay. The obvious part is the initial, just getting it all squared away, is most of the task, for the pitch is adequate performance obtainable with a tolerable pilot work load, and I would say the pitch by itself is, is it satisfactory without improvement, no, and it comes over here, and I couldn't more than consistently get adequate, I did get desired a few times, but I wouldn't...I couldn't...I wouldn't want to bet that this next run, that I would be able to get it,

that's for sure, so, I'm going to leave it in the adequate for pitch, and I'd say considerable pilot compensation, so a 5 for the longitudinal, and of course the big thing is the lat-dir and a couple of things come in here, I'd better start further down. Is it controllable, well, yes, is it adequate performance obtainable, no way, and it definitely, I think would require improvement, and the concern is, I'm exceeding a...the capabilities here limited the airplane by either tailstrike, or wing strike, or something, structural strike of some kind, and on 3 passes I hit it once, and I'm as spring loaded for an engine out as more than most people would be on a day to day kind of a thing, and even with my thinking about it, and so on, I'm amazed at how little bank angle it takes to strike something, and to maintain bank angle it took almost complete concentration on the bank angle, and let the pitch go away, and that's why occasionally the pitch was really pretty bad is because I was so concerned about the bank angle, and the odd part is, and the part that's really kind of detrimental, is without the crosswind, it's a pitch problem, and with a crosswind the primary concern is with bank angle, and so, not only do you lose an engine, you say oh my god, you real quick got to say, have I got a crosswind or not to determine which one to concentrate on, obviously, not a doable thing. So, I'm going to have to drop that down into where it is a problem for control and that would put us in the considerable or intense, and I'd say considerable pilot compensation for control 8, for the lat-dir with 35 knots of wind.

#### Pilot D

Task 7036 One Engine Out Takeoff - 35 kt x-wind 22 Jan 97; Runs 7-10

This again is a tough one, it looks like, you know, if you sit here and train, you can do the trained dog act and get the thing off, but I'm concerned that, you know, on a wet night, with no practice for six months, it's going to be pretty tough. I think there is some operational procedures that could really help alleviate the conditions here, with a 35 knot crosswind, you're almost for sure going to have some headwind, so we can stand a higher rotation speed, so we can get a cleaner break with the ground, I think that's the problem here, we've got this extended period of time on the ground with the nose high, which is a very vulnerable situation, because the tendency to want to roll both on the ground and shortly after takeoff. Very easy to get a wing tip. I think I'm going to give it based on... well, based not only in fact that I did clip the wing twice, I'm going to give it... and almost got the tail, well, I'm going to give it a pilot rating of 7 longitudinally and 7 lateral.

#### Pilot E

Task 7036 One Engine Out Takeoff - 35 kt Crosswind 07 Jan 97; Runs 52-53, 55-56

And we have been discussing here a lot, Lou and I, about it's kind of real borderline desired/adequate for both longitude and lateral... and so it's really difficult to rate this one. The work load is definitely higher, a couple things happened. With the high cross wind the lateral tracking becomes a higher work load which takes away from your ability to close on the pitch rate guidance and so there is some performance degradation on pitch rate guidance, the actual pitch capture of 10 degrees appeared to always be desired so you end up meeting that, but it's just kind of you're on both sides of the pitch rate guidance bars on the way up there. You also tend to drift upwind... I did drift upwind about 12-15 ft for the four runs I did, so I was just barely out of the desire for lateral runway centerline performance on the ground. Part of the problem with that is, is once you rotate you really don't have any cues to see as you get attitude on the aircraft you really can't see the runways centerline and so if you hold what you've got than you're going to end up drifting into the failed engine. So that's kind of a hard task for me, I'm pretty much holding what I've got and I'm obviously

drifting a little bit, but once that nose starts coming up towards high pitch angles, you really don't have anything... Am I missing something Lou that I could be cueing onto? (No) So it's really hard to complete that one. So it's hard to meet that criteria based on the fact that the pilot is not given very much to help him know that he is deviating. So that is a tough one right there. As far as the aircraft performing... performance in this crosswind certainly I think with the learning curve I do a lot better and I think the aircraft control law is such that you could do a good job, so but still we are pretty much borderline desired adequate, so for the overall longitudinal shooter Cooper Harper rating, it is controllable, high performance is obtainable, is it satisfactory without improvement? No, it is borderline 4/5 based on the performance requirements we had, I think that I am going to rate longitudinal as a 4 and give it the benefit of the doubt. The lateral directional, controllable? Yes, adequate? Yes, satisfactory? No. That's also borderline based on our performance criteria borderline 4/5, I'll rate that a 5. To try to indicate the borderline nature of this task, and I'll give it a 5 mainly for runway centerline deviation control on the ground, and we have already commented is to why that's difficult.

Pilot F

Task 7036 One Engine Out Takeoff - 35 kt Crosswind 23 Jan 97; Runs 12-14

We did, I think, three runs for data, for the engine failure with a crosswind takeoff, and a couple comments, first of all, with the crosswind on the runway, the yaw cue is offset, and so, it becomes confusing when you lose the engine, there really is no cueing to help you, except for visually outside. Especially in the low vis environment, I think this would be a... you're taking some useful information away from the pilot. The second thing is, is after rotation, the yaw cue is way up high in the display, and you're flying a flight director that's down low in the display, it would be very helpful to have the yaw cueing down in the display. I guess, I think that we need to go back and look in detail at the idea of using yaw versus lateral acceleration, I understand the problem that we've seen in the past, I guess the concern that I have on the runway, is that you are going down the runway with this... with the crosswind, with cue displaced the entire time, and first of all, I think there's going to be a little bit of a negative training between conventional airplanes and this airplane, because the guys going have grown up his entire life looking at lateral acceleration, either in a cue or mechanical ball, and then the second thing is, is that's really a useless indicator on the runway, and that's really a useless indicator as far as the engine failure goes until I'm in flight, and when I'm in flight, if I chose to hold wings level, there is going to be some sideslip on the airplane, so the balls going to be displaced. The other comment that I have, is as you rotate, and become airborne, there is a change in the rudder control laws, which takes I think about 10 seconds, what I was told, and to me that was very disconcerting, and depending on how rapidly I try to capture the command cue, I could easily... if I went after it with just bank alone, exceed the bank limits, if I went after it by releasing the rudder pedals, and trying to get... keep up with this ramping motion, it was very easy for me to get some lateral motion, I won't really characterize it as a PIO, because it was something that I could arrest quickly, but it was unpredictable, it was at least, somewhat of a perception of being uncommanded, as you let the rudder out, you'd get a roll input that you had to arrest with the ailerons, and so I really thought that was disconcerting, and I didn't really like that phase of the takeoff. Actually, to me that was the most uncomfortable phase of the engine loss, was right after I had already lost the engine on the runway, I'd rotated, now I'm airborne, and I have to go through this transition, once I got everything squared away, the airplane, very little rudder requirement, and climbout when you're at 212, and the airplane flies just fine after you get through that initial transition and rudder pedal command. The engine failing on the runway is easy to handle, during the rotation though, there is a distinct increase need for

rudder, and right at that point, I think the pilot, I basically had to try to do that visually out the window, the cue did not help me at all for that, because when I lost the engine, the cue was displaced, when I stuffed in the rudder, I was tracking straight down the runway, the cue still displaced, because there's yaw, or beta on the airplane, and so, then as I rotate the requirement for rudder, I really have no cueing at all, even if I look at that cue, I don't really know how to interpret it during that phase, because I'm going to go from a rotation phase... a phase where am I'm tracking straight down the runway, and have beta to a phase where I'm going to drift, and the betas going to go to zero, and I don't have a good feel for that, how that transition should look to me on the ball, particularly in low vis, I think that would be a problem. Anyway, are we just rating the... Okay, we got desired on all the parameters at one time or another, I mean adequate on all the parameters at one time or another, but we didn't get adequate, oh yeah we did, we got adequate at all at one time. The two big, we got desired on everything except for pitch control, which on some of the runs we did not get even adequate, and we got adequate on the bank angle, and again, that was I think attributed to the blip after airborne during the transition and rudder control law. So, we definitely got adequate performance here, and in both axis this time. I'd come in, and I'd say it's controllable, I'd say adequate performance is obtainable with a tolerable pilot work load, although the... that blip is... when the rudder control law changes, that is very disturbing to me, so I'm going to answer yes to this, but I'm not real thrilled about that, I guess. Is it satisfactory without improvement? I'd say no, I'd come in, and moderately objectionable deficiency, very objectionable deficiency, but tolerable deficiencies, I guess I would, I'm looking at the 5 or 6 range. I'd probably, again if we were using half ratings, I would probably go 5 1/2 here, because I think it's more than considerable. I don't know if I'd quite go with extensive or not, because it's VFR, if was IFR, I think you might actually be down in level 3, to tell you the truth, and even though that I would rate this in a level 2, I would say that the transition is unacceptable, in my mind, and I also think the display, the yaw display needs to be thought about and discussed in detail, I'm not really sure I have a firm feeling on if that's okay or not. Let's see, I guess I'm going to go with the 5, but I'll make the comment that, I guess a strong comment that I really don't like that transition, and I'd almost be willing to not rate it as saying that it's not adequate with a tolerable pilot work load, except for we did get adequate performance, and the work load wasn't that high, it was just very uncomfortable. Yeah, you know the lateral problem on the runway, and the display problem as far as trying to make sure that you're still tracking straight in pitch, I think degrades the pitch performance some, yeah, I could maybe say that it was a 4 in pitch, but I'm just going to go with a 5 and a 5. Okay, thank you.



## **Task 7040 Dynamic VMCA**

Pilot A

Task 7040 Dynamic VMCA 14 Jan 97

Not rated.

Pilot B

Task 7040 Dynamic VMCA 08 Jan 97; Runs 62-66

Not rated.

Pilot C

Task 7040 Dynamic VMCA 13 Jan 97; Runs 53

Okay, the...of course the lat-dir is the giant problem here if...with the nose up at 35 degrees and I lose, you end up losing quite a bit of airspeed, so, you're below the VMCA, and that's shown by even full rudder not being enough to bring the nose back, but lowering it down went by the time you get to 120, you can bring it in. There didn't appear to be enough rudder to stop the initial dynamic overshoot, even after 120, no matter how quickly I put the rudder full in. However, once it did finally slow down and settle, then I could hold, there was enough rudder to hold the beta at zero, but it very, very, seems to be very sensitive to any airspeed, and I would put in what I'd think was right, and make a slight change, and suddenly realize I'm...I've either got too much rudder, or occasionally even, I had to almost switch the rudder to get it back where I wanted it as quickly as I did, so boy, that's really a tough thing. We tried at below 120, and that was completely unsatisfactory, that I had no...you know, that's too slow in my book, there are too many things changing, couldn't keep up with it, didn't have enough control authority to do what I wanted to do, anyway. So, 120 did appear to be the right one, the key to not letting the heading change, if that's the main criteria, is that you have to put the wing down very quickly. If you wait until the nose goes over, it will almost yaw your 10 degrees by the time you come back, and so you're going to overshoot that for sure, so, as soon as you pick up that it's a engine loss, you have to drop the wing to fight the heading, and putting in all of the rudder possible is the only thing, and once you get it back, then I ended up holding about half the rudder, so that was, That was fine. The big thing that I noticed though, was the difficulty in ever getting the sideslip to zero and keeping it there, almost any other change I may disturb that, by quite a bit. I have a little problem with the necessity to hold a heading being as critical as it is, but if that's the task, that's what I was trying to do, and I managed to keep it in, and I guess that was desired, was it, did you...it was...it did keep a desired, but it took a lot of concentration on that specific parameter to do it, and usually loss of engine concerned about airspeed and getting the sideslip back to zero, so I don't run out of roll authority more than I am of how many degrees I turn, but I managed to get the desired when I did concentrate on that. I think the...the plan of having it once you get the sideslip zero, have it lock in is a great one, that could likely be tighter because that was a major variable on this, I had to work that many times, if there's some way to automate that, once you get it to zero, it will stay there, that would be a definite improvement, and anything else to talk about. Those are the things that come to mind, anyway.

Pilot D

## Task 7040 Dynamic VMCA

Not performed by this pilot.

Pilot E

### Task 7040 Dynamic VMCA 10 Jan 97; Runs 32-35

We looked at 125, 120, and 115. 115 we cannot maintain heading, we're drifting off to the right at a fairly rapid pace, and never could get the sideslip under control with full left aileron and full left lateral command, and full left rudder. At 120 same thing happened, part of the problem is as soon as the trigger, as soon as the engine fails, you start decelerating pretty rapidly, one thing you might try to do is be a lot more aggressive on pushing over, but the problem is, if you push over too aggressively, you then accelerate through your airspeed, and you can't... the airspeed, speed stability is such that you can't be too aggressive with your pitch commands or you don't maintain your air speed, so, if you're too aggressive, when you pitch the nose up, which I did my first couple of practice runs, I end up accelerating quite rapidly through the airspeed, which then negates the maneuver, so, it's a real balancing act to try to maintain that airspeed. In all cases you do bleed off about 10 knots once you lose the engine before you can get it down to recover, unless you do it real aggressively where you then rapidly accelerate through it. With that in mind though, it appears the somewhere between 120 and 125, would be the VMCA, now that's for the dynamic maneuver, if steady stayed, we found we were able to get down to as low as about 110, if we just gradually decelerated when we had the sideslip under control. One of the things that is very interesting to me, is the fact that with full rudder commanded and full left aileron, you cannot... you cannot trim out the sideslip error, it is quite large, it's almost a full deflection on the little sideslip trapezoid, and it just won't seem to come back, you have to almost accelerate to some number of knots above the target speed to get it to come back, or wait quite a long time, so there's some interesting things going on, it looks like though, 120, 125 is a first cut, rough order magnitude... is the VMCA dynamic.

Pilot F

### Task 7040 Dynamic VMCA 21 Jan 97; Run 36

I guess the biggest comment that I have is it... I'd have to do an awful lot of these to break out, whether, there is some coupling motion or there's just me coupling up with the stick. When I go to push though, I tend to induce some roll, and also as the airspeed goes, I think we're picking up some motion too, because you've got full rudder in, you're pushing the nose over, and then when... as the airspeed starts to increase again, you have to start backing out a little bit of rudder, and then put the rudder back in as you get back to 120. Anyway, I think part of it, or the dynamics of the airplane, I think part of it, a large part of it is excited by the fact that when I push forward, and I can't just really concentrate on making it appear, push input that I'm inducing some roll and put into it. The other thing is recognition of what rudder to put in. You know, knowing that the engine fails, I could of just stuffed in the appropriate rudder, but if I waited until I saw on the beta cue, what engine failed, and what the rudder requirement was, it was almost too late at VMC. So, I guess my point is, I think that... I guess I don't think that the cueing in the HUD is real good for pilot recognition that the engine has failed and what he needs to do to solve the lateral directional problem. Part of that might be in the beta cue, because as with the old ball, when you picked up a rate you immediately had input that you had a rate one direction, and the pilot really was responding

to a rate or an acceleration not to beta, and once he got everything under control, then he was using the ball to solve the beta problem, but you know, in order to have zero beta it really would require the ball in the bottom of the race, and a little bit of bank. What I'm stumbling around trying to say here is, is that I don't think that beta recognition is real good, because I think it takes a while for you to build up some beta, so you don't get immediate feedback where you used to with the ball, where you had an acceleration rate in the direction, and I think that's going to cause a delay in the pilot taking the appropriate action, and definitely would be a training issue, and I think this is something that we need to be real careful and look at in a lot of detail, and I think having a lateral acceleration cue versus a beta cue, would probably improve performance on this task. I guess that's all the comments I have. One additional comment was, and we had made this earlier, is because of the beta cueing also, once I put the rudder in, I stuffed some rudder in, and then I'm looking at the cue, and the cue swings out, or swings to where I want it, and then it swings passed, and then it comes back. So basically, in trying to center the... in what I'll call centering the ball, I have to accept one overshoot to do that, and again, I don't think that's a real big deal, but it's worth noting.

## **Task 7050 Dynamic VMCL-2**

Pilot A

Task 7050 Dynamic VMCL-2 16 Jan 97; Runs 96-99

Run Number 99 appears as though the VMCL of 130 is adequate prior to the automatic flap extension at 400 ft, that's just enough rudder to counter the thrust required for a three degree descent, and with the gear down, and when the flaps reconfigure, the added drag requires more thrust, which causes you to lose directional control at that point, so the added... so another task probably needs to be done to determine the minimum speed for which you can control the airplane with landing flaps in approach configuration.

Pilot B

Task 7050 Dynamic VMCL-2 08 Jan 97; Runs not available

Okay, there won't be any CHR's on this, we'll put N/A on those on the card. The technique was basically to wait until the engine failure was called out which was about a second to a second and a half it looked like after the engine failure actually occurred. So we had some yaw rate established at that point. I put in something approaching 5 degrees angle of bank and lots of rudder, in occasion full rudder to try to correct for it. I wasn't targeting zero bank, I was targeting less than 5, so I allowed some bank to build up, didn't try to zero that out, and the idea was to try to minimize the yaw rate and get the airplane back on heading towards the runway. It worked, at a 130 knots, it appeared to me as though 130 knots was the minimum speed that I could have made this successful in that I was right at the boundary at full rudder and 5 degrees angle bank I was just able to arrest the heading as the airspeed stabilized at 130, so I don't think any slower than that would have been successful. The technique is doable within tolerable work load, so I think it was a successful card. That concludes my comments.

Pilot C

Task 7050 Dynamic VMCL-2

Not performed by this pilot.

Pilot D

Task 7050 Dynamic VMCL-2

Not performed by this pilot.

Pilot E

Task 7050 Dynamic VMCL-2 09 Jan 97

Not rated.

Pilot F

Task 7050 Dynamic VMCL-2

Not performed by this pilot.

## Task 7060 Engine Unstart

Pilot A

Task 7060 Engine Unstart 14 Jan 97; Runs 5-7

Block 3 - Operation after Upsets This is run number 7, and the unstarts from cruise, Mach 2.4, number 3 unstart, ripple unstart. It's controllable, you get adequate performance, and it's probably satisfactory without improvement, I would give it a...probably a 2 or a 3. Frankly, it's probably a 2. Yeah, lateral and directional, and longitudinal. Yeah, obviously, the tach would be helpful here to, in the event having a dinner, or distracted looking at a chart, and could be quite some time before you. Get back to the airplane, so the tach would be helpful. The...obviously, if the autopilots engaged, and you have tach installed, it could be a non-event. That's fairly benign maneuver. There's about 20 lbs. of rudder required, maybe 20 or 30 lbs. of rudder to zero sideslip, and it's fairly easy to hold the flight path vector in the unstart circle, inside the unstart circles that are shown here, I think it looks fairly benign, very little pitch input as a result of the unstarts.

Pilot B

Task 7060 Engine Unstart 08 Jan 97; Runs 25-27

We did four of [these] for data, three of them I put inputs in and got desired performance, and the fourth one I didn't do anything and still got desired performance, although we got some cycling unstarts on No. 1, which you probably wouldn't want, but when I eliminated the induced unstarts by putting the rudder input in, and the rudder input was the primary input required, I was able to keep it within desired performance and not have any additional unstarts. Let's see, the maneuver was performed according to the instructions in the evaluation basis worked okay. Not much of a tendency to oscillate...no tendency to oscillate. Maybe no pronounced tendency to oscillate, there might have been a little bit of an oscillation in bank angle and/or side slip but nothing pronounced. No problem within the desired parameters, in terms of bank angle control and pitch attitude. Okay, longitudinal; controllable, adequate, satisfactory, improvement not required, mildly unpleasant deficiencies, minimal pilot compensations, HQR3. Lateral directional, same thing, controllable, adequate, satisfactory, minimal pilot compensation, HQR3. I think that the primary reason for the any ... anything, talking about compensation at all, is just the fact that the task does demand some inputs and to monitor the angle of bank and pitch attitude. That concludes my comments.

Pilot C

Task 7060 Engine Unstart 13 Jan 97; Runs 34-36

Is it satisfactory without improvement? I'd say, yes. Improvement not required and due to the size of it, I had just a little mild deficiency there, I would have to say probably, minimal pilot compensation required for desired performance. A three. The size and inertia of the airplane is evident and I was trying to make a trade-off. It is likely that as I get more familiar with the way the airplane feels, I could probably even improve the performance but we are already at desired so I don't see any question on that. I would give a three for that. The rudder forces all seem quite reasonable with nothing inordinately large about them, that's for sure and with the exception of the tendency to overshoot, probably because of the inertia and size of this thing, it was quite easy to keep it within the red ring. After I checked

the red ring, I looked at the side slip and kind of fine tuned things with that. I did notice at one time in there, again during ... if I might try it, I did at one time start to push in the wrong direction but it picked it up quite quickly. It is quite an intuitive display and a good technique. (How much time before you're applying rudder on this?) I'm doing it before it gets to the edge. That's a little miss lead on this because if there is a surprise factor on this you're probably going to get further out than that. (Are you saying a second or so?) Yea, but I let it get to the red ring and then I recovered. I let it get that far. Of course the big thing is that slug tells you right away that something is not right, so it isn't like you are flying along and suddenly it moves off to the side. When you get that airframe "punck" like that, you say, "whoa, what was that". It does tend to focus you quicker than say a more benign (situation). A three and a three.

Pilot D

Task 7060 Engine Unstart 22 Jan 97; Run 26

We're at Mach 2.4 and we have a engine #3, engine fails, 4 follows, and we did one run where I didn't hardly... make any inputs and things kind of took care of themselves. Second one, I tried a little bit of rudder to try and keep the unstart... keep centered in the unstart envelopes a little better, and that was reasonable. Then of course, I had to use a little bit of bank angle to keep the heading in. Longitudinally there's really no task at all. The flight control system is holding the flight path well enough. So, I'm going to give it a 2, because it's really a non-task, and 4... correction, lateral I'm going to give it a 4 just because there is that little bit of a tendency to PIO in roll, once you do get in the loop, but really pretty good.

Pilot E

Task 7060 Engine Unstart 10 Jan 97; Runs 17-21

This is a fairly easy card for pilot, you have to carry left rudder as soon as you get the #3 engine fail, and with the inlet unstart circles up there, it's pretty easy to judge just how aggressive you need to be with your rudder to keep from getting an unstart on the opposite side. The task is to kind of be modified as we're flying this... trying to maintain 385 knots, or recover to 385, and let the Mach bleed off. In order to do that you've got to push the nose over, but it just, just takes almost a very, very, slight forward stick and very slow pushover to keep from exceeding the 1/10 G for the desired criteria. With the G tape, that's certainly doable, and I think if we played with this one or two more times we'd easily have no problems. I think it can basically... this task we know desired criteria, I'm going to rate it that way. No problem with the controllability, left with some devices the flight path gamma dot V maintains the flight path on the horizon, and there is no G pulse when you have the ripple unstart on the right side. Therefore for the Cooper Harper ratings, for the evaluation segment inlet unstart, longitudinal Cooper Harper, task is controllable, adequate performance is obtainable, is it satisfactory without improvement? I'm going to say no, and rate it a 4. The... it's just... you've got to be extremely careful when you push over to maintain your airspeed, that the G is very, very sensitive, and it's almost an imperceptible amount of force on the side arm controller to get that nose coming down, so, it does take a great deal of careful compensation not to exceed a 2/10 G limit. The lateral Cooper Harper rating, basically, the heading never deviated more than about a degree and a half on any of the ones I did, and that's well within desired, and the bank angle didn't deviate at all. I did try to correct back to that one and a half degree heading and put in a little bit of bank, but then that was controlled, and I used about 2 or 3 degrees, so for the lateral rating, is it controllable? Yes, adequate? Yes, satisfactory without improvement? Yes. I'd rate it a Cooper

Harper of 3, even the rudder application with the symbology showing the inlet unstart circles, that's fairly routine. Bruce asked me to give another Cooper Harper rating, not considering the recovery to airspeed, which necessitates the very, very, gradual very just imperceptible pushover to avoid the G exceedence, with that in mind, the longitudinal rating would be for the actual unstart and subsequent engine failure and retarding of the throttle to idle, there's basically no requirement for the pilot to be in a longitudinal loop. So, is it controllable? Yes, is adequate performance obtainable? Yes, is it satisfactory without improvement? Yes, and I would rate this a difficult between a 1 and a 2, because there's not anything really the pilot needs to do. I would rate it a Cooper Harper of 1. Just to make sure we... on the lat. dir. for that task, that subtask that Bruce just described, controllable? Yes, adequate? Yes, satisfactory? Yes, a 3, it does take a compensation with the rudders to assure you don't get a unstart on the other side.

Pilot F

Task 7060 Engine Unstart 21 Jan 97; Runs 22-24

Okay, I'll just repeat the same comment that I did before, I think it's more recognizable that you have an excursion in yaw or lateral excursion for the flight path vector than it is off of the lateral acceleration cue that is in the roll pointer. To do the Cooper Harper, the task is controllable, it's adequate performance with a tolerable pilot workload. Is it satisfactory without improvement, I would say yes for the task that we're doing. I do think that pilot recognition is something that is going to have to be looked at specifically for this task. Again, just because the cueing with confusion factor up at cruise in this condition where you expect longer delay times, I think there might be a need to look at, I'm not making a statement that you have to do this, but I think there may be a need that you... to investigate maybe some additional cueing or something for a task like this. Anyway, for this particular task, though, I do think we got desired performance. It's satisfactory without improvement as far as handling qualities go, and then I'll go into the first block, excellent, highly desirable, pilot compensation not a factor, good negligible deficiency, pilot compensation not a factor for desired performance, and fair, some mildly unpleasant deficiency, minimum pilot compensation required for desired performance and disregarding the pilot recognition cueing just doing this task as we're expecting it, we know what we're going to get. I would say it's a two (2), if we're not going to do any half ratings, and again, I'm kind of factoring the pilot recognition issue out of it, there are certainly plenty of cues to maintain control and easily fly the airplane. My concern will be more a cruise... that's up at cruise and not really right on top of the airplane or paying attention or something, I think the recognition time might be a little bit longer. I'm sorry, yeah, I have a... I guess a hard time splitting axis, but yeah, I would say it's a two (2) in both axis, actually, you cannot touch the stick and just use the rudder with the control laws and it holds bank, and we've deviated probably, I think the most of them those three ones, was about a degree or degree and a half of heading. You cannot get in the loop and roll, and it's easy to correct back to heading once you've had the dispersion, but like I said, you could basically just stay hands off the stick I think, and it will hold pitch and, well hold to flight path, and not roll off, just a little bit of rudder correction is all it really takes.



## **Task 7070 Engine-out Stall**

Pilot A

Task 7070 Engine-out Stall 13 Jan 97; Runs 76-78

Straight ahead, and Cooper Harper, I'll have to give it a 2, lateral directional, and a 2, longitudinal. Looks quite good, no particular problems in either axis.

Pilot B

Task 7070 Engine-out Stall 06 Jan 97; Runs 55-57

The card was performed as per the instruction, performance was obtainable. I've changed my techniques a little bit on the push and on the recovery. Instead of wrapping my hand entirely around the stick as I recover, I'm just putting force on the aft end of the stick. Just by opening my hand up a little bit and I'm finding that helps me avoid inadvertent inputs and that substantially aided the PIO problem this time, although there's a tendency still, I certainly didn't get into it, in any sense, other than that, the desired perimeters were attainable, again the longitudinally is the task of interest in the entry in the lateral directional primarily in the recovery with the large pitch change. Longitudinal HQR with the tolerances as previously mentioned in the previous task, it's controllable, adequate, satisfactory, minimal pilot compensation required for desired performance, and mildly unpleasant deficiencies HQR3. Lateral directional, same thing, controllable, adequate, satisfactory, no improvement required, fair characteristics, minimal pilot compensation HQR3. That concludes my comments.

Pilot C

Task 7070 Engine-out Stall 15 Jan 97; Runs 107-109

These all look very familiar, about the same amount of work load, same amount of performance, if you wouldn't of told me the engine was out, I probably wouldn't of even known it, other than just the touch of rudder that I needed to keep the sideslip zero, but no real increase in work load at all, 3 and 3.

Pilot D

Task 7070 Engine-out Stall 22 Jan 97; Run 22

It's just ditto, ditto of all the others here, task is slightly easier because of the... not having to roll it. Again, it's trimmed as we started out, so it really isn't a very difficult task, just a little bit of attention to beta, but I'm going to give it the same pilot rating, 4 and 3 because of the tendencies... well, because of the force buildup causing a little bit of additional compensation, which is good, and a little bit of the PIO tendencies, both longitudinal and lateral.

Pilot E

Task 7070 Engine-out Stall 07 Jan 97; Runs 107-109R 15

This one with 75% power in the 3 good engines. It's a little bit squirrelier in your... the speed instability is a little bit greater here, it's a little bit squirrelier in maintaining your constant 1 degree, 1 knot per second deceleration rate, and you can tend to overcontrol that a little bit if you want, if you are not careful and also it's a little bit squirrelier maintaining wings level, so the whole thing is just a little bit less controlled, you got a little bit more on a knife edge. Never the less, you met the desired criteria on all of the recoveries. So for the longitudinal Cooper Harper, for the evaluation segment, it was controllable, adequate performance was obtainable, satisfactory without improvement? Yes, a 3. For the lateral direction, controllable? Yes, adequate? Yes, satisfactory? Yes, for a 3 also, the... it's a level one, but it just seems to be just a little bit on the edge here and not quite as stable or rock steady as one with idle power, so the engine out does seem to add a little bit of sensitivity, extra sensitivity, to the control inputs to the task.

Pilot F

Task 7070 Engine-out Stall 23 Jan 97; Runs 20-21

And again, I don't see any real big difference in the stall than the other ones that we've done. You get some small beta excursions, as you start out there is no requirement for rudder at all. As you increase the pitch, there's a slight, very, very slight requirement for right rudder, I almost think because when you put in the rudder on this stall, you tend to rock the wings a little bit. I think it would be easier to do the task, just to accept a little bit of the slight offset in beta, and not touch the rudders. The roll is still objectionable to me, I can definitely overcontrol and get overshoots in roll, I'm still hesitant to call it a PIO, but I could see if I was really, really trying to be real high gain on this, I could see, maybe exciting a PIO, I think that... you know, if I'm very patient, whenever I start getting overshoots, and start overcontrolling them, I can stop them right away. They're definitely not divergent. I can stop it right away by just backing off on my gain a little bit. I guess it still bothers me a little bit, though, that I think there is a tendency there, and I guess for consistency sake, I'm going to probably end up at the same place I was before, simply because I think it's minimal pilot compensation vs. moderate, but I really am having a hard time answering, is it satisfactory without improvement? The more and more I do this, the more and more I'm kind of tending to say, you know, I really think maybe the 4 is a better rating than the 3, but let me go through this. It's controllable, adequate performance with a tolerable pilot workload, satisfactory without improvement, and again let me just read the descriptors for 3, it's minimal pilot compensation required for desired performance, fair, some mildly unpleasant deficiencies, and for 4, minor, but annoying deficiencies, desired performance requires moderate pilot compensation, and I have a hard time going with moderate. I'm still going to give it a 3 and a 3, but I think, I guess what I'm really trying to say is, is I think that the roll axis could use a little bit more work.

## **Task 7080 Engine-out Turning Stall**

Pilot A

Task 7080 Engine-out Turning Stall 13 Jan 97; Runs 78-81

I would have to rate the lateral directional, because of unexplained anomalies, well, I guess I was getting into the desired range, but I might rate it a...I'll rate it a 3, pitch at 2, and the reason being, that there seems to be some strange, I don't know if it's the simulation is not correct, or there's strange phenomenons in this airplane, but as you roll into a bank, and start decelerating it requires right rudder as you decelerate, and then that in turn requires...causes a steeper bank angle, and causes you to have to oppose it with aileron, lat-roll control, and then you get into a contest between rudder trying to reduce zero sideslip, and aileron control...roll control trying to hold 30 degrees of bank, and it tends to degrade into a slight PIO. The sideslip angles are not very large, about 1 or 2 degrees, I guess 2.9 was the most recorded, so they're not large angles, probably not even worth correcting for, but if you try to attempt to correct for them, then you get into a small PIO in roll, the recovery is pretty straight forward, but once again as you roll wings level, I think the turn coordination and engine out compensation, sideslip, and such, cause a need for some left rudder on the recovery, and so there's something going on with the turn coordination and the control law in these ... in these tests that seem a little strange, it seems to interfere with control slightly, it's not a major problem, but just doesn't seem right.

Pilot B

Task 7080 Engine-out Turning Stall 06 Jan 97; Runs 58-60

Accomplished the card pretty much as written. Desired performance was attainable in both axis with the criteria for longitudinal as previously mentioned. I am working fairly hard, this time, in the entry both longitudinal and lateral directionally, recovery is fairly benign in both axis, but I'm working to keep 30 degree angle of bank and keep the airspeed bleed rate on target. It's not quite to the point where I'm ready to call it a level 2, but, I'm still working hard, so this was a border-line level 1, I think. Longitudinal, it's controllable, adequate and satisfactory, improvement not required, mildly unpleasant deficiencies, minimum pilot compensation required for desired performance HQR3...Yeah, for longitudinal, I think that's valid. For lateral directional I'm going to change my mind, it's controllable, adequate, however I think , deficiencies warrant improvement.....and say that minor but annoying deficiencies, desired performance requires moderate pilot compensation HQR4. I'm just really fighting the angle of bank in the entry, so give that an HQR4. That concludes my comments.

Pilot C

Task 7080 Engine-out Turning Stall 15 Jan 97; Runs 110-112

Finally saw something different, in the turning engine-out, it took the extra work just to keep the sideslip zero in the beginning bank angle, and it seemed to be pretty sensitive to how rapidly I rolled out, if I rolled out quickly, I'd get pretty good split in the sideslip, in other words, sideslip would build up pretty large, and then in trying to get it stopped, I started into a PIO that was...it was converging at least, and then finally get it stopped, when I really went for it in a hurry, It got adequate performance, if I just kind of let it, you know, just eased off on it, I could get desired, with the PIO in there and everything, I'm very difficult to call it

desired no matter what. So pitch, however, I didn't notice any difference, so, the pitch was a 3, but the lat-dir I'm going to give a 5. It...while...if I used a special technique, I probably could get desired, it's very sensitive to technique, and in any case, if I see a PIO, I can't really call it desired, and my way of doing thinking of things.

#### Pilot D

Task 7080 Engine-out Turning Stall 22 Jan 97; Runs 20-21

The IC has the airplane all trimmed up with the rudder already in it and everything, so the task really isn't much more difficult. I did concentrate on the... keeping the sideslip zero as far as the performance, in other words, at least one there was actually better on the beta, than on the symmetric thrust ones. I don't think there's enough difference here to warrant any different pilot ratings. Still be 4 longitudinal and 3 lateral. I did notice I got just a little PIO in roll, because Lou was trying to get me to get back to zero, hard zero, which I don't think is really necessary for this kind of a task, but it did show up that I did get a little bit of PIO in roll. I'm not sure I mentioned on here earlier, that maybe a little more force build up as we approach the stall would be beneficial as a warning. What we have is nice, but I think just a little more might help.

#### Pilot E

Task 7080 Engine-out Turning Stall 07 Jan 97; Runs 110-112

The evaluation segment was from the start from a 30 degree angle a bank turned up to a wings level recovery and in that part we noticed it was hard to hold 30 degree angle a bank. I was having to put a lot of rudder compensation in there, but it's not a steady rudder, it seemed to vary, so I was having to actively work the rudders, of course that would translate in having to actively work the angle of bank. And also it was a little bit difficult to hold the 1 degree per second deceleration. A couple times I would get little spikes where it would seem to drift off on my own, I would seem to get a big jump in the deceleration rate, so you are kind of having to chase that the whole time, so a fair part of the task up to the stall is a little bit high work load. In the recovery I used several different techniques, first one just relax back pressure and made a nice smoothly recovery and slowly let it roll back to wings level, then I aggressively pushed forward, and aggressively rolled wings level once I got the waterline above the horizon. Got a PIO, almost instantaneously and it stayed through 5.7 degrees alpha, which is the lowest alpha I got. The third one I didn't do quite as aggressive as a capture, I tried to smoothly capture wings level once I got the waterline below the horizon and it seemed to work out pretty good until I got to down around 6 or 7 degrees alpha then it started to develop a roll PIO, so the roll PIO is actually towards the lower alpha. For the evaluation, I met the desired criteria on everything. Longitudinal; is it controllable? Yes, adequate? Yes, satisfactory, longitudinal I'd say... yes and rate it a 3. Lateral, controllable? Yes, adequate? Yes, satisfactory? No, rated a 4. It gained a 4 for two things, one the flight roll PIO tendency on the recovery at lower alphas and the other reason is that it's just so darn hard to hold 30 degrees angle at bank and that's part of the evaluation task, is..., including holding that 30 degrees angle at bank that the work load is very, very high, so let's make it a 4 for that.

#### Pilot F

Task 7080 Engine-out Turning Stall 23 Jan 97; Run 19

Turning stall, 75 percent power on all the engines, except for number 4, which has failed. Basically, not a big difference between the other turning stall that we did, requires a little bit of rudder as you enter the stall, a requirement for increase rudder, or at least that was my perception is, as we approach the actual stall. During the recovery, then when you unloaded the airplane, you had to reverse your rudder. I released... I believe what I did, was release the rudder during the recovery. I was kind of surprised, I almost felt like I needed a requirement to use some opposite rudder, I never did, but I almost felt the requirement that I needed to use opposite rudder during part of the recovery maneuver. Nothing that seemed, you know, a real big deal, and you're not going to keep the ball perfectly centered during the engine-out stall and recovery anyway, but anyway, it seemed very controllable, basically, all the same comments that I had before with the exception of when I rolled out and pushed the airplane, the movement of the ball was kind of, I don't want to say disconcerting, but again as you start the roll rate, you're going to pick up some beta, I guess that's okay, again I guess I just, I think we still need to kind of make sure, there maybe a need to have NZ, or NY and N beta both displayed somehow, and some kind of display format. Anyway, I still think that that needs to be considered a little bit further. For this task, it's definitely controllable, you get adequate performance with a tolerable pilot work load. Is it satisfactory without improvement, you know, for all the same reasons, I'd still think that holding precise bank angle requires a little bit of reduction in gain, to do it very well, and... but I'd basically answer yes to that, and I'd go in, and I'd say it's mildly unpleasant deficiency, mainly the ability to hold bank angle, and minimal pilot compensation is required. I think it affects both axis a little bit. So, I'm going to give it a 3 and a 3.

## **Task 7095 Manual Thrust Landing**

Pilot A

Task 7095 Manual Thrust Landing 15 Jan 97; Runs 62-64

There's definitely a added work load with the manual thrust, however, it appears as though the ability... there's... even with a lot of friction and sticktion in this throttle you can still pull the... within adequate tolerances on airspeed, the... there is more work loads, since... we ought to spread your attention out on airspeed. It would be helpful, if once you get on the glideslope with manual throttles you didn't have to go through a configuration change, with so close to the flare, it tends to destabilize the approach, that's all right for an autothrottle operation, but for manual throttles, it's a little poor. Cooper Harper rating; so, it's getting adequate on the touchdowns, let's take the... I think we were generally desirable in the approach, so, I'm going to give it a 3 in longitudinal, and a 2 in lateral, and the flare, I would... from 200 ft on down, you say, from that point on down, the Cooper Harper rating would probably be 4 on the pitch, because of the work load on the... having to use manual throttles and overcome a recent configuration change, and in the flare up, add thrust, so, there's a lot of things going on all at the same time, and it's kind of dynamic, it would be better if you didn't have that configuration change to upset you at the very last minute. Laterally, I had no real problem, I'd give it a 2, I guess, in the flare.

Pilot B

Task 7095 Manual Thrust Landing 07 Jan 97; Runs 9-11

In the approach phase, no serious problems, so the workload is a little bit higher, obviously in manual throttle, a little bit more attention required, particularly where airspeed changes occurring in the approach. However, nothing, unsatisfactory. Longitudinal HQR, its controllable, adequate, satisfactory, improvement not required, minimum pilot compensation HQR3. Lateral directional, same thing, controllable, adequate, satisfactory, improvement not required, mildly unpleasant deficiencies, minimum pilot compensation HQR3. The primary task longitudinally was monitoring airspeed and primary task lateral directional was just bank angle control. Required a lot of inputs. And I've talked about why in the previous evaluations. Okay, now in the landing segment, bit of a problem with sink rate control. I'm having more of a problem with sink rate control than I did before, its fairly consistent. I'm finding less of a cushion. I think its a ground effect problem. I'm finding as I get down low that when I raise the nose that there is more of a split between the commanded and actual gamma that requires me either to rotate further which tends to make me float and there is a tendency to do that, or not rotate enough. In which case, just prior to touchdown, you see a need for cushion and sink rate and of course as you raise the nose it lowers the landing gear. So, you're not really...there's really nothing you can do at that point other than except a relatively high sink rate. I'm able to get within the adequate territory pretty consistently but its consistently high if I try to control my X-distance at all. My X-distance by the way, is routinely in the adequate area, not in the desired area so there's a fairly consistent trend here and relatively high work load. Longitudinal HQR, its controllable and adequate, I think improvement is warranted. I'm going to say that this is another where I would like to have a 4.5 because the pilot compensation longitudinally is probably less than considerable. But on the other hand, I'm not able to get desired performance consistently. But I'm going to give it an HQR5 longitudinally. Lateral directional is not too bad, I can pretty much ignore that. Its controllable, adequate, satisfactory, improvement not required, minimal pilot compensation HQR3. That concludes my comments.

## Pilot C

Task 7095 Manual Thrust Landing 13 Jan 97; Runs 95-97

Okay, for the ILS parts, the localizer intercept, and the glideslope intercept, I have the same comments, pretty much as the ones with the autothrottle, really, is not real difficult, but on this one due to the throttle movement, and I'm not sure whether it's engine response, or display response, but when I make some large motions with the throttle, it looks like an awful long time for the excel karat to move, and as a result, the temptation is to make another change before you see what your last one did, and then get you going a little bit, and while by itself, you wouldn't think that's a big deal, that takes some concentration away from the rest of the things, like putting it on the glideslope, and I would find myself in a little high or a little lower than what I expected when I came back to that. The lateral-directional on the ILS, I didn't notice any particular problems with that at all. It...it seems the whole airplane as throughout all of these, seems to have the...a little more sensitive in roll than in pitch. The pitch just seems to take for, you know, considerably more sluggish type motions than the roll, however, certainly nothing that caused any problem. Okay, now, as far as the Cooper Harper for lat-dir on the glideslope, comes up to satisfactory without improvement, well, just due to enough times getting into adequate, I really can't say that it would be satisfactory without improvement, although it's not...was not horrible. Did I get off the glideslope, or the localizer enough, or was that always desired. You were in the desired range, that's what I thought, okay. Deficiencies require improvement, yeah, I'd go over to that, and I would say 4 would be the Cooper Harper for that. It was desired performance, took moderate pilot compensation, and I concentrated on it, a little more maybe than I did before, and thus was able to keep it within the desired. It was almost, it was almost the 4 on the previous run, this time although I think it did move up into 4 for the lat-dir on the localizer. In pitch, so, this will be kind of a combination of glidepath control and speed. This one is, this one was really significantly more difficult than the last time. Satisfactory without improvement, no, requires improvement, never could do better than adequate, and I had just...have this feeling that I'm not sure how much more practice I got, I would ever be able to improve it significantly over that, it just seemed like working and the things that were going on toward the end, it actually, this is something that I didn't mention before, until about 400 ft tracking the glideslope, is not particularly difficult, in fact, when I was getting off, I was purposely getting off, I wanted to be start, with a little below the glideslope, when I got in close, so that I could...that would help negate some of my problems I was having in the flare, and landing long, and so that was fairly accurate, but as soon as I'd get into the, oh, 400 and under range, then things would start to happen, I wasn't controlling, and if I wasn't looking at just the right thing when it happened, why I would get off and sure enough, every time, I got off on airspeed, and I got off on deflection, and...so, I'm going to give that a 6 for the pitch, and I believe that's what I gave it the last time, wasn't it, for the second segment, but I'm talking about the last part of the first segment here, and my...just getting ahead of myself here a little bit. Never got out of adequate, so, I'd still stick with that, no, no, that was extensive compensation just to keep that adequate, that could of gone inadequate real easy, I'm going to leave that a 6. Now, when we get into the second segment now, all it is is a magnification of the problems that I saw, the lat-dir, again, would stay, and I kept that within desired, and I was working probably moderately, so, I'll stick that with a 4, we maybe learning a little...seeing a little bit of learning curve on this, but the fact that I did keep each of 3 in the desired, and I was working moderately hard, would give that a 4 also, and in the pitch, so, I think we were adequate every time, sometimes almost desired, but not quite, but boy, that was still a lot of work while I was trying to do things that I had to tell myself I had to do, not that I did naturally, and so I'm debating between the considerable and the extensive part now,

and that's a tough question, not going to give it a half, but I would give it one, I'd say to get that adequate, I was probably working at the extensive level, I guess I'll have to leave that at 6, there's some question in exactly, it's on the high side of a 6, but it's a 6, and that's for the pitch in that lasts from 200 ft on down to touchdown, and the work that I was doing there was strong enough in pitch, that it was affecting the lat-dir some, I think if I had a better pitch airplane then I'd be able to concentrate a little more on the lat-dir probably could improve that, but that's not the case now, but I wouldn't be surprised. My biggest concern is the pitch, I'm trying to think if there's anything else that's got in there. As far as all the controller and so on, I didn't have any complaint. On one of the runs it seemed as though I had more breakout than other times, I don't know what that was about. It wasn't enough to effect performance, I don't think, but it was something that I definitely noticed on one of the runs, that was the only run I noticed it on, so, I'll look at it again, when we do some more, and make that it's not just how I happened to observe it that one time, and it might be, but in general, I didn't have any complaints with the controller as far as gradients and harmony, and all that stuff. I did change my technique a little bit in the flare that helped along, before I was going from the regular descent to flared attitude a little bit quicker in doing it, almost open loop, but I wanted to do it quick enough so I didn't just smash into the ground, and as I get a little more comfortable getting in close, than I slow that rotation down just a little bit, and that helps the...how long the landing is, okay.

#### Pilot D

Task 7095 Manual Thrust Landing 23 Jan 97; Runs 54-56, 58-60

Okay, on... as far as the glideslope goes, the addition of the throttle control task makes it a little harder, particularly there is a lag in the acceleration chevron, if we could get rid of that with some throttle lead, that would sure reduce the work load there. With the lag in, it definitely increases the work load. The delta V tape is a little hard to see. Maybe just a little bit insensitive for the performance criteria we're using, I think it would of helped me either if the display was more crisp, or if the scaling on the delta V tape made small errors more apparent. Pretty much ditto, as far as the glideslope and the loc and the roll PIO etc. from 4020 are, so, I'm going to give it a pilot rating of 5, longitudinally, and still 4, laterally. Okay, on to the landings with the manual throttle, ditto on the comments for the chevron and the delta V, it's just a little harder to see those, when you're, especially when you're concentrating on other things. It definitely increases the work load, I did change my technique half way through there, and because we got one we landed very short, and I had noted that earlier, that a two segment flare was required, I moved my visual glideslope intercept point down to 1500 ft plus vs. the 1300 ft it was originally, and this has helped, so, I'm going to disregard the one where I landed very short, and assume that we had adequate performance, and another comment on all these landings so far, both 4020, and 7095, is that it requires a very high pitch rate, if you want to start your flare at 50 ft to get the H dot, to be able to get the desired H dot, and I guess that's because of the different ground effects that we had on the previous vehicles. Pilot ratings, landing, longitudinal, 5, lateral, 4.

#### Pilot E

Task 7095 Manual Thrust Landing 08 Jan 97; Runs 43-45

Obviously the manual thrust increases the work load substantially. First run, run No. 43, I'm missing the glide slope capture, because I was just finishing up the deceleration from 190 to 159. That has a glide slope than when I'm pushing those over to aggressively capture the glide slope, very quickly accelerated on me, that was more or less my fault rather than the



aircraft's fault. The runs 44 and 45 were more representative and basically those indicated very high work loads to maintain the air speed. I felt I met the desired criteria. Score cards show the deviation of 6.6 and 6.7 knots. That happened for a brief instant, but I would say 90 percent of the time or more I was within 1 or 2 knots, so I am going to consider that I met the desired criteria for airspeed control on the approach, at least for the glide slope intercept segment downs 200 ft. On the... actually about the... for 300, 200 ft, for the transition point when the flaps come in, when you really have to put a lot of power on and on all the landings you can't really anticipate that, and I got a very rapid 5 to 6 knots deceleration before I could catch it with power application, and that must be at some point when the drag really increases precipitously during the autoflap transition. This is another reason why I think the autoflap transition is not a good idea that close in on the approach. You are down around 200 ft or so, but having to make a very, very substantial power addition, or it should go very quickly to a slow condition, which in this aircraft the backside characteristics already as a problem could lead to a firm touchdown and the like, so I think this manual thrust landings certainly indicated another problem with the autoflap transition that late in the game. Same comments applies as far as a flare and touchdown, basically from 50 ft on down, it's the same as the nominal thrust landing, approach and landing, and that is, it is very difficult to judge the proper flare. The first couple I over fledged just a little bit, and went just a little bit long, had good H dots, but just a little bit long, and the last one, I was correcting for the airspeed deviation off the last of the autoflaps coming in and had to make a really quick save at the end and got a very nice H dot, but landed short, so overall performance was adequate. So it's still a little bit of a guessing game, I still haven't quite figured out the technique to make consistent landings. Okay for the Cooper Harper ratings for longitudinal for the glide slope intercept, is it controllable? Yes it is, is adequate performance attainable? Yes, is satisfactory improvement? I'm going to say no and rate it a Cooper Harper of 4 mainly for work load, the manual throttle task is very high work load and certainly I think desired performance requires moderate pilot compensation, is a good description there. For lateral directional, for the glide slope intercept portion, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, I'm going to rate it a 3. It's probably a little more than minimal compensation, but not as much as moderate so it's kind of a borderline 3, 4, but more of a 3, more than a level 1. For the precision landing phase, longitudinal basically met adequate performance, although I had good H dots, I couldn't quite get it in the box so that's going to obviously keep it out of being anything higher than a 4 or anything, make it higher than a 4. So controllable? Yes, adequate performance is attainable? Yes it is, satisfactory without improvement? No, it will have to come in as a 5 based on criteria and performance and I made a lot of comments already on the difficulty of landing task. Lateral directional, controllable? Yes, adequate? Yes, satisfactory without improvement? Yes, a 3, again comments of lateral axis could be improved with some different sub modes we could put in there, but it's doing the job, and again I want to reemphasize that I think the manual thrust landing certainly does bring out another problem with the autoflap transition being so late in the approach.

Pilot F

Task 7095 Manual Thrust Landing 21 Jan 97; Runs 89-91

Okay, basically, controlling the airspeed, there's a couple factors that I think are unrelated to the evaluation which at least influenced me, and that is one, the airspeed display is pretty fuzzy on here, and I end up relying mostly on the tape, and then when I do cross-check the airspeed, it takes a... I guess a significant amount of attention where I have to look at it for a bit before I really can decipher what it's really reading. So, that is one factor, and I think that's degrading the airspeed control and performance on final, because I'm spending an

awful lot of time controlling airspeed, and out of the work load of controlling airspeed, a lot of my time is spent trying to decipher that digit, and that's slowing my cross-check down a fair amount. So, other than that, I don't think that it's really that hard to track. I guess if... to rate the task, I'll go on, it's controllable, is adequate performance obtainable with a tolerable pilot workload? I'm going to say yes to that. Is it satisfactory without improvement? and I would say no, although, and I'm trying to, I guess decide, I don't want this to taint your data, but the reason I would say no is, if I could read that digit better, I'm not so sure that I would have the same response. So, I'm not so sure how much of this is a display issue. Certainly, it is a higher work load effort to control the airspeed with the manual throttles. There is some time delay in getting the thrust response, and the sticky throttle also makes it difficult to set precise power settings, I end up overshooting and going... throttle too fast forward, and getting an acceleration then too far aft, and it's not because I'm setting the throttle where I want to set it, it's... I'm setting the throttle where it gets set, because by the time I put enough force to get through the friction and breakout to move the throttle, it scoots past the setting that I want. One of the techniques that I used, was to pull the other throttle back, that did two things for me, it said a base throttle setting of about 20 percent, so I had a good idea of where that was, and the other thing that it did, is it gave me something to rest my hand on, and twist my hand around for setting power. The other issue is the flap reconfiguration on final, and with the flap reconfiguration, I think where... if I could read the display better, and with the throttle stick not... the throttles being smoother and less friction, I think that you can handle it, but that's still going to be a very, I won't say a very, but a higher work load task close to the ground, you know generally, they want stabilized approaches by 500 ft, it's kind of what the ops guys look for, even in the decelerating approach, and you're not even going to have that with the manual throttle sticking. Although, I think it would be a do-able task, and I think you'd get better ratings if the throttles and the displays were better, even for that portion. You can control the airspeed through there, and actually you can do it, I think... I think you could do it if a reasonable work load, if the display and throttle were fixed, because there's no pitch transient, it's just basically an increase. The drag increase and the acceleration, what I would like to do, if I was going to do this operationally, is I would hit that point with the cushion of airspeed maybe, and that's another thing too, I mean generally, I don't really shoot to be on speed when I configured just before glideslope intercept like with a gear, until usually a little bit farther down the glideslope than we're doing here, now that's just my personal technique, but you know, you're going through two dynamic proportions to push over, and the gear extension, and then the flap reconfiguration, and try to hold this tolerance of air speed. So anyway, I would go in at the level 2, and I guess, it says the desired performance requires moderate pilot compensation, and 5 is adequate performance requires considerable pilot compensation, I'd go with a 5, mainly for the description that I just gave. Going back to the approach task, I think if I average everything together, I probably got mostly desired performance, and when I say everything together, I mean all of the 3 runs. There were a couple times there, where on the last two data runs, the first one I have the gamma, just... maybe a quarter degree below the horizon, but it didn't seem like we were sinking. The next time I put it like a half a degree below the horizon, it seemed like we hit fairly firm. Touchdown dispersion, again, for all the points that we talked about the first time is difficult, not being able to be real stable, and having to work the airspeed issue through the flap reconfiguration, and not being stable setting up for the approach, I think makes it more difficult than, obviously than with the autothrottles. I guess I feel like I can probably get better performance than what I did, but none the less, that was 3 data runs, and I don't think actually... well, we got adequate I guess on a couple, and the non adequate actually on one. I'd go in, it's definitely controllable, adequate performance is obtainable with a tolerable pilot work load. Is it satisfactory without improvement, and I guess I'm going to have to say no, because we didn't get desired performance, and also that would eliminate a 4 on that. So, I guess I'd have to go with a 5 for this task. Let me read... 5

is adequate with considerable, and 6 is adequate with extensive, I'm going to go with a 5, because if I back off on trying to get desired performance a little bit more, I think you could reasonably get adequate performance most of the time, and again I'm going to say that I think I would get different results, I don't know if they'd be significantly different or not, but if the display was a little bit clearer and the throttles moved a little bit more smoothly with less force, I think that would effect being set up on the glide path, or being more stable on the approach, and I think that would improve the performance, performance in that phase. So, we'll go with a 5 for lateral and directional as well as longitudinal, and we'll also, I'll give it the same rating for longitudinal and lateral and directional for the approach portion. The other thing that I would say is, is although, you know these are pretty... I think this is a well defined task, and I think this is the kind of task that you want to be doing to really look at the flight control design, but even though we're getting into the level 2 flying qualities here, I do think that improvement is warranted, particularly in the areas that I've mentioned that, in overall these are pretty tight performance tasks, and there's a lot airplanes today out there that I think might, you might have to work pretty hard to get them in the desired box also, so anyway, that's it.

## **Task 7100 Unaugmented Landing**

Pilot A

Task 7100 Unaugmented Landing 17 Jan 97; Runs 89-91

On the approach and landing, manual throttles, no augmentation. Is it controllable? Yes, adequate performance obtainable, with tolerable pilot work load, actually it certainly is a high work load, there's no... I guess it would be... not a tolerable work load, and deficiencies require improvement, yes, and adequate performance not obtainable with tolerable pilot... maximum, tolerable pilot... adequate performance not obtainable, with maximum tolerable pilot, actually we did obtain adequate performance, so, I guess you could say it's a level 2, and requires extensive pilot compensation, I'd guess I'd give it a, actually the compensation wasn't all that tremendous, it was work, but I certainly didn't have any PIO's to worry about, except pitch requires considerable pilot compensation, it's between a 4, a 5, and a 6, and since we obtained desirable conditions on several, it's between adequate and desired, I think I'll give it a 5, longitudinal. That was for the... actually I think I would... for the landing it would be a 5, and... well, I'll give it a 5 for both, both of them, and lateral directional, actually wasn't all that bad. We met laterally, we met all of our requirements, for desired, for the most part? I think we could give it a 3, lateral directional, yes.

Pilot B

Task 7100 Unaugmented Landing 10 Jan 97; Runs 11-13

This ones a hand full, throughout, I was able to get desired performance on the approach fairly consistently, occasionally slipping into adequate, but I'm really working hard for it. This is another one where a half of rating is probably going to help, and this is true both longitudinally, and laterally directionally. There is a tendency for PIO in both axis, fairly pronounced tendency, which I'm damping myself, basically providing the SAS function on my own, just by reducing the inputs, and it tends to make the inputs jerky, and you accept small term deviations that you might not otherwise, but the large deviations seem to smooth out. So, let's see, there is a ability to accurately maneuver in the final approach path, to maintain the profile and speed, and I was able to get trimmed flight, I think I kept the deviations fairly low, again, borderline desired, adequate performance, so, longitudinal CHR's; controllable, adequate, deficiencies warrant improvement, I'm going to say adequate performance requires considerable pilot compensation, HQR5, and same thing lateral directional; controllable and adequate deficiencies warrant improvement, adequate performance requires considerable pilot compensation, HQR5. For the precision landing, very much the same, the work load seemed uniform throughout the approach, it was high, uniformly high, I should say, throughout the approach. There was a tendency to PIO, and bobble in pitch and roll for that matter, also some directional wandering tendencies, the directional axis seemed to be happy wherever I put the nose, and I did have to use rudders there on the last one to control that. No geometry strikes, no tendency to float or bounce, although, on the second approach, I did sacrifice runway distance to get the sink rate under control, just because you can't afford to get tight...tightly in the loop, in the longitudinal axis particularly. Okay, so, longitudinal HQR; it's controllable, and adequate, I was able to get adequate performance, controllability is in question here, however, if you go through the matrix, the way it's written, adequate performance is obtainable, so that puts you up in the level 2, now the work load is tolerable, I think, for adequate performance, it's high, but it's tolerable, and I'd say adequate performance requires extensive pilot compensation longitudinally, so, I'm going to give it a HQR6 there. Lateral directional; it's controllable,

adequate, satisfactory, and I think in this case, adequate performance requires considerable pilot compensation, HQR5, so, the last two were 6 and a 5, and what did I give on the first two? 5 and 5. That concludes my comments.

#### Pilot C

Task 7100 Unaugmented Landing 16 Jan 97; Runs 117-118

Okay, the localizer and glideslope, and so on, that part of the task, the longitudinal control was fairly high work load, the biggest thing I noticed was airspeed control was a lot harder, and I'll have to say that part of it is the inability to make small changes on this particular throttle, you kind of overdo each time and each direction, you have to kind of bracket it, so it's kind of tough, and the...but in general, things were staying pretty well behaved, I didn't feel like I was on the verge of losing control or anything, just it was wallowing, and certainly a terrible ride, I'd hate to have been in the back seat. Okay, adequate performance with a tolerable pilot workload, and this is where the basicness on a standard airplane with everything working, and so on, and at this point I'd think I'd call that, no, it would...if it were an all up airplane, it would require improvement, adequate performance, I could get, but that was way more than tolerable pilot work load, so a 7 on that, and actually it was much more controllable than I had expected when we started it, and I think that would be pretty much the case with both lateral directional, and longitudinal. By really working my buns off, I actually got quite a few desired performances in there, but with the work load, is what does it, so the second half of the question about adequate performance and tolerable pilot work load, I'm afraid drags it down into 7, for each of those, and oops, wait a second, I just slipped a cog here, I was thinking more of the landing, no...no, that's...let me back up here, we're just talking about the glideslope, so most of the comments I made were very similar...for the glideslope part, it would be the speed control that was the most difficult, and I might be able to, with the glideslope, give it, go up here and say that adequate performance was obtainable, and not satisfactory without improvement, and I could give it 6, adequate performance, in other words, what made me work so hard was trying to get it up into the desired adequate, though would get with, say considerable pilot compensation for the glideslope and localizer, so I'm going to give 5's to both axis for the ILS part, and then when we get down here to the landings, however, adequate performance obtainable with tolerable pilot work load, and here is where I'm going to turn the corner due to the work load, not due to the performance that I actually got, and those would both be 7's. You know, if we were doing it as a system with everything done, I was pretty impressed at how well it would do, but the work load was way higher than you would accept on a standard airplane, and that's what brought it down into the 7, and the adequate performance, you know, if I would...I could have backed off some on my compensation, but as soon as I would have, I know it would have been right in the adequate at best, but it's tough, and it's the factor of it is the friction on the throttles, you can't make small corrections, and I know that's due to the test, but that's all I can see, so that's what I've got to rate, okay.

#### Pilot D

Task 7100 Unaugmented Landing

Not performed by this pilot.

#### Pilot E

Task 7100 Unaugmented Landing 10 Feb 97; Runs 40-41

No autothrottles, no augmentation in any axis. One of the things I noticed was the lack of an aileron rudder interconnect kind of makes it a little bit sloppy. That certainly is not the most serious of the problems but it does add a little bit to the sloppiness. I just wanted to mention that before I forgot it. Up and away I did a number of doublets. Both pitch and roll doublets, I didn't do any rudder doublets. It just basically tends to give more input than what the pilot wants, so I end up becoming the damper in the system and provide the pitch and roll damping. It tends to overshoot in both pitch and roll, so you have to be very smooth on the inputs and you need to not over control it because you could get into a PIO and both axis. I pretty much left my feet flat on the floor and didn't get into the yaw axis at all and the one time I thought I might have to but it came back out to balanced flight and I just didn't want to have the workload of flying 3 axis. So you shouldn't see too much rudder activity at all. Pitch, when you make an input it does tend to take off and it was almost like it was negatively stable which is the problem. It does have negative static stability, so when you make a pitch input it does tend to just keep going, so then the pilot has to become the stability augmentation system. It is not too bad up and away but when you get down to higher gain tasks of approaching the flare, I definitely felt the workload increase dramatically in pitch. I was making very very small inputs, high frequency, low amplitude inputs in pitch. And pretty much once I was in the flare, I thought I had two good landings as far as the H dot was considered. I thought I had actual gamma close to the horizon but as Dave pointed out there may be some filtering which could be a delay in which case it may not have actually been my actual gamma so in which case I was a little bit confused by that. But non-the-less pretty good performance laterally as far as the Y dispersion and very good performance, both of them were in the box on X but both of them were firm. So I was in the box and firm on both of them. I think the landing performance longitudinally is probably going to be low adequate. Laterally probably desired. So for the approach rating, throw out the fact that on the first run that I was doing some doublets trying to see if I could get into an irrecoverable PIO and I basically overshot the localizer and had to correct back. So we'll look at that and I think it was probably fairly close to desired, borderline desired/adequate longitudinally. So for the longitudinal approach rating, controllable? Yes. Adequate? Yes. Satisfactory? No. I am going to rate it a 5. It could be a 4 or a 5, it's really borderline. The workload was pretty high though and that's why I'm going to give it a 5. For lateral as far as the localizer control, controllable? Yes. Adequate? Yes. Satisfactory? No, a 4. I met the performance there but with a high workload. For the landing phase, longitudinal, it was controllable, adequate performance was attainable. Is it satisfactory without improvement? No. I am going to rate it a 6 and basically it's just difficult to... If you put a slight input in it will tend to overshoot. The aircraft will give you more than you want and when you are trying to set up for the flare, you have to be real careful that you don't balloon and that was what I was tending to be afraid of. I was afraid that if I made a big input in the flare that I might balloon and I didn't want to do that. So I probably talked myself into not putting enough attitude on it. So that would be a 6. For the lateral, I did meet desired criteria but with workload. Controllable? Yes. Adequate? Yes. Satisfactory? No, a 4. Certainly this configuration is controllable and flyable but it does require a high workload and I would not want to... well it would probably be fun to look at this with a crosswind, high turbulence and an offset and it might be an interesting task.

Pilot F

Task 7100 Unaugmented Landing with ASE On 24 Jan 97; Run 90

Realizing there is a lot of ifs and unknowns about this kind of configuration of landing, and also what the probability of having to do a unaugmented landing would be, anyway, it's kind

of interesting, the nose kind of wanders around in pitch roll and directionally. I should say in pitch and directional, roll actually, being able to maintain wings level, and make small corrections, probably is the easier of the 3 axis to control, but you are getting excursions in yaw, and some pretty major excursion in pitch at times. Visual... we did it in visual conditions in the simulator, and as we got down close, just focus in the attention on the runway, and trying to get the lineup and do the touchdown, and not paying as much attention to the localizer and glideslope, it's the technique that I used. One thing that, that I noticed close to the ground is, I seem to pick up some pretty good descent rates and at least my perception was that the back side characteristics were very noticeable in that, a couple times I pulled back on the controller to try to bring the flight path vector up, and I really didn't get the response I wanted to until I added some power in there. Basically, we kind of crashed in the box, I guess, we landed with 12.6 ft per second down, which is pretty hard, and we had a max bank angle below 50 ft of 5.3 degrees, which was only adequate. I would have been very apprehensive in the later portion of the approach, we've got some oscillations, I don't know that I'd really call them PIO's, because I'm not... I'm sure I excited them, but it seemed like the airplane was really doing it on it's own, not a really a factor with me coupling it up, but there were a couple good excursions of gamma in the nose down direction, and again, thinking of gamma, kind of as attitude, because you know, we're flying gamma, where normally we'd be flying attitude, it becomes a real issue in my mind of not only touching down hard, but I was kind of wondering if we might touchdown on the nose wheel. Although, I think in retrospect, we probably had a fair margin with the waterline up above the horizon, but anyway a little galloping pitch action that we got with a couple oscillations down close to the ground, would not be comforting in a real airplane at all, anyway, that's about it. (Special Task not crossreferenced.)

## **Task 7211 Flaperon Hardover during takeoff**

Pilot A

Task 7211 Flaperon Hardover during takeoff 17 Jan 97; Runs 4-6

The effect of the flaperon hardover, which occurs right at... for just after rotation is just a slight perturbation of roll, and it's probably less than 5 degrees of bank, and lateral direction Cooper Harper, since we're in desired performance, I'd give it a 3, and pitch control a 2. There's very little, it's hardly... the hardover is almost not noticeable, it's almost indistinguishable between... as from just normal turbulence through windsheer.

Pilot B

Task 7211 Flaperon Hardover during takeoff 09 Jan 97; Runs 40-42

Block 5 - Failures Summary very similar to what I've seen before, it's a relatively difficult task, but it's certainly do-able. The difficulty is there because of the metrics that the type parameters, probably the most critical one is in rotation and it's the pitch rate, deviation from pitch rate. Which having said that, is not in here is it. Apparently we have different metrics on the score card than we have on the actual card. Looking at the actual metrics that are in the card, I think the only one that's critical here is bank angle control and that's due undoubtedly to the flap around hard over. The system is apparently able to keep out...take out the residual moment that you get a transient there where you're getting some bank angle deviations that exceed on occasion 5 degrees. I believe in all cases they were less than 10, I didn't get anything outside the adequate bound. The rest of it looks do-able. We are, by the way, getting some motion spikes here just sitting here. Okay, in longitudinal, HQR; it's controllable, adequate, I think deficiencies probably were an improvement, this is level 2, I'm going to give it a HQR of 4, desired performance requires moderate pilot compensation, and lateral directional, same thing, well maybe not the same thing, controllable, adequate, I think deficiencies warrant improvement. This is another one where I would love to give it a 4.5, I'm going to give it a 4, desired performance requires moderate pilot compensation, HQR's a 4 piece in longitudinal and lateral directional. That concludes my comments.

Pilot C

Task 7211 Flaperon Hardover during takeoff 16 Jan 97; Runs 32-34

Well, let's do the pitch first. Is adequate performance obtainable, tolerable pilot work load? In general, yes, yeah, yeah, it's a yes on that. Is it satisfactory without improvement? No, and getting even adequate performance due to the lat-dir problem, and not being able to concentrate very much on the pitch, I'm going to give that a 6. I've got the adequate performance, usually, but it was taking, all the...everything that I had available after the lat. dir. problem was taken care of, was used...had to be used on the pitch phase. So, 6 for longitudinal on that, and when we go to lat-dir; is it controllable? yes, adequate performance, tolerable pilot work load, and I'm going to say no on that, due to the sensi...or the importance of keeping the wings level to such a fine tolerance. Boy, somewhere through there if you're not really working the lat-dir, you're going to touch a wing tip, which is exceeding the limitation, and so I would say that that is considerable pilot compensation required to keep from touch the wing tip, for another words for control, 8 for the lat-dir, so, 6 and 8.



Pilot D

Task 7211 Flaperon Hardover during Takeoff

Not performed by this pilot.

Pilot E

Task 7211 Flaperon Hardover during takeoff 31 Jan 97; Runs 8-9

The only evidence of a hardover is a little bit a sensitivity in roll at the hardover. You tend to get just a little bit of wing walking. Just a rocks back and forth a couple of degrees. You get this feeling of a very sensitive lateral axis. Also there is a feeling, in the motion base, there is a feeling of kinda a loss of lift. Almost like when you're stalled. There is just that uneasy seat of the pants feeling that you don't have the lift you want. I think you've obviously lost some lift with that hardover and the motion base does a good job of at least conveying that kind of uneasiness in the pit of you're stomach. So I think that's kind of interesting. At any rate maintains desired criteria both laterally and longitudinally was not a problem although it certainly does take pilot in the loop effort. So for longitudinal rating controllable yes, adequate performance was attainable yes, satisfactory without improvement I would say yes, Cooper Harper of 3 minimum pilot compensation being the main characteristic there. No real tendency for coupling in the pitch axis. I didn't see any PIO or lack of pitch insensitivity or oversensitivity. So it wouldn't seem to be a problem. Laterally controllable yes, adequate yes, satisfactory no. Cooper Harper of 4 mainly for that little bit of roll at the failure where you do get that roll ratcheting at the failure. That does take a little bit of compensation there and so still desired but probably level 2 on that.

Pilot F

Task 7211 Flaperon Hardover during takeoff

Not performed by this pilot.

## **Task 7212 Elevator Hardover (TE down) during takeoff**

Pilot A

Task 7212 Elevator Hardover (TE down) during takeoff 17 Jan 97; Runs 8-10

Cooper Harper for lateral directional, I'll give it a 2, and for pitch, let's go through the tree here, it's controllable, is adequate performance obtainable with tolerable pilot work load? I'd say it cannot obtain adequate performance, so, we have level 3, deficiencies require improvement, and not obtainable controllability not a factor, give it a 7. During these tests, there is a large split in the commanded versus actual gamma, and I guess that's one cue that something is wrong with the control system, and it might be one of your first clues that something is wrong, and I was able to blend the commanded versus actual, and to obtain whatever flight path was possible, you kind of, actually it amounts to giving you sort of a status of how well the fly by wire is performing, and that gives you, I think gives you a little bit of a feedback, on relative to what you're doing, and how well the airplane can do what you ask it to do.

Pilot B

Task 7212 Elevator Hardover (TE down) during takeoff 09 Jan 97; Runs 45-47

Summary that control is an issue here, there...you're right on the edge, saturating elevator, and there are times when pitch rate doesn't want to go positive on you, so, control is an issue, there is an PIO tendency when that happens because you're saturating the control, and then finally as airspeed is changing it does take an effect and you have to come back down again. I got into a bit of a phugoid or a low frequency oscillation with this so, this is a problem. Adequate performance as defined by the card, is not achievable in longitudinally despite maximum effort in terms of tracking the commanded...tracking the desired, I should say flight path angle. From the safety standpoint, I'm not overly concerned about that, I think we've got the metrics a little bit too tight for this. However, there is a design issue associated with the difference between the commanded and the actual gamma on the display. There is such a wide split, that if the pilot focuses on the commanded gamma, instead of the actual gamma, which you often would do in this phase, since you don't expect much of a split, you can lose the fact that there is a split real quickly because it gets out of your field of view, and in one case, on one of the practice runs, I had a descent where I thought from the flightpath angle I should be climbing pretty quickly. So, there is a safety issue there. Whenever you get a split like that, I think you're going to have to talk about what to do with the display, what might be appropriate is to ignore the commanded gamma at that point, and just go with actual gamma. We've certainly got to talk about that. Okay, longitudinal HQR; it's controllable, there are times when control is an issue, however, I'm not ready to call it considerable pilot compensation is required for control. This is another one where I would like to give it half a rating if I could. I'm going to get longitudinal HQR of 7, adequate performance not obtainable with maximum tolerable pilot compensation controllability not in question. For lateral directional, it's controllable, it's adequate, and I'd say it's satisfactory, minimal pilot compensation, HQR3. Obviously, the problem here is longitudinal. So, it's a 7 and a 3. That concludes my comments.

Pilot C

Task 7212 Elevator Hardover (TE down) during takeoff 16 Jan 97; Runs 36-38

For the lat-dir, adequate performance, tolerable, yes, satisfactory without improvement, no, deficiencies require improvement. The performance was in the desired to adequate range, and it's difficult to hold it real accurate, because I spent so much time against the backstop pulling like crazy, that I'm getting inadvertent little inputs in there. I should be able to get adequate performance consistently though, and it still was requiring considerable pilot workloads, I'm going to give that a 5, and it's due to inceptor being against the stop, pulling hard and not being able to make the fine adjustments in roll. Okay, now for pitch, adequate performance tolerable, no, requires improvement, and I was not able to get adequate performance no matter how hard I worked, so certainly that was it, but I don't think controllability was in question, I did have to use a technique of as soon as it was in, and I saw what was happening, was to come against the stop, but it was very natural, the display was telling me what to do, without much question, and so I did keep pulling it right on back. The ... one other thing, is once you start the nose down, get much of a rate going, it's almost impossible to stop it within a reasonable period, and you end up quite a ways down. The fact that this comes in at a 100 ft, however, you know that you're well above that, by the time you start having any difficulty like that, and that's why I didn't think I was going to, you know, actually lose control of it, certainly not very nice in...call that considerable, and retain control, no, you're probably being very nice to it, but I think probably, well, I'll say 7, for the task that we were given, which is the climb out. I wouldn't want to be close to the ground when it happened, but that's not the task, so, for this task, where it happens at a 100 ft, I'll give it a 7.

#### Pilot D

Task 7212 Elevator Hardover (TE down) during takeoff 09 Jan 97; Run 66

During the actual takeoff procedure itself, I'm having essentially identical performance and problems that I had during the takeoff cards, so, I'm not going to let that influence the pilot ratings here, after the failure at a 100 ft, again, we've got this problem with the display, really need to work on this thing, so, that when the split between the actual and the commanded exceeds something, it reversed to some other kind of control system or something, if I didn't revert to theta control, I could drive myself into a divergent PIO. I'm going to give it a pilot rating of longitudinally 8, and laterally 4.

#### Pilot E

Task 7212 Elevator Hardover (TE down) during takeoff 31 Jan 97; Runs 11-12

Not a very difficult task. We had somewhat similar problems initially on getting the pitch attitude on rotation which seemed a lot harder a lot more difficult to meet desired on this card than on 7211 for some reason. I was very very in the last two or the two data ones, very high gain and tried to stick very very closely to the rotation guidance. In fact I was slightly even above the rotation guidance on the last one and still did not meet the desired pitch attitude so I think that card may have a problem with that metric there. As far as the elevator hard over failure no lateral response whatsoever so no lateral impact. Longitudinally I couldn't really tell anything either. It still seemed like I had good pitch response, good control, no PIO, no difficulties to report. I figure it was a solid level one performance. For longitudinal rating, controllable yes, adequate yes, satisfactory without improvement yes, Cooper Harper of 3 no intolerable tendencies, no PIO, no problems. For the lateral rating, controllable yes, adequate yes, satisfactory yes. For a 3 also, didn't notice any of the little roll ratcheting that I noticed on 7211.

Pilot F

Task 7212 Elevator Hardover (TE down) during takeoff 23 Jan 97; Run 92

Again, you know, as far as the task, I guess the way I'm going to set this is, is we're expecting it, we know it's going to happen the minute we get the master caution light. We call for the flaps when you set the flaps. Again, controllability, it's very uncomfortable putting in a big pitch command, and getting a big split, and not being able to arrest the flight path vector. This would be very scary to be in a airplane. I guess, lateral control suffers a little bit, just because we're paying so much attention to pitch. I guess, after cutback we were able to just barely get back up to the horizon, but I released a little bit on backpressure on the stick during the cutback trying to follow the cue with the actual flight path vector, and I should've never done that. That got the actual flight path vector way, way low, below the horizon, it took forever to get it back up, I just... I'm very uncomfortable with the control margins that the pilot has during this task. Again, as the ground rules that we're expecting this to happen, we know it's going to happen, we know what the performance is going to be like, and we can call for flaps immediately, I'm going to say it is controllable, is adequate performance obtainable with a tolerable pilot work load? Again, under the guidelines I guess or the ground rules that I'm kind of considering for this test, I'm going to answer yes to that. Is it satisfactory without improvement? And the answer is no. This is... in my opinion is, slightly better than the approach case, and I would probably tend to give it a 5 1/2, if we were giving half ratings. To get adequate performance, I guess, it's not extensive, but it is definitely considerable, I really think it's somewhere in between those two, in my mind at least, I'll go ahead and... just because it is better than the other task, I'll give it a 5, but I will caveat that by saying that if you take into account, you know, that this could be in the weather, that there has to be some type of crew recognition time, a time for the crew to respond, I don't think it's acceptable, and on both this and the previous task, if I was doing this in the real airplane, and I was really surprised late one night when this happened, it would scare the shit out me if I lived through it, so, maybe I shouldn't of said that, but, it would... I don't think either one of these would be a good thing, so, all right. Yeah 5 lateral.

## **Task 7252 Elevator Hardover (TE down) during landing**

Pilot A

Task 7252 Elevator Hardover (TE down) during landing 17 Jan 97; Runs 13-16

Nose down, full nose down elevator on approach, reconfiguring to toga, or go-around flap setting, at about 300 or 250 ft. Results are to some degree erratic, however, if you don't require any large pitch inputs for whatever reason, the landing can be adequate and close to the box with a reasonable sink rate, however, if any, for any reason, a large pitch input is required, and stops on the stabilizer are encountered for any extended period of time, then the results are not so good. High sink rates are possible, so the results are pretty much a question of how lucky you are on this... on the circumstances, however, consistency wise, under these circumstances, we're looking at a Cooper Harper of, on longitudinal, well, let's just go look at the tree here, it's controllable, well, that's questionable, I suppose that under average conditions for this test, it probably is, is adequate performance obtainable with tolerable pilot work load, were we getting... I guess, were we getting adequate performance? Probably on average, yes, however, is it satisfactory without improvement? Well, no, I guess that would vary between a 6 and 7. Major deficiencies, I like to... controllability, not in question, that might be an 8. I guess I'll give it a 7 in longitudinal, and lateral directional, I'll give it a 3.

Pilot B

Task 7252 Elevator Hardover (TE down) during landing 09 Jan 97; Runs 52-54

We changed the procedures a little bit because we were crashing the motion system routinely, that being we need to disconnect the auto throttle, I guess you can set that in the IC file or do it manually. We chose to do it manually in the interest of time in conjunction with the elevator or with the flap reposition that is. Once we did that, and I had enough practice in there, the task was do-able. Requires a lot of skill I think to do it, you're really working to keep control. Yeah, this is kind of an interesting one longitudinally, because you can get to adequate performance, but it's not fair to say controllability is not in question. There is a pronounced PIO tendency here, and I think that you're...I'm going to lean in that direction because you're really fighting to keep control. With a caveat that there is a learning curve, and I was getting better at it, and with time I could probably get it down to where control is not an issue, but I don't think that happened in the time that we did it. So, longitudinal; it's controllable, adequate performance is not attainable, with a tolerable work load, considerable pilot compensation is required for control, HQR8. Lateral directional doesn't seem to be a big problem, it's controllable, adequate, and satisfactory, minimal pilot compensation for desired performance, HQR3. I didn't see a problem with that. So, it's an 8 and a 3. That concludes my comments

Pilot C

Task 7252 Elevator Hardover (TE down) during landing 16 Jan 97; Run 42

This makes for a very easy run, it was not controllable, I think I crashed it 3 or 4 times out of 4, everytime anyway, and it's very easy to get things...mixing things up, but it appeared that once I made a nose down input of any flavor at all, then full aft, I couldn't, and I didn't know what to do with the throttle, because the command flight path marker was off the top, and so, of course I have no delta velocity right there, but I don't think that would of made a

nickels worth of difference, I think I was going to crash it no matter what, and so obviously, 10 for longitudinal, it probably could have been a 10 for lat-dir, but I don't know that, the longitudinal so overwhelmed that it was a 10 in longitudinal. I'm sure I was out of bank angle limits, and once I was full aft like that, I wasn't able to pick up a wing, so I'll give it a 10 for both, but it's a mood point, you know, you've got a 10 in one, and that's a 10.

#### Pilot D

Task 7252 Elevator Hardover (TE down) during landing 24 Jan 97; Runs 63-64

Okay, we made a couple of data runs there, we got them both in, but my evaluation is, is it was just pure, blind, luck, because there is a terrible tendency to PIO in gamma brought on by the display, you don't know which... you don't know what to fly a gamma command, you can't fly it, and the actual gammas got so much lag in it, that you can't fly it, you just kind of have to do it hands off, and hope that you're going to get somewhere near the runway, and I think it was just blind luck that was doing it. Lateral, hardly any task at all, longitudinally I'm going to give it a 8, lateral I'm going to give it a 5.

#### Pilot E

Task 7252 Elevator Hardover (TE down) during landing 31 Jan 97; Runs 11-12, 16-17, 21, 23

I think there is a problem here on the implementation of this task. If you initially get the failure and you reset the flaps and add a little bit of power, I did for about 3 runs in a row, got a huge actual gamma of pitch down almost of crashing out there at a mile short. If you do nothing, don't touch the pitch or don't really touch the power, it pretty much comes into almost a, my last landing was all desired, and obviously it is a huge handling qualities cliff out there. So something is not right and we need to do a lot more looking at this. I think if you don't mind we will hold off on my rating until we look at this some more.

Task 7252 Elevator Hardover (TE down) during landing 10 Feb 97; Runs 5-8

We are still seeing the same problem with the speed decay intermittently about every other time we operate the speed drops off about 10 knots slow or something. Once it stabilizes around 150 or 151 when you have to correct for that slow speed condition you tend to get illogically a nose down response on the flight path marker, on the actual gamma. It goes quite nose down with the attitude and the response goes quite far up so you get a big delta between theta and gamma or a huge angle of attack. Then you kind of get out of phase. It takes some very smooth flying to get this thing back under control. One of the metrics here; deviation from approach airspeed says plus or minus 5 for desired and 10 for adequate, the thing really tends to want to go fast and it tends to fly better fast so I think that metric if you all ever redesign this task, needs to be changed, because that puts you in adequate all the time. Everything else seems fairly nominal as far as your performance standards. Okay at any rate, as far as the rating, laterally it's no problem. At least for the straight in, we weren't given a lateral task. So lateral is kind of unknown. Longitudinally, there is a real problem here. There is an intermittent big pitch down that could result in the loss of the aircraft. If you are very smooth and don't add any power and don't take any power off it appears to fly better but sometimes even doing that you tend to get the little pitch over. I think we need to investigate this without the speed decelerating or correlate whether or not this pitch over or gamma over not necessarily a pitch, because it's your gamma that dips about maybe 5 or 6 degrees. It's pretty abrupt or violent there for a transport aircraft. I shouldn't say violent but

pretty significant, pretty large delta. I think we need to figure out what's causing this speed and figure out whether or not initiating this thing at 10 knots slow, whether or not that causes this problem. So I think this task needs a whole lot more investigation. However, longitudinal Cooper Harper rating; Is it controllable? No and rate it a 10 even though most of the time I was able to control it. At times it was not doing what I am commanding and therefore it is not controllable. However I believe we need to make sure we sort the task out before we look further at it. Lateral directional; is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Yes. Cooper Harper of 3. There is no lateral problems whatsoever and that 10 rating I really don't feel comfortable with that but then again I don't feel comfortable by saying it is controllable until I find out more about what is causing these really abrupt negative flight path angles, I really think we need to look at this a lot more closely.

Pilot F

Task 7252 Elevator Hardover (TE down) during landing 23 Jan 97; Runs 85-90

I guess my initial response is, is that, I really don't like the way this works in that, I'm now controlling the actual flight path, and I have to really lead it, I have to anticipate what I think... how I think the actual flight path is going to respond to the commanded flight path, and especially for the initial perturbation, when the flaps, or when the... when you initially get the hardover, that initial response, you get a big split there, and it's... you can't... before you come back and push the nose forward, you have to start doing that before you actually see a response, in other words, you have to about stop the cue, and just when you stop it, you have to reverse the command. Then as you come down lower, and the command come together, you get the actual on the 3 degree line, and then you get your... but your commanded still stays up about, maybe a little bit above the horizon or around the horizon somewhere, and you have to fly like that for a while, and then you have to just kind of put them together, and if you... you have to anticipate everything, and if you miss the anticipation, there's really little time to correct, because you can't really go make a large input. If you make any large inputs other than the initial one, you can get out of phase, and kind of get into a PIO. The first data run that I did, I got all adequate, or well, adequate or desired performance, then the second few that I did, I started trying to too tightly control the task, and we did not get very good results out of the adequate zone, on some parameters all of the time, and then towards the end I figured out that I was trying to control things too tightly, rather than being patient, but just using anticipation. So anyway, coming in, is it controllable? I'm going to answer yes to this, although I do not think that a crew could catch this error, manually reset the flaps, and recover the airplane, VFR. I think this is beyond what I think would be acceptable, in other words, I guess what I'm saying is, is I don't think this is something that I would... even for a malfunction, think that would be acceptable to put out in revenue service. I just think that, you know, we're jumping on right on resetting the flaps here, we're not allowing any time for pilot recognition, and if we delayed on the flaps a little bit longer, I don't know that you'd be able to recover. You also have to consider that, you know, this is CAVU conditions, and any kind of weather conditions, I think even if you did recognize it, immediately get the flaps reset, I'm not so sure that the results might not be catastrophic. So, you know, the bounds of this task is; we knew it was coming, we knew what was going to happen, we were ready to jump on it right away, and so in the context of that, I'm going to say it's controllable, is it adequate performance obtainable with a tolerable pilot work load? Boy, that's a hard question, and I'm looking over in the blocks for guidance here to, it says in Number 7, is adequate performance not obtainable with maximum tolerable pilot compensation, controllability not in question. Number 6 is adequate performance requires extensive pilot compensation. Knowing what compensation to use, I

would have a tendency to go towards the 6 level, I guess, and I would have a tendency to say it, because with extensive compensation you can... you can get adequate performance here, and I think we've shown that with the numbers. Again, in the context of this task, which we knew were going to happen, which were not accounted for recognition time, or anything else, I'm going to answer yes to that. Is it satisfactory without improvement, definitely not, and I'm going to give it a 6, but I'm going to emphasize that that's only for this specific task that we're evaluating, if I put in some recognition time in there, or accounted for normal crew recognition time, I'm not so sure that I could answer yes to; is it as controllable? So, you know, there's kind of a disparity here, and I kind of feel like my rating is in error. I probably kind of feel like it should be done in the 7 or 8 range, but if I make the jump, with the leap of faith, if you will, that we're doing it in the context of this task, and it's okay to... you know, know it's coming, and the minute I see the red light to call for the... you know this is happening when the adequate and the commanded cues are already split anyway, so, if I call it just on the red light, ask for the flaps and reset it, if I buy into that concept, then I guess I'd rate it a 6, but anyway, we'll do a 6 both axis.



## **Task 7253 Rudder Hardover during landing**

Pilot A

Task 7253 Rudder Hardover during landing 17 Jan 97; Runs 18-20

One rudder hardover at 300 ft, and we are getting desired adequate performance in general, generally adequate, and so I'm going to say in the longitudinal axis... we're getting, how about the... the bank and all the lateral things, those are all desired and...? Okay, I guess the things that you're rating are not things that seem to crop up, one of the things that came... probably the most substantial thing, is on landing there's a lot of almost full rudder required during the roll out after touchdown, to stay on the centerline, and that's probably one of the more significant things, as well as rudder applied during the... rudder requirement during the approach... a certain amount of rudder, and so, I would... we're actually getting desired performance out of this, but we would, I don't know whether it's satisfactory without improvement, tolerable pilot work load? Yes, is it satisfactory without improvement? Probably, no, you don't want to have hardovers, though, I give it a level 2. Let's give it lateral directional 4, and we're getting generally adequate, adequate to desired in longitudinal, so I guess I would tend to give it a 4 in longitudinal. Most of the problems in the longitudinal are, have to do with the distraction, of having to deal with a rudder hardover. We did notice on the approach, that as the instant rudder hardover comes in the commanded flight path vector and the actual flight path vector immediately split out the instant, the hardover comes in, seems rather coincidental, and that there's sometimes a large split, and it requires a certain amount of jockeying to get back on the path, and the glidepath, and zero out, get down into the proper touchdown zone, although, most of the time it was too much trouble to get adequate performance, somewhat difficult to get in the desired box.

Pilot B

Task 7253 Rudder Hardover during landing 09 Jan 97; Runs 55-57

The hardover itself is reasonably benign, you've got enough rudder to compensate for, but while you're concentrating on the directional axis, the longitudinal gets away, and I tend to error on the high side, instead of erring on the low side during something like that, so, you're correcting for that from then on, and that caused me to flow a little bit down the runway, and I was able to get adequate on two of the three, and I was a little bit long for adequate on one of them. So, I'm working hard, but adequate performance is achievable, control wasn't really in a question...in question. Longitudinal is where it suffers because that's the critical axis for this runway box, but it's really...where it's happening is lateral directional, so, it's Cooper Harper is going to be a little bit odd here as a result. Let's see, longitudinal; it's controllable, it's adequate, I'm able to get adequate performance, and I'd call it considerable pilot compensation, HQR5. Lateral directional, it's controllable, adequate performance is achievable, and I think it's fair to call it moderate pilot compensation and give it a HQR of 4. Let's see, so what did I say here, I said a 5 for longitudinal and 4 for lateral directional. That concludes my comments.

Pilot C

Task 7253 Rudder Hardover during landing 16 Jan 97; Runs 46-48

Well, after practicing and learning what to expect and all, it was controllable, but I'd have to say barely, I was on the edge of problems most of the time, certainly no adequate

performance with tolerable pilot work load, even though I was...the actual touchdowns, I was managing to get adequate performance, that was even close to the tolerable pilot workload, and definitely would require improvement. Every...let's talk about longitudinal, longitudinal is very similar to what I was seeing, or was much more useable, and useful, able to control it. The pitch itself, I probably should start with that one, it was, I'd say satisfactory without improvement, and give it my usual 6 or so for the longitudinal, it was getting adequate performance, and the pitch itself wasn't too bad. The reason I was getting some of the dispersion, is I was having to just freeze the controls due to a lat-dir problem, and thus the longitudinal part suffered, but the actual flare and so on, there was, you know, it's kind of difficult to see that while you're trying to stay alive keeping the wings level, but I'd give the...a longitudinal a 6, the lateral-directional is the one that I my first, very initial comment was about, is it controllable, yes, but barely adequate performance, no, and I was able to keep from exceeding the limitation on this specific task, but that was at least intense pilot compensation, and every time I started to mix up a little bit with the aileron, and do anything even remotely fast, in other words, just almost moderate, I would start to get into a PIO, and the only thing I could do is freeze the stick, and then start the task from that point, and on one of them, I was getting a increasing oscillations, it felt like just before touchdown I was lucky to be that low, it's really pretty grim, and the other thing I noticed, on the practice runs in particular, I wasn't hawking the sideslip indication nearly close enough, and once you get that sideslip way out there, and then start making large corrections, rudder and aileron, pretty soon you get into a PIO that does go absolutely uncontrollable, and so it's very imperative that you not let the sideslip get away from you, because once you do, it is a very devil to get in. This task, I think, if you lose any...do any of these things close to the ground, I would want to go around, would be my first indication, and then I'd rather fight the problem all the way around the pattern I think, then trying to salvage a pass like that, because it is much, the odds of it being successful aren't very good, and the lateral-directional rating was a 9. I took extensive...I think that's what it is, extensive pilot compensation, to keep from exceeding the limitation.

#### Pilot D

##### Task 7253 Rudder Hardover during Landing

Not performed by this pilot.

#### Pilot E

##### Task 7253 Rudder Hardover during landing 10 Feb 97; Runs 11-13

I tried as much as I could in the short time we had to do the task as we continued on down to put in some rudder doublets and mess around with the controls and see if there were any problems. The directional response is just slowed somewhat by the loss of one rudder panel and see if it was hard to do much in the directional axis to get you into trouble. The speed decay at operate is still there on this one. Get you down to about 151 knots sustained and that's a problem. Also the feed forward gains that prevent you from ballooning on glideslope in close are not active so you have a real problem holding the thing on glideslope. There is a steady delta between actual and commanded gamma which keeps the ghost gamma visible pretty much from 200 ft all the way down and well into the flare. So if we ever redo this task we will probably want to fix that. Longitudinally, I tend to be more or less fairly close on the three data runs. Two of them... one of them in the box, one of them close to the box and one of them a little long and I got pretty much adequate H dot so it was pretty much adequate type performance. So for longitudinal rating for the landing; Is it

controllable? Yes it is. Is adequate performance attainable? Yes it is. Is it satisfactory without improvement? No. Adequate performance requires considerable compensation. Be a Cooper Harper 5 based on performance and once again the dynamic ground effects really made it very difficult to predict the response in the flare. Laterally, I met the desired criteria all the time even with the... I was always within the 10 ft parameters even with the rudder failure. So controllable, yes, adequate, yes, satisfactory, no. I'll rate it a 4. It does take moderate compensation to meet desired performance.

Pilot F

Task 7253 Rudder Hardover during landing

Not performed by this pilot.

## **Task 7254 Rudder Hardover during landing rollout**

Pilot A

Task 7254 Rudder Hardover during landing rollout 17 Jan 97; Run 22

It's a full left rudder hardover at touchdown, and it appears as though it is... seems survivable, and lowering the nose helps getting on the brakes, using the nose wheel steering, however, you will not remain on the runway, we go roughly two to three hundred feet off the runway, and although, it appears to be survivable, assuming that there's nothing... no other airplanes you're going to take out, and that's the only comments I have.

Pilot B

Task 7254 Rudder Hardover during landing rollout 09 Jan 97; Runs 63-64

Technically this...the failures being introduced in a flight phase where you don't have adequate control power to compensate for the failure, because you're introducing it when your nose is in the air, and in order to get authority you're going to have to change the flight phase, you're going to have to lower the nose to the runway, so, I think technically this is a level 1 failure. This is one of the ones that, yeah, you can control it and we were able to do it without crashing, but after practice and after understanding what it was that I had, but you introduce this to a pilot without a thorough brief on what's going on and you're probably going to lose the airplane, so, I think this is definitely a level 1, and I've been told we don't need to rate it, but controllability is definitely an issue here, and I'd say from a certification standpoint, control is going to be lost at some point in this maneuver. If I had to rate it to just about any reasonable criteria, it would be an HQR of 10, for longitudinal, or for lateral directional rather, for longitudinal it's not a factor, the...nose lowering, is okay, and the landing as much as we've seen before. So, that concludes my comments.

Pilot C

Task 7254 Rudder Hardover during landing rollout 16 Jan 97

That would be level 3, if that happens to somebody for real, you're going off the runway, would be my guess, because just saying rudder hardover, you got to know which one right away, and in order to get enough directional control, you have to put the nose down, you have to put it down so fast, you're really going to drive it down, you break something just doing that, on the hand, if you don't put it down that fast, you're going to go off the runway, so, one way or the other, you're going have one bad news ride there, and again, having that happen to you right at touchdown would likely be worse case, if it were earlier, you could go around and have it organized, if it happened later, you probably already have the nose somewhere near the runway anyway, and it might even be better, but right at touchdown, that definitely would be a level 3, and I think you're going to lose that. Just in a side one, I did some landings here, with no motion, I was desired up and down the line, and I have no explanation for that.

Pilot D

Task 7254 Rudder Hardover during landing rollout

Not performed by this pilot.

Pilot E

Task 7254 Rudder Hardover during landing rollout

Not performed by this pilot.

Pilot F

Task 7254 Rudder Hardover during landing rollout

Not performed by this pilot.

## **Task 7261 Elevator Hardover (TE up) during 2-axis upset**

Pilot A

Task 7261 Elevator Hardover (TE up) during 2-axis upset 17 Jan 97; Runs 0-71

As far as the effects of the hardover, they're almost negligible, but the only thing that you notice is the waterline moves up a couple two, or three degrees, and the flight path vector stays right where it is, and it's virtually a hands off fault, and not a problem. Longitudinal Cooper Harper, I think I could still give it a 3, and lateral directional a 3.

Pilot B

Task 7261 Elevator Hardover (TE up) during 2-axis upset 09 Jan 97; Runs 77-79

We accomplished the task as per the card within desired performance bounds with some compensation at the hardover. You've got to readjust your pitch attitude, but it's nothing that I would call moderate. So, give both longitudinal and lateral directional, it's controllable, adequate, satisfactory, mildly unpleasant deficiencies, minimal pilot compensation, HQR3. That's a 3 and a 3. Comments complete.

Pilot C

Task 7261 Elevator Hardover (TE up) during 2-axis upset 16 Jan 97; Runs 65-67

For lat-dir, it is satisfactory without improvement, and the lat-dir was really not a problem at all, I think probably a 2, I hardly even had to think about that anymore. In pitch, satisfactory without improvement, probably no, would be not, it would come to desired performance once I learn how easy I need to pull, I did get it, but it really took a lot of compensation watching, and very good concentration to keep from exceeding the G limit in particular. Attitude was not a problem, and I never felt like I was...getting to ready to go into a unusual attitude at all, it all was just the G, and without actually feeling G, it's kind of hard to track accurately much closer than what we did. Did manage to get desired, and it was moderate pilot compensation, 4 for pitch, so, that's longitudinal 4, lat-dir 2.

Pilot D

Task 7261 Elevator Hardover (TE up) during 2-axis upset

Not performed by this pilot.

Pilot E

Task 7261 Elevator Hardover (TE up) during 2-axis upset 10 Feb 97; Run 30

We only did two runs for these because we are getting some kind of glitch as you are make the recovery. There is a big split between actual and commanded gamma which we don't know why it's happening. But it is pretty much a non eventful recovery up to that point. The initial failure causes a slight nose up of about 1.3 g nose up spike. And then that damps out and I smoothly added power at a very smooth rate commensurate with what I want to do at Mach 2.4 at a high altitude. We don't want to be jockeying the power too much and didn't really didn't get any coupling with power in pitch. It took a little bit of aft stick force which

is interesting with the trailing edge up, I would have thought I wouldn't have had to work so hard in the pitch axis but it took some fairly high stick forces to get the nose coming up but about a 1.3 g recovery is what I chose to stay below the 1.5 max. I had no problem commanding the g. I thought I could have selected whatever g was asked, I just chose about 1.3/1.35. Therefore longitudinal and lateral directionally it is no problems noted. For the longitudinal rating; Is it controllable? Yes it is. Is adequate performance attainable? Yes it is. Is it satisfactory? I would say Yes, rate it a 3. I tell you what I'm going to take that back. I'm going to say it's not and rate it a 4. The reason being, you get the initial pitch up when you have the failure and it does take a little bit of compensation to kind of recover from that. It is a little bit of work to... you can fly the selected g but it does take a little bit of effort. Lateral directional; Controllable? Yes. Adequate? Yes. Satisfactory? No. Also a 4. The main reason is the continual problems we have had with the lateral axis in which it takes a little bit of work just to hold wings level or to hold an angle of bank. It just won't hold an angle of bank, you have to work at it. So that does make the workload a little higher than it should be.

Pilot F

Task 7261 Elevator Hardover (TE up) during 2-axis upset

Not performed by this pilot.

## **Task 7262 Flaperon Hardover during 2-axis upset**

Pilot A

Task 7262 Flaperon Hardover during 2-axis upset 17 Jan 97; Runs 73-74

In the... the asymmetry was such that, and a right turn, we would go out to about 25 degrees of bank, and a left turn, it would bring the wings level, which makes it extremely easy, so, we're not using any excessive bank angles, however, we're basically inadequate to desired performance for lateral directional, and I think I could give it a 4 in lateral directional, and a 2 in the pitch axis longitudinal. It seemed to be a noticeable roll, but it is easily corrected, and not a big problem.

Pilot B

Task 7262 Flaperon Hardover during 2-axis upset 10 Jan 97; Runs 2-4

Block 5 - Failures The hardover was to the right in all three cases, so there's a difference between which direction I put my initial angle of bank in, if it's to the left, it helps me recover, if it to the right it impedes recovery. The longitudinal CHR or the longitudinal task was pretty much as before at this Mach number, you just got to pay a little bit of attention to control and pitch attitude, and watch airspeed, and particularly you've got to watch the unstart envelope. Lateral directional CHR was made difficult by the hardover obviously, controlling angle of bank, particularly to the right, and the right is what's going to drive the lateral directional CHR, longitudinal is the same in all cases. In all cases the maneuver was possible without exceptional strength or skill, and without exceeding in D. Longitudinally HQR, it's controllable, adequate, satisfactory, minimal pilot compensation, HQR3. Lateral directional, it's controllable and adequate, however, I think this is more like level 2 performance, desired performance requires moderate pilot compensation, HQR4, so, in summary the HQR's are a 3 longitudinal, and 4 lateral directional. That concludes my comments.

Pilot C

Task 7262 Flaperon Hardover during 2-axis upset 16 Jan 97; Runs 70-72

Let's talk about pitch first, no we'll talk about lat-dir first. I would say not satisfactory without improvement requires, or...yeah, requires improvement. It's almost two tasks, whether you do it right to the left. When you do the left bank it's almost self-recovering, which would make it much easier, when you do it to the right you get into a control power, even hitting full stop was not enough to keep it in the desired, so, it was not difficult to keep it adequate, I mean, it was fairly easy to get adequate performance, and I was always right on the edge of...at best, I was right on the edge of desired and adequate, but consistently, especially with the...starting with the right bank angle and this failure, adequate performance required considerable pilot compensation, and that would be a 5 for lat-dir, and in pitch, I'm going to say it's satisfactory without improvement, even though one time I was up in the...I only got adequate performance, the lat-dir really, if...what little bit of extra effort it took on the lat-dir, let the pitch get away, and it's such a fine adjustment on G without actually feeling G, to try to track it, you have to be looking right at the gage, so, I believe...let's see...on that, satisfactory without improvement, I'm going to say no, and give it a 4, I've got the desired performance, but it required moderate pilot compensation, and again for the reasons I said, so, 5 for lat-dir, and 4 for longitudinal.



Pilot D

Task 7262 Flaperon Hardover during 2-axis upset

Not performed by this pilot.

Pilot E

Task 7262 Flaperon Hardover during 2-axis upset 10 Feb 97; Run 32

This was not a real big problem. 3 and 6 failed and they failed to give a right roll. So when you are in right angle of bank, you had to initially work a little bit harder to get it to roll back to wings level. When you are in a left angle of bank, it pretty much handles the recovery for you and no problems longitudinal recovery. No problems with overcontrolling pitch or anything like that and once you initially counteract the roll input from the failure, it's pretty nice to maintain wings level. Therefore for the longitudinal rating; this is basically your load factor which you very easily able to control to within probably to within a couple hundredths of a g. It is not a problem there. Is it controllable? Yes it is. Adequate performance attainable? Yes it is. Is it satisfactory without improvement? Yes. I'll rate it a 3. Laterally; controllable? Yes. Adequate? Yes. Satisfactory? No, a 4 and mainly because of the same thing. It doesn't want to hold a particular phi. You have to work to maintain a bank angle or wings level.

Pilot F

Task 7262 Flaperon Hardover during 2-axis upset

Not performed by this pilot.

## **Task 7286 Go-around with Autoflap failure**

Pilot A

Task 7286 Go-around with Autoflap failure 17 Jan 97; Runs 76-78

This a loss of all aileron flaperon, and what do you call those other things out there, all the trailing edge... all them trailing edge devices for roll control were lost on the go around, so, we're down to rudder to control a bank angle, and notice that... one think I noticed was that the deflection of the... on the go-around, the relative position of the waterline symbol, and the flight path vector symbol, is kind of a good indicator of how much sideslip you have, and how much rolling moments you're inducing to get the airplane rolled back, and that's kind of helpful to have that information available to you, in this kind of circumstance. They look moderate roll rate coming back, could be achieved by maybe one or two degrees of sideslip. May not be so obvious if you had a large crosswind though, however, you can probably use a sideslip indicator to help you rolling left and right, as far as the magnitude of the sideslip, and then the... later the... ensuing roll, then the sideslip comes into effect. And so, I didn't... I had a couple of runs that were pretty much straight down the line, and didn't require much correction, and a couple of runs that required some correction and with judicious use of rudder, it seemed like you could keep it straight. However, so lateral Cooper Harper, let's go through the decision tree. Is it controllable? Well, in this case yes. Is adequate performance obtainable with tolerable pilot work load? I guess yes. Is it satisfactory without improvement? No, and deficiencies require improvement. I think, actually we were getting adequate performance in terms of roll basically. Okay, moderately objectionable deficiencies I think would be a good way to describe it, requires considerable pilot compensation, could be a 4 or a 5, basically, I want you to know what's required, taken by surprise it could be disaster, but I'll give it a 5, and on pitch, I'll give it a 3... Cooper Harper.

Pilot B

Task 7286 Go-around with Autoflap failure 10 Jan 97; Runs 5-7

The effect is at the trigger that you basically lose lateral control from the wing devices, and you go to the rudder, and since you have to excite the roll mode through the Dutch roll, you're getting into some Dutch roll, once I realized what was going on, I stopped getting in phase with it, the first time I was in phase with it pretty good, and the apparent mode is PIO, it's not quite that, because the mode is damped...the basic mode is damped, you just have to completely get out of the loop, and let it damp a little bit, then you can get back in the loop again, and it's not a problem, that's the first input after the failure that excites it. Okay, so from the sample of an evaluation base, this...the aircraft had the ability to go around from low altitude without contacting runway, minimum of airspeed loss, no tend...well, no tendency to PIO, yeah, I think there is a tendency to PIO, so I...we're right there on the boundary, desired and adequate, and that's in primarily in roll and yaw, there were no geometry strikes. I was able to keep the performance to within adequate, but not always within desired, so longitudinal, just the standard problems of flying the approach, it's controllable, adequate, I think the task is a level 2 type task. Flying raw data down to 30 ft, I think pushes you into a level 2 territory, so, I'm going to say desired performance requires moderate pilot compensation, HQR4. Lateral directional, it's controllable and adequate, deficiencies warrant improvement, and this is another one that's somewhere between 4 and 5. Since we got some PIO there, I'm going to push it into a five, so, lat. dir. is a 5, adequate

performance requires considerable pilot compensation, so the HQR's are 4 longitudinal, and 5 lateral directional. That concludes my comments.

#### Pilot C

Task 7286 Go-around with Autoflap failure 16 Jan 97; Runs 109-111

Well, let's talk about pitch first. Once I get sorted out whether I had throttles or not, and things like that, that usually worked out reasonable, it's...I could get adequate performance okay, and that is a lot of work though, and adequate performance, that's close to a 6, that's a high gain task anyway, I may be nice to it, I'll say...I'll give it a 5 in pitch. I could get the adequate performance, and it was at least considerable pilot compensation, and just giving the fact that, to take an airplane around at 30 ft like that, that's a really high work load anyway, how much extra due to handling qualities, well, I'd have to say just considerable, so, I'll give a 5 for pitch. lat-dir, however, it's not adequate to performance obtainable, with tolerable pilot work load, I managed to luck out and get it once, but in general, when I flew it the way I would just normally, normally fly it, it was very close to the edge of control, and...just...I was lucky that I didn't need a quick input any lower, I'm sure I would of done some disastrous things, and I certainly was working hard to maintain control, and barely successful, I'm going to say 9, that was intense pilot compensation to keep from...to keep the bank angle from going crazy, and like I say, I could find a way with preknowledge, I could find a way to do it, but from anything that would be a normal procedure, the control would have been very difficult, 9 for lat-dir, and I think it was 5 for longitudinal.

#### Pilot D

Task 7286 Go-around with Autoflap failure

Not performed by this pilot.

#### Pilot E

Task 7286 Go-around with Autoflap failure 10 Feb 97; Runs 33-37

This is one with a real handling qualities cliff. If you are not very very careful with the rudder inputs at the go-around when you have the autoflap failure, you can get into a divergent PIO and lose control of the aircraft. I did two, the first one I lost control, the second two I was very smooth and very small inputs. I accepted a very slight roll off and didn't try to rapidly try to correct it and I was able to control it that way. So there is a real handling qualities cliff there and therefore it needs to be emphasized that the comments are more important than the ratings on this one. I met the desired criteria in roll which is basically... Actually I would probably say I met the adequate which is plus or minus 10 degrees. Yea, I had a non divergent PIO so basically I was adequate. However you are right on the edge there. So the rating is going to reflect what I actually did but my opinion is that this is a very dangerous situation and it's a potential for loss of control of the aircraft. So longitudinally; exceeded the desired but met the adequate criteria for altitude loss and a lot of that was... I have always had a problem at the go-around finding the TOGA button and getting the autothrottles off and also this thing really balloons in close, so you are really fighting trying to keep on glideslope. Therefore I was a little bit late getting the autothrottles off and then I have to get the throttles off and then the TOGA. So there's a lot of mess going on which really negates my ability to make an optimum altitude loss recovery. Nevertheless for that one, longitudinally; Is it controllable? Yes it was. Is adequate performance

attainable? Yes it is. Is it satisfactory? No. I met adequate criteria and I'm going to rate it a Cooper Harper of 5. For the lateral one, again the caveat is, you got to do this just right not to lose control, so... I will go ahead and rate it based on my performance. Controllable? Yes. Adequate? Yes. Satisfactory? No. Basically met the adequate criteria which is plus or minus 10 degrees angle of bank with PIO is not divergent, I'm going to rate it as a Cooper Harper of 6. Requires extensive compensation not to overcontrol it.

Pilot F

Task 7286 Go-around with Autoflap failure 23 Jan 97; Runs 105-107

I guess, before I forget, the first note is on one of the climb outs we saw, that as you're accelerating, lowering the angle of attack, you get to the point where if you have like 5 degrees of right bank, you can put in full left stick, and it will just hold 5 degrees of right bank, and if we step on the rudder, to try to roll us, we have to step in order to roll left, you'd have to step on the right rudder, and I guess, these are two separate issues, and I realize that this is a failure state. This failure state with the go-around, where you can get in a condition of climbout where you could not, if you were in 5 degrees right bank, cannot roll back to wings level, I don't think would be suitable. The task here is really limited to rating the go-around task, accelerating, and for that part of the climbout, it's probably really not what we're tasked to look at here, so, I'm going to ignore that part for rating this task, because I think it's beyond the bounds of the task. If I was rating that, when I get to the question is it controllable? The answer would be no, and I'd have to give it a 10, because I'm getting to the point, where I cannot, I cannot roll the airplane back to wings level. Is it adequate? Again, ignoring that we'll answer yes, is it adequate performance obtainable with a tolerable pilot work load, and boy this is a hard one to answer too. Where it says adequate performance... I'm reading the qualifier for a seven (7), adequate performance not obtainable with maximum tolerable pilot compensation, controllability not in question, well you know, that's kind of true if you just real ginger, and make sure you don't get any bank inputs in... that's not true. Again, I'm having a real hard time answering this yes and no question as far as adequate performance with maximum tolerable pilot work load. I think in this case just because, I think I'm going to say no, and I think I'm going to come in here and give it a 7 in the lateral axis. Again, I don't like splitting Cooper Harpers, but I think I will split the Cooper Harpers here, I think I'll give it a 7 laterally, and I think I'll answer yes longitudinally, and come up and say is it satisfactory without improvement? I think the answer is no, because the lateral axis does have some impact on my ability to perform the pitch function, also because of the split and the cues that we saw, mostly we did get desired in the last time, but it's hard to get the pitch capture task. Some of the... let me think about that for a second. I guess I'm going to say no, and I'm going to give it a 4 for pitch. This is kind of a post flight from this session, I guess, just a couple brief comments; One, realizing that there were malfunctions throughout there, but even without the malfunctions throughout the evaluation, it seems to me like the flare control is a little bit inconsistent, because sometimes I can put the... and we noticed the big inconsistency going from zero wind to crosswind, I mean to a headwind on the circling approach, I believe, but my perception at least is, is sometimes I can put the flight path vector one... you know, just touching the horizon line just below, but touching the horizon line, and I'll get a descent rate, and on other times it seems like I just level off and float down the runway, and there's no split cue, but I'm trying to a very fine controlled task, and I wouldn't think that for those very small inputs down there, that I should be getting perturbations between commanded and actual, unless that's a function of ground effect, and anyway I think that needs to be further investigated. I just wanted to reiterate a couple things, on the elevator hardover on takeoff, and on landing, although we can do those tasks as mentioned, the crew recognition would have to be

considered, and overall controllability would have to be considered. It's really hard trying to anticipate with those large splits, and I think those need improvement. The flaperon loss roll control, I think we need to look at the fact that at zero alpha, right rudder would cause a left roll, and also that I run out of total roll control authority at zero alpha on the climbout, where if I'm having 5 degrees of bank set, and I use full stick, I can't roll to wings level. The decrab... oh also, with the flaperon you can't use a steady heading sideslip crosswind landing type control from 200 ft, and that's... or am I confusing those. Okay, we did the... but now what... was that with the... Okay, just... I think I got what I was saying was confused here. The... all flaps locked at 30 degrees takeoff... or go around case, is a case where we saw the rudder and roll, right rudder causing left roll, and the fact that at zero degrees alpha, and also at zero degrees alpha, that if you set 5 degrees bank, or if you have 5 degrees of bank, you cannot roll back to wings level with full stick, and then you had to use the 50 ft decrab on the flaperon failure, which caused you to lose 75 percent of your roll authority, and on that one, you couldn't do the... the crosswind controls from 200 ft down, you had to do the 50 ft decrab, and then you also had to, I guess, make sure that once you did the decrab, you didn't float, or you would get the roll off, and again all of those, I think, need to be assessed, but I don't think they'd really be suitable, and anyway, just to carry over from one of the other day's landings, the 50 ft decrab, I really should think that even with the high winds, the 35 knot winds, you should have the capability to do a 50 ft decrab with this airplane. Anyway, that's it.

## **Task 7291 Loss of 75% Roll Control during landing w/X-wind**

Pilot A

Task 7291 Loss of 75% Roll Control during landing w/X-wind 17 Jan 97; Runs 26-30

Cooper Harper on the longitudinal, I think we were getting alternating desired and adequate, or was it we occasionally had inadequate too, didn't we? Hard sink rates, high sink rates. So, on average I would guess, its says back there, without improvement, well, a little bit annoying. I think the sink rate problems, with high sink rate, were due to primarily the... on my own part not realizing that with a strong crosswind, as you push in rudder, an other wise reasonable landing can be made a very hard landing, because if a lot of thrust is not added, in proportion to the amount of rudder that's used, and so that's basically what gave the hard landings. After I became accustomed to adding the proper amount of thrust for the crosswind condition, that went away, so I think taking that into account, the... I think we can say we were somewhere between a 4 and a 3, adequate and desired on the pitch control, and I don't think the pitch control was really affected all that much in terms of the... this particular failure. I guess I'll give it a 4 on... in terms of pitch and autothrottle would help under these circumstances, autothrottle to touch down would add the amount of thrust that would be required to arrest your rate descent so you could concentrate then on, on the task of a normal flare. The lateral directional control, we got a wing tip strike on occasion, but generally it could get adequate, or varying between adequate and desired after a reasonable amount of practice, and although, occasionally if large... large inputs are made for whatever reason, then it goes quickly to a 10. So it's... you're just right on the edge of a problem, so, I guess I'll just make the comment that, I guess I'll give it a 5, but with the comment, that if large control inputs are made, they have to be made on this... on our approach for whatever reason, then the rate limiting, the control surface limiting occur to the point where they can create a disaster. But it's a matter of circumstances, and on the particular approach, heavy turbulence could present a major problem.

Pilot B

Task 7291 Loss of 75% Roll Control during landing w/X-wind 09 Jan 97; Runs 67-69

15 Knot crosswind landing, Loss of 75% Roll Control during landing w/X-wind. Task was do-able with adequate and desired performance in general. Bank angle suffered a little bit on occasion, let's see, and the wide distance suffered a little bit on occasion. I found that Procedure A was a whole lot easier than Procedure B in the practice with motion off, so we didn't do any Procedure B with motion on, and that's different than what I found without the failure so, there may be an issue of technique here with the failure, but it's certainly a level two type failure. The work load goes up considerably, but it's not catastrophic, it's entirely do-able. Longitudinal HQR; it's controllable, and adequate, and adequate performance requires considerable pilot compensation, HQR5. This is another one where I might give it between 4 and 5, but I feel like I'm working hard enough and I'll call it a 5 for longitudinal. For lateral directional, same thing, controllable, adequate, satisfactory, but I'm working, and HQR of 5 as well, for the same reasons. So, 5 and a 5. That concludes my comments.

Pilot C

Task 7291 Loss of 75% Roll Control during landing w/X-wind 16 Jan 97; Runs 56-59

Let's do the longitudinal first, that's easy, yeah, all those things are going to be up to...satisfactory without improvement, I was getting some desired in there with fair amount of work, but I was getting desired in longitudinal also, so I bring that up to a 4, and lat. dir., is it controllable, boy, this is just barely with tons of compensation, I could definitely, would require improvement. The problem is once you get a bank angle in on the ground, I would just go right against the stop, trying to bring the wings level, and whether it came back or not, as almost happened, is luck of the draw, so, I'm going to give that a 9, and...because I couldn't keep it in control enough to keep from touching the wing tip without a huge amount of compensation on it, so 9 for lat-dir

Pilot D

Task 7291 Loss of 75% Roll Control during Landing w/X-wind

Not performed by this pilot.

Pilot E

Task 7291 Loss of 75% Roll Control during landing w/Crosswind 10 Feb 97; Runs 18-20

Task 7291, 15 knot crosswind approach and landing, 75% roll loss, card 60. This is not a good task either. The 200 ft forward sideslip technique... what happens is you have with that rudder coming in in a crosswind, you do start to get some roll moments on the aircraft and when you try to oppose them you rate limit and get into a big PIO. You just can't control it, had two geometry strikes. So I elected the 50 ft decrab method and what happens on that one is you just touch down right before the thing gets out of control. I had roll PIO on three of the four approaches I did with that technique, including the practice ones and was saved by the runway. So this was not good at all. For the longitudinal rating, is it controllable? Marginally yes. Is adequate performance attainable? Well I got adequate performance on all of them but I'm going to say no because I want to rate it, deficiencies do require improvement and I'm going to rate it a 9. Intense pilot compensation is required to retain control. Literally if I had flared any higher than 50 ft I think probably on one or two of those, I would of had a geometry strike and a divergent roll PIO. So, obviously you're just on the hairy edge on that one and actually there is no a whole lot the pilot can do even though you are trying real hard. It is a question of being right there. Any kind of gust or anything else, I think you would lose control and get a strike. That would be.... I should be talking laterally. The longitudinal rating, let me go back over that, scratch that longitudinal rating. Is it controllable? Yes is it. Is adequate performance attainable? Yes it is. Is it satisfactory without improvement? No. I pretty much met adequate longitudinal performance criteria. Pretty much in the box. Maybe just a little firm one time when I wasn't... so it was borderline desired/adequate. So I would say; is it satisfactory without improvement? No it is not. Deficiencies do require improvement, adequate performance requires considerable pilot compensation, a 5. For the lateral rating, Is it controllable? Yes, marginally. Is adequate performance attainable? Yes it is but controllability is in question and therefore it is going to have to be level 3. And I'm actual going to change that and rate it a Cooper Harper of 8. Considerable pilot compensation is required to maintain control and basically you can just not allow any kind of rolling moment to get started because you can't stop it, so you have to anticipate rolling inputs and correct them right away. And the other thing you have to do is maybe even minimize the flare. You may even have to kinda drop the nose and get it to land because you can not overpower that rolling moment.

Pilot F

Task 7291 Loss of 75% Roll Control during landing w/Crosswind 23 Jan 97; Runs 98-101

We found out during the practice runs that you can't do the forward slip from 200 ft, so you have to decrab at 50 ft. We also found out during the practice runs, and one of the data runs, that if you decrab at 50 ft, and then float down the runway that you're gonna die, well maybe not die, but it's not a good thing. Anyway, again, by the time you would get this, and get the recognition, I think it would be a little late for the pilot to make the analysis at that point, that oh yeah, I have to decrab, and oh by the way, if I decrab and I float, I'm going to lose, or I'm going to end up not having enough roll control authority to continue landing the airplane, and I also think that it's not, again... I don't think it would be suitable to have an airplane where you have to decrab at 50 ft, and you have to be on the runway within X amount of time, or you're going to lose... run out of roll control authority. So, given all that as it is, I'm just going to go in and rate the task as flown with the decrab at 50 ft, just consider that, I guess what I'm saying is, is that's a compensation, you have that in the back of your mind, I think it's unsuitable compensation, but if I'm just rating it as far as how extensive the compensation is, the suitability of that compensation, I guess, isn't directly relevant to the ratings, so, given that I don't think the compensation is really suitable, I'm going to ignore the suitability and just look at the extensiveness of the compensation. So, is it controllable? Yes, adequate performance obtainable with a tolerable pilot workload, and I guess, here quite easily I could answer no, if I took in crew recognition, weather, and also the fact that yet, one of the compensations you have, is that once you decrab, you have to make sure you get on the ground pretty expeditiously. I'll ignore that though and answer yes. Is it satisfactory without improvement? No, and I guess in question is, how much compensation is there. Adequate performance requires considerable or extensive compensation, and I guess I'm going to say extensive compensation, I'm going to go with a 6, just note that if, if you consider the idea of that, that if you float, and the compensation of having to get on the ground is not suitable, and that's not one you can use, you could easily answer no to the controllable question. So anyway, that's that. Yeah, I'm sorry, we'll do 6 and 6 both axis, again you know, certainly it's a roll control problem here, and certainly you could probably be in... again, on how you bounded the task, you could actually be in level 3 or even in the 10 range for lateral control, but it's really so tied together with the task that you're doing here, I'm just going to stick with a 6 and a 6 for the two of them, plus the bounds that we talked about.



## **Task 7292 Flaperon Hardover during landing w/X-wind**

Pilot A

Task 7292 Flaperon Hardover during landing w/X-wind 17 Jan 97; Runs 32-35

It's all adequate and desired. With a hardover flaperon and with crosswinds from the left, we seem to get a wing tip after touchdown during the V rotation, and just after the V rotation, and however, from the crosswinds, from the right... the left... we get no wing tip strike, so if there's a favorable crosswind direction and an unfavorable direction, it's a wing tip strike, however, the adequate to desired performance can be obtained in terms of the approach and the touchdown. I guess I would have to rate the lateral directional, they have a major deficiency, it's... I can't say that it's controllable in the one crosswind direction, so I'd have to give it a 10, however, if the proper runway is used for the proper crosswind, it could be as high as a 3, without any major deficiencies, so it depends on the crosswind direction for lateral directional Cooper Harper. Longitudinal Cooper Harper, looks like we were in the adequate to desired range, I would give it a 3.

Pilot B

Task 7292 Flaperon Hardover during landing w/X-wind 09 Jan 97; Runs 74-76

General after the practice, I was able to get it within desired and adequate performance. I'm deliberately reducing input, so to avoid lateral PIO, there is a pronounced tendency for lateral PIO. In fact, on the last one I got into a little bit of that even after touchdown. We're also only able to do this do to the moments encountered from the crosswind from the right-hand side, you do it from the left, you'll get a wing strike on the right hand side after touchdown. Longitudinal HQR; it is controllable with a lot of work, and adequate performance is attainable, however, the tolerable work load, I think here, is the issue, there's a considerable amount of work load to maintain adequate performance, and I'd say considerable pilot compensation is required for control, make this the lateral directional, because these arguments apply to the lateral directional axis, so, the lat-dir is HQR of 8. Longitudinal; it's controllable, adequate, I think it's fair to say that desired performance requires moderate pilot compensation, HQR of 4. It's almost...I'm almost tempted to make it a 5 here, but it's close enough that I'll give it the benefit of the doubt, and call a 4. So, longitudinal is a 4, lateral directional is an 8. That concludes my comments.

Pilot C

Task 7292 Flaperon Hardover during landing w/X-wind 16 Jan 97; Runs 60-62

Ten. No question, as soon as it fails and it starts to do bank angles, and I try to make any corrections at all complete, divergent PIO, and when I just let, I said okay, I'm going to let it drift and settle down, and then try to sneak it back, and in doing that I didn't have time to even line up, and so to hurry it along, next thing I know, it's back into PIO, it's a ten as far as I'm concerned, and that's lat-dir, and pitch is no different than before, so, I don't know what were those, as little as I saw, it was probably a 4, I think it was, something like that. Rather academic point.

Pilot D

Task 7292 Flaperon Hardover during landing w/X-wind 24 Jan 97; Runs 58-60

Really the failure itself is pretty innocuous, the aircraft recovers very nicely, but for some reason, it apparently is doing something to control system, my tendency to PIO laterally on this particular control system is aggravated immensely when this failure is in, and I'm getting roll PIO's, essentially I have to let go of the stick laterally to keep the thing under control, and if I had let go of it at the right step, we make it, if I don't, we get a geometry strike. Pilot rating longitudinally is 7, but the lateral is an 8.

Pilot E

Task 7292 Flaperon Hardover during landing w/Crosswind 10 Feb 97; Runs 25-28

This is task 7292; The 15 knot crosswind with a Flaperon Hardover. The flaperon hardover is attempting to roll you to the right and there is a big difference between a right crosswind and a left crosswind as far as controllability. With the right crosswind and I'm essentially going to rate it for the right crosswind but give you a rating also for the left crosswind. I only recorded against the right cross wind. The right crosswind, you initially get a rolling moment to the right, if I make an aggressive input to the level the wings which you would do if you were normally flying an approach and you get a roll upset, not knowing whether it's wake vortex induced or turbulence, whatever. The pilot typically will make a very aggressive move to stop the roll and go wings level. If you do that, you get into a pretty significant rate limited PIO which it is difficult to get out of. I actually had to physically get out of the loop and then smoothly get back into the loop to retain control. So learning from that, I made a very smooth small amplitude correction to the initial upset and that worked out fine by being very very careful and making very small, smooth roll inputs. For the rating now with the right crosswind with the flaperon failure that gives you a right rolling moment. The longitudinal rating basically pretty much desired performance so controllable? Yes, adequate? Yes, satisfactory? I'm going to say yes and rate it a Cooper Harper 3. It is borderline level one/level two. You're trying to be so smooth with the roll inputs that you really get your gains up and you are pretty much smooth in all axis. I will admit that I'm reluctant to put in any significant control input either longitudinally or laterally in the flare because I pretty much want to get it on the ground and I'll accept a firm touchdown in order to land it safely. So I was fortunate that those worked out so well. Obviously had I not... had I hit the dynamic ground effects in such a way that I was coming in firmly, I don't think I would have made a pitch input for fear of overcontrolling it and ballooning and then getting slower and not being on the ground. For the lateral rating; pretty much I met the desired criteria for displacement and I don't really like the fact that you are right on the hairy edge especially when you get that initial roll upset. So is it controllable? Yes it is. Is adequate performance attainable? Yes it is. Is it satisfactory without improvement? No it is not. I'll rate it a Cooper Harper of 4 for meeting desired criteria. I'll make this caveat. It is very very close to being uncontrollable. I think being smooth you can do it repeatedly but that has to be the foremost consideration being smooth on the control inputs. I'm going to go ahead and rate a left crosswind because it is significant. Longitudinally it is really difficult to rate it because you are in such a fight in the lateral axis. but I will give it a lateral rating. Is it controllable? No it is not. Cooper Harper of 10. Basically you were not able to overcome the right roll. You do not have enough... you have insufficient control power and will continue to roll to the right. I did make one touchdown that it was a pretty nice touchdown actually and once I slowed down, it just kept rolling off on the right main gear and eventually got a geometry strike, at full left full lateral control commanded.

Pilot F

## Task 7292 Flaperon Hardover during landing w/Crosswind 23 Jan 97; Runs 77-80

Basically, the transients easily controllable as long as you kind of let the flight control system take care of it. If you try to get into closed loop, which I think here would be a tendency to do if I was really surprised with this on final, I could see overcontrolling and maybe initiating a PIO. I'd probably be able to recover from the PIO, but I'd probably choose to go around, and if I waited too long to go around, down near the runway, I think you'd get a geometry strike. Basically, the technique that I use for the failure is, is I put in a very small roll control, much smaller than I would, due to the initial roll off that I get from the flaperon failure. The point is, is the flaperon failure, you get a pretty high roll rate, but then it kind of arrests itself, by the time the pilot recognizes the roll rate, he's putting in a... or at least this is my perception, at least, he's putting in, in the opposite roll command, and the system rolls off from the other direction pretty rapidly then, and that kind of starts you off into somewhat of a lateral PIO. As far as the landing itself goes, I don't know that it's really that much more difficult than the landings that we were doing the other day after you get everything stabilized, it's just that, you're not really starting from a stabilized approach, you're trying to get it squared away. Another thing is, is I have to be a little bit ginger with the ailerons and the rudder, just to make sure that I don't excite anything, at least that's my perception again, based on the practice runs. We were able to get almost desired performance, but adequate, and I'm just looking at the last run here, we were 96 ft long on the desired box, and we had a heading error of 3.1, which put us into the adequate area. Still alignment is not the easiest thing to pick up, and once again, you're still kind of trying to realign the airplane from the perturbation that you get with the flaperon bank and the flaperon hardover, which causes a bank, which causes a course perturbation, and I think that's part of, it increases the work load just a little bit. I think you could probably, after a few more runs, I think I could probably get all desired performance, but that's really not the point here. I think, let's do the Cooper Harper, it's definitely controllable, you get adequate with a tolerable pilot work load, with the acceptable, or the note that, I really think if somebody was flying with this on final, that there'd be a little tendency to get into a PIO. I think that they could recover from it quickly, but I think it would induce a couple of oscillations. Is it satisfactory without improvement? We're not getting desired performance, I'd have to answer no, we're not getting desired performance, so, that would really put us into the range of a 5, and I'm going to give it a 5 in pitch and roll, it's probably a function of both of those axis are hard to get squared away on, or to get the performance parameters on. Pitch is probably slightly harder, but the reason you're having the problem with the pitch is just because you're not as stabilized, and you can't put as much attention to the pitch task as you could before. I guess, I kind of think we're a little bit shy of considerable, but I would consider considerable pilot compensation, so I kind of, I guess I kind of want to rate it a 4, but based on the performance parameters, we'll give it a 5 and a 5.

This is the amendum to the statement after we rated the task, we went back and tried Procedure A, which is the decrab at 50 ft, and in retrospect, I think that... I don't know that, we just tried it real quick, and we didn't really get appreciably better results, we got about equivalent results. I think that probably, if I really, really worked at it, on the next run, I think I could probably get desired all the way through, doing the decrab this way. I guess the point is, is I chose the decrab at 200 ft because we had had a couple during the practice runs, big oscillations closer to ground, and my philosophy was, is I'd rather get things stabilized up high, I put in the rudder and everything up high, so that I have a chance to get everything stabilized before I get down next, or close to the ground, and then in retrospect, I think you can do better on this task, if you do Procedure A. And reason is, is because you get the transient from the flaperon failure, you get the airplane squared away again, and then you can get your tracking solution taken care of, and then you do the decrab and landing, and so

you kind of segment each task versus... what I had to do was play the alignment problem, and then also play the... correcting back to centerline problem, simultaneously doing the Procedure B. I'm not so sure, right now, I'm not so sure I have a strong preference one way or the other, I think you could do it either way, but I guess I think it is slightly easier using Procedure A, probably should've done it.

## **Takeoff Rollout Pilot Questionnaire**

### **Pilot A**

Takeoff Rollout Pilot Questionnaire 13 Jan 97

#### **1. Adequacy of Yaw Control Power (Engine out) ?**

It's quite adequate, required 20, 30 percent rudder, light forces, seemed to be plenty of control.

#### **2. Ability to maintain runway center-line ?**

I found at least from the view of the pilot, maintaining center-line until after liftoff in which case the runway, I think probably in retrospect, one of the things that caused a deviation off centerline was the fact that the runway disappears from view, and you no longer...you no longer have a...something to reference to, and so there's a tendency to drift off centerline once you get above about 5-10 degrees of pitch, and ride around in the liftoff area, but I think it's not because of the rudder control power, or the control authority is plenty adequate, but I think it's just the view that you have of the centerline and where you are on the centerline, I think that could be overcome by just making some standard corrections back onto centerline using bank angles, or maybe a little more rudder.

#### **3. Braking Capability ?**

Was...seemed to be adequate.

#### **4: Effects of wind and turbulence ?**

The crosswind seemed to be taken care of with rudder adequately, I saw no large problems with the crosswind, and as far as the takeoff rollout, I guess the main problems that I saw were the...just the...were the fact that runway disappearing and there's less indication that you have drifted to one side, maybe that can be solved by some additional cues, or just practice and change in procedures.

#### **5. Summary of Good/Bad features ?**

The rudder control seemed to be adequate at high speeds, 170 knots, V1 seemed to be...I don't know VMCG is, but it must be...must be quite, quite, high. What is it...127, so, you're well above VMCG, so that's...that's what it feels like on the airplane. There's plenty of rudder control. The thrust asymmetry compensation would probably maintain the centerline, but still I think there's a...in order to maintain the centerline after liftoff, I think it's a delicate balance of applying some bank angle to get back on centerline, and getting...due to thrust asymmetry, and bank...and you don't want to use too much bank angle because you're going to get a strike, pod strike, so that's ... I guess that's the summary on that.

### **Pilot B**

Takeoff Rollout Pilot Questionnaire 06 Jan 97

#### **1. Adequacy of Yaw Control Power (Engine out) ?**

That was entirely adequate. I don't believe I was at the stops. The combination of rudder and brakes, it's a handful, you're working but it's entirely doable. And I'm deliberately keeping it really tight on the order of 5 ft or less of deviation. There's no need to really have to do that. But even despite all that, it's doable.

#### **2. Ability to maintain runway center-line ?**

That's fairly easy. Particularly in the absence of engine failures. And certainly in the absence of crosswinds its real easy.

### **3. Braking Capability ?**

Seems adequate. I don't have a problem with that. I think I'm feeling anti-skid releases. I don't know if that's simulated or not but I'm certainly feeling an inconsistency in longitudinal acceleration and deceleration which feels like anti-skid releases. Whether that's an anomaly or a real good simulation... I don't know. Okay.

### **4: Effects of wind and turbulence ?**

The wind is more of an affect than turbulence. You can definitely see the requirements to point the nose into the wind to compensate for the side ports on the airplane on the rollout. That's a little bit disconcerting because you don't really have an aim point of velocity vector would be nice there. and other than that, it's doable. I'm pretty much using the center-line to use for drift control.

### **5. Summary of Good/Bad features ?**

In summary---relatively pleasant. Fairly solid level 1 airplane on the rollout no major problems.

## **Pilot C**

Takeoff Rollout Pilot Questionnaire 15 Jan 97

### **Takeoff Rollout Pilot Questionnaire Question 1.**

Adequacy of Yaw Control Power, Engine out. It seemed like without the crosswind in there, there's very little difficult, and as I recall, I had desires on those, that was not a problem. I was surprised how benign it was, and didn't see any particular problem, I often waited for a little bit of...oh, no, yeah...this is engine-out with no wind...I waited for a little bit of motion before I put the rudder in just to make it a little practical kind of a thing, and it was...as soon as I saw it start to move, I pushed in the rudder and came right back, so, plenty of yaw control that I saw with engine-out no wind. Ability to maintain runway center-line is very, very easy, no problem, one time just to see what it's characteristics were a little better, I purposely moved myself off to the side then came back and recaptured the centerline, it felt fine, it wasn't too sensitive, I didn't overcontrol, and it felt nice, nice and tight, I was very comfortable with it the whole time. Braking capability ? Looked pretty good for an airplane this heavy, and we were stopping well within the end of the runway, and that appeared to be very good. Anti-skid; this is a good simulation of those, there's no pulsing in the breaks or anything, I just climbed on them and waited for it to stop, it was a no brainer, but they did appear to be effective. Effects of Wind and Turbulence ? The crosswind with the centerline, or the engine-out made big time difference, and this time I don't think I ever kept it in desired, and adequate was the best I could do, but that sure did get my attention, and one problem, it's awful easy to revert to old feelings and when you start making big changes to the left with the rudder, sometimes people tend to put in a little stick to the left also, and with the bank angle constraints this airplane has on the ground, that would be of concern, I didn't see it, and just...that's an observation off to the side, not anything that's a big production about it all. Good features ? Really accurate, plenty of power, good control, and the bad features were not do to control power, particularly things like that, but that crosswind just gives you fits, and it's really difficult and the set of the requirement for precise wings level, raises your anxiety quite a bit because it doesn't take very much rocking to touch something, but in general the yaw axis control was fine.

## **Pilot D**

Takeoff Rollout Pilot Questionnaire 22 Jan 97

Okay, Pilot D on the 22 of January, commenting on the takeoff rollout for all of the various tasks we did, up through the engine-out with the crosswind, which of course was the most difficult.

### **1. Adequacy of Yaw Control Power (Engine out) ?**

The adequacy of the yaw control power, engine out, by itself was, plenty adequate, if you throw in the crosswind and the engine out, it became slightly marginal.

### **2. Ability to maintain runway center-line ?**

Ability to maintain runway centerline. Didn't seem like any big problem, except perhaps during the rotation.

### **3. Braking Capability ?**

Braking capability on the rejected takeoffs, seemed adequate, we were stopping at about 3000 ft, of course that's just a mathematical thing there anyway.

### **4: Effects of wind and turbulence ?**

The effects of the wind turbulence. The turbulence doesn't seem to be a big factor in the takeoffs, it maybe contributing to some real PIO's and some wing tip strikes on the crosswinds, but it didn't feel like a big factor. The crosswind was a big factor, and it was giving me a hard time on the engine out crosswind.

### **5. Summary of Good/Bad features ?**

Summary - The good features... having a hard time coming up with any real, good, strong features. I think the tailstrike bar was one that I liked. I think there is several things that need to be improved in the display, and procedurally or aircraft changes also. Starting out I think that it would be nice to have the V speeds up on the head up display for the takeoff roll. That would really cut down the scan pattern, and for this phase of flight... any additional clutter is not going to be a problem. It doesn't have to be a full airspeed scale. It can be just V number, is all we really need. I had a little bit of trouble with the pitch rate rotation, I'm not sure that it's really needed, or that it be tracked as closely, maybe this is the real problem, that the performance criteria is maybe just a little tight to be realistic, I don't think it needs to be quite that tight. The 10 degree tail strike is a bad feature of the airplane, or the 12 degree tailstrike, whatever it is. It's really adding to the work load, and making it hard to take advantage of the performance of the airplane, and that particularly shows its self up in the crosswind engine out where the inability to get a clean break with the ground is really contributing to strikes on the aircraft problems. If you have the big crosswind and an engine out, it's very easy to get the... I had a tailstrike at 4 1/2 degree, correction, the nacelle or wing tip, I'm not sure what strike. At 4 1/2 degrees roll angle, that's really way too restrictive, I think operationally. I think we either need to put longer landing gear in the airplane, or if we have strong crosswinds, or maybe even normally, we need to think about increasing the takeoff speed just slightly to get away from this extended period on the ground. Had another problem on the takeoff rollout, actually this is not the takeoff rollout, why don't I truncate it here, and we'll pick it up later.

## **Pilot E**

Takeoff Rollout Pilot Questionnaire 07 Jan 97

### **1. Adequacy of Yaw Control Power (Engine out) ?**

I thought there was adequacy. My biggest problems were not having information to really tell me where I was on the runway centerline, once I start rotating I can't see any... I can't see anything to tell me if I am drifting or not, but I didn't feel as a pilot I ever go to a limit. I never put in full control deflections of either aileron or rudder. The control law may as Lou said, may have commanded full deflection, but I never asked for anything like that so I wasn't asking for anything more.

### **2. Ability to maintain runway center-line ?**

The ability to maintain runway centerlines for no crosswinds is no problem. For the crosswinds it is easy on... or very simple when you're pre-rotation and once you start rotating you lose any cue to tell you where you are on the centerline so it's difficult at that point.

### **3. Braking Capability ?**

Braking capability I thought was fine, no problems there.

### **4: Effects of wind and turbulence ?**

The turbulence just kind of creates a little disturbance about the commanded gamma and you do occasionally see some deltas between commanded gamma and actual gamma. I was always closing on commanded and the actual take care of itself for these tasks for the take off and up and away. When certainly in the engine out crosswind, you do have a tendency to over bank the aircraft on the ground which could lead to a geometry strike, and airborne the only problem is with the big crab angle with the HUD being so big it's kind of hard to keep track of everything.

### **5. Summary of Good/Bad features ?**

The only bad features was the lack of the cues once you rotate as far as maintaining your own centerline because this thing rotates at such a high angle you quickly lose any cues as to where you are laterally on the runway. Good features being a flight path command control law, it's very nice as far as being able to put the flight path where you want it. In turbulence though, it does bounce around more so than I would like, but it's not bad, it's just a little more of a work load in turbulence. For the engine failed below V1 and I am assuming these are for all the tasks I did right ? Oh, just the takeoff and roll-out. I have comment on some things that are beyond takeoff roll- out. Sorry about that. Any rate, for takeoff roll-out though, runway centerline is very simple or do, bank capability is excellent, effects of wind turbulence, the crosswind just for roll-out does require a little bit higher work load to maintain centerline, but you kind of have to set the water line upwind and you have to kind of feel where the center of gravity is, but what I was doing was kind of working out real well. It's good/bad features, really no bad features and I've listed the good features.

## **Pilot F**

Takeoff Rollout Pilot Questionnaire 23 Jan 97

### **1. Adequacy of Yaw Control Power (Engine out) ?**

For the cases that we looked at, now we were looking at engine failure after V1, so we should of been a fair amount above VMCG. The airplane was very controllable, it took slight rudder pressure to return the airline back to centerline tracking. I thought that was all, I didn't feel like I was lacking in any control power to make the correction for those particular cases that I flew. In the crosswind case, I also didn't feel that, you know, it took



some more rudder throw, and then at least in my... from my perception, as you rotated it, it took increase in rudder, when you had the engine out in the crosswind, and there I felt like I was using a lot of rudder, I don't think that I was up against the stop, although you guys can check the tape of the strips and see, but anyway, I didn't feel like I was... had a lack of control power per yaw control in any point for the maneuvers that we flew. ...there may be some cases where, I guess I'd ask you to look at the strips real carefully for the after rotation phase, and I realize that that's really after rotation is not really covered under the takeoff roll, but while I'm thinking about it, I would check the strips there, because that isn't quite a bit of a rudder requirement, and I'm not so sure that there might be some cases where you are approaching, using all the control power that you have. I can't really make a definitive statement from what I saw here, but I think it's worth looking into.

## **2. Ability to maintain runway center-line ?**

Ability to maintain runway center-line. With the display as it is, I didn't think that it was difficult to maintain runway center-line, no wind... in the no wind case. You have the DME right below the waterline and the two of those on the extended center-line really work well to help the pilot control the airplane to the runway center-line. With the crosswind case, I tried putting in some cross control, some aileron, because it seemed like we were, without having a heading change, or without really seeing any appreciable bank angle, but I... like a wing coming up and compressing the strut, it seems like we were just drifting laterally on the runway, and when I did that, I think I got some pitch control in there, and we ended up with a bumpy ride down the centerline, which degraded the task later on during the rotation phase, and also the end of the runway center-line tracking task. The technique in the crosswind that seemed easiest was to just keep on correcting back to centerline, or on the last one of the last runs that I did, I noticed that I could just hold in a heading correction on the rudder, i.e., just keep the waterline a little bit into the wind, and the picture was is, as if I was going down the runway, with centerline yawed, and again I didn't see any appreciable change in bank, i.e., looking for a compressed strut, so I was a little bit curious about that, and I guess this would leave me to just ask a question about your ground model, and how accurate the ground model is. Anyway, we had a little bit of discussion, and I guess I can kind of understand, as far as a skid angle goes to restore the offset in the forces in the Y direction due to the crosswind, why we could probably saw what we saw.

## **3. Braking Capability ?**

We didn't do any aborted takeoffs, so I can't really answer that.

## **4: Effects of wind and turbulence ?**

The turbulence I don't really have any comment about the wind. I do think that we need to look at the beta cue. I made comments during the runs on all of these, but the beta cue, from the perspective of it being way up at the top of the display, and your focus, or field of regard is at the bottom of the display, and also the fact, that you're running down the runway now, with this beta cue displaced, and with the engine failure, until your airborne, that beta cue really doesn't help you, so you have to visually satisfy, or... I guess it gives you no aid in how much rudder to put in for the engine out problem, and as far as during the rotation, as you bring the nose up, and you start losing the runway extended, it becomes difficult to figure out how much, how much rudder you need to stuff in there, and it would be nice to have the cueing that was more accessible in your cross-check and it would also be nice to have, well, let me rephrase, the second thing is, is I think we really need to look seriously at what the beta cueing does for the pilot versus lateral acceleration, perhaps a need for both to be displayed in different formats, or how it's going to be used. I think there's a lot of issues around this that are really important, I think it's important to remember that pilot's have grown up using the lateral acceleration cueing methodology, and I don't really want to take

any cues that the pilot would normally have away from him during the rotation phase in the transition in the flight, and I'm not so sure that he can use the beta cueing to full advantage, during the initial... during the rotation phase, and just as you, and after you break ground, and I think that's about it.

### **5. Summary of Good/Bad features ?**

I didn't really see, as far as just actually tracking the rotation, any real big problem, except for, even just on the initial roll, having the beta cue displaced is a little bit distracting for me. Oh, the one other thing that I was going to mention is, is in low visibility, the pilot's field of regard is going to come in closer to the bottom of the display, and so I think it would be worth looking at some tracking in real low visibility, because the display that you have for tracking with the waterline on the horizon, and then the little DME number right underneath that, really aids in being able to track the centerline, and I don't think in low visibility conditions, you're going to be able to be looking up that high in the HUD, and I think that there should be an assessment made with, I guess without those cues, or with reduced visibility, so that you can look at the ability to track close in, and I realize that this is more than just a flying qualities issue, this is an XVS issue, and a lot of things involved in this. So you know, I didn't see anything with control laws that would cause me any concern from the evaluation we did, but that's just kind of a side note.

## **Takeoff Rotation Pilot Questionnaire**

### **Pilot A**

Takeoff and Rotation Climb Questionnaire 13 Jan 97

#### **1. Adequacy of Pitch, Roll, and Yaw Control Power ?**

First question is adequacy of Pitch, Roll, and Yaw Control Power ? Seemed to be plenty of...plenty of control power in all directions.

#### **2. Predictability of Pitch, Roll, and Yaw Responses to Pilot Inputs ?**

The only problem that I...one of the main problems that I noticed was just trying to maintain that constant directed pitch increase on the liftoff following the inputs for pitch, seemed to throw me into a bit of a PIO around that pitch guidance on rotation. Seemed to me that I was able to use a lot smoother technique when I didn't have the guidance, just to maintain nice, smooth, pitch rotation, and I think perhaps, just some regular feedback on whether your pitch rate technique is too slow or too fast, and just let the pilot adjust it, and I think the...it's possible that, that guidance...that special guidance is not necessarily required or even desired, the pitch bar for tailstrike was sort of a handy reminder, that of where you might get into a problem there.

#### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

That all seemed to be quite easy, no special problems there, as far I could tell. The bank angle seemed to be a little touchy as far as the response, the motion cues seemed to be quite pronounced for just a small amount of lateral input, and a track...track hold feature with zero bank would be helpful in maintaining track. It's fairly easy to let the, just the turbulence, the turbulence would cause the bank angle to vary and then the track to vary.

#### **4. Ability to control airspeed during climb (autothrottle off) ?**

That seemed to be relatively easy, I think we're getting desired performance on that, yeah, I didn't see any big problems there.

#### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If Yes, was the task continued or abandoned ?**

The only PIO tendency might be in tracking the rotation rate after...at VR, I would tend to overshoot or undershoot, and not track that rotation rate guidance as precisely as I wanted to. It might be...part of it, I think might have been due to the fact that there was no...it didn't seem to be any obvious indication of one that was going to start moving, it would appear, and it would may or may not move up, be like, kind of like the drag race, racers have these lights that sequence down, and say okay, bingo, now you go, I need to add some kind of a gamma guidance like that, it would be good to have some kind of indication up there, as to when it...when it's going to start moving. I usually over start it too early, and then had to slow down, and speed up, and so, I think I might have been better off just to ignore it completely, and do a normal rotation rate on it. Maybe there's a technique for using it that I haven't mastered yet, but it's not readily apparent.

#### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

...seemed to be...seemed to be quite reasonable, Sensitivity, the only sensitivity problem I noticed was perhaps in roll it seemed to be just a little bit sensitive. It's hard to get it out of the detent without experiencing some kind of lateral G, noticeable lateral G, and I don't

know if it's a fact that we were up in the front end of the airplane that moves around more than the other parts of the airplane. Pitch/Roll Harmony seemed good.

**7. During the Takeoff Rollout, were there any problems ?**

During Takeoff Rollout, didn't see too many problems, the only problems I saw were maybe on the engine failure trying to maintain centerline, but the deviations all were quite reasonable compared to existing airplanes.

**8. During the Takeoff Rotation, were there any problems ?**

Takeoff Rotation, I think I described, the only problems I could see were in trying to track that rotational guidance, and I'm not sure exactly what the problem was for me, but it seemed as though, slightly difficult to track it, I know how important it is to track that precise takeoff rotation rate, but it was difficult to get desired performance in tracking that rotation rate.

**9. Effects of winds and turbulence ?**

Were not especially a problem.

**10. Summary - Good/Bad features ?**

The rudder tracking on the runway seemed quite good, plenty of rudder control power, brakes were good, and the pitch control seemed to be reasonable, I think most of the problems are associated with the display, the way the display guidance worked on rotation. So that's the end of that.

[This pilot answered some of these questions later in his series below]

**Pilot A**

Takeoff Rotation & Climb Pilot Questionnaire with crosswinds 13 Jan 97

[This pilot answered most of the questions on this questionnaire earlier.]

**9. Effects of winds and turbulence ?**

Question is, during takeoff rotation, okay, the effects of wind and turbulence ? The crosswinds that we evaluated in the second session today makes a difference in that using rudder, creates a lot more drag, and if you ... if you don't get the rudder in just right, and keep the airplane on the centerline, and try to correct for some deviation, you cannot use a bank, and you have to use, in some cases, more rudder to correct back, in which case that increases the drag even more, and extends the ... extends the liftoff more, and creates more... more deviations, so, there is some fair amount of sensitivity to keeping the airplane on the center ... centerline, and when you start rotating, and you get into the rotation, and you've got a lot of rudder pushed in, and you have to increase it even more then to keep the airplane straight, then that does have a effect on the ability to track the centerline in the airplane performance, so there is a effect there. We did have one pod strike, and one of them is attempting to turn back towards the centerline, that doesn't work, and although I had the visual impression that I was high enough to turn, when in fact the airplane is so long, it seemed like you're quite high off the ground, when in fact, your wheels are still on the ground, or you're less than a couple feet high. So, that was the trap that I fell into, that might be a characteristic of... due to the physical dimensions of the airplane, that can be a potential problem in this kind of a scenario. It's important to keep the wings level until you're at least 20, 30, 40 feet high, but as far as the ability to control the airplane on a engine-out takeoff, it was not a major problem if you keep tracking the centerline. The effects of the pitch rotation guidance on takeoff were ... seemed to induce some oscillation and required much more

attention, I think, it kind of takes away from the attention you can pay onto the other portions of the takeoff, so that may be...that may have a detrimental effect, maybe there's a way to present that kind of information in a ... another form that's a little easier, rather than having two of these brackets out on the extremes of the bore sight symbol.

## **Pilot B**

### **Takeoff Rotation and Climb Questionnaire 06 Jan 97**

#### **1. Adequacy of Pitch, Roll, and Yaw Control Power ?**

Pitch, Roll, and Yaw Control Power was adequate. I don't recall hitting the stops, I guess that's a good thing because the side stick had some problems at the stops longitudinally. Periodically when I would wipe out the controls I would get a vibration against the stops. Again, the procedure of cleansing the controls as Bruce calls it is generally adequate to stop that but there's an anomaly there.

#### **2. Predictability of Pitch, Roll, and Yaw Responses to Pilot Inputs ?**

I think that the predictability pitch , roll, and yaw response is good. The only special control technique is the dag-gone pitch rotation rate metrics are so tight that you've gotta really anticipate the movement of that bar. You can't react to and that tells me that it kind of inordinately sensitive. But again, if we're increasing the task flow to brake up the HQR's then that's fine.

#### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Pitch Attitude Tracking , I thought was relatively pleasant. I gave it a HQR4 on that one task because of what I just talked about. The sensitively required. That is the metrics...the tightness of desired tolerance. Flight Path control was good, fairly easy. Bank angle control was probably the least easy of all of this in terms of fighting the turbulence. And it just seems like there's a disparity in the longitudinal and lateral directional axis in turbulence. If you pretty much don't make any inputs, let go of the stick in turbulence, you're going hold flight path longitudinally, you are not going to hold bank angle lateral-directionally. You gotta make lateral inputs. And it would be nice if we had a bank angle...a functional bank angle hold system that would latch at zero a little bit quicker than it is. Heading control was also relatively easy. I'm not really controlling heading here, I'm really controlling the velocity vector position with respect to command guidance in general and that was relatively easy.

#### **4. Ability to control airspeed during climb (autothrottle off) ?**

I'm not really doing that a lot yet in any of these tasks, again, because I've got guidance. I'm not really controlling to airspeed, I'm controlling to the position of the command guidance. However, having said that I'm able to maintain airspeed when it is controlling airspeed by doing that.

#### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If Yes, was the task continued or abandoned ?**

I did not notice any PIO tendencies in the speed, pitch, or roll axis. However, there was an oscillation of the control system that I talked about that occurred on a couple of occasions. There was an anomaly, I hope.

#### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Force and displacement, there was an inconsistent breakout that I felt in the longitudinal axis that if you left the stick alone for awhile in a certain position it tended to stick there. When you're moving the stick around, stopping briefly through the neutral point, you seem to get a..I seem to get a lighter breakout and friction bend than when I left it there. The effect is though every once in awhile the stick is sticking , if you will , in a center position. You can always breakout, but it just seems like every once in awhile the breakout friction was inconsistent. It got higher . So there's something going on there. I commented when it happened, so you can go back and look at the data and look at the force and displacement. A bit inconsistent. I don't think that it inordinately affected my CHR's. But it certainly affected the feel of the airplane. Sensitivity felt about right. Pitch and roll harmony, I think is as good as you can make it in a side stick control is okay. The characteristics of the control loss in the two axis are a bit in disharmonious in that ,again , you don't have to do anything to maintain flight path longitudinally. You do have to do something to maintain that lateral directionally in turbulence. However, sensitivity and harmony appeared good. There is an observation that you should note and that's periodically when I'm making large pitch inputs, as in take off rotations or cut-back, I'm putting in inadvertently lateral inputs in associations with longitudinal. I don't really have an error , it's just the nature of the control and being off axis from your body is causing inputs. We also noticed that in the last Ames.2, Ames.1, Ames.2.

**7. During the Takeoff Rollout, were there any problems ?**

No problems during the takeoff rollout. I've talked about that.

**8. During the Takeoff Rotation, were there any problems ?**

During takeoff rotation I had a problem that I've mentioned before due to the sensitivity ..or due to the tolerance in the metrics. It's tight enough and there's a little bit of a problem with pitch rate predictability. Again, from a mission relatable standpoint, I don't think It's a problem, I think we're making it a problem by the stringency of the requirements.

**9. Effects of winds and turbulence ?**

Turbulence affecting me, is as I mentioned primarily lateral directionally.

**10. Summary - Good/Bad features ?**

In summary I think from a mission standpoint, its a solid level 1 configuration, despite the level 2 HQR's. That concludes my comments.

**Pilot C**

Takeoff and Rotation Climb Questionnaire. 15 Jan 97

**1. Adequacy of Pitch, Roll, and Yaw Control Power ?**

I don't think I hit the stops on anything, I rolled as fast as I wanted to, I pitched as fast as I wanted to, control power seemed fine.

**2. Predictability of Pitch, Roll, and Yaw Responses to Pilot Inputs ? Any special control techniques required ?**

It was pretty good, things get so...get...quite busy there right at rotation and the...I had to leave the pitch quite a bit, in order to keep the rotation a little more than I had expected. Any special control techniques required ? The only thing that I did, that I learned that would help, is about the time the magenta brackets came on, I would start the backpressure coming in for the rotation, and by the time it was telling me to come up, I was having the nose come up, it was still in desired on the upper side and pretty soon the bracket caught me, in other

words, I could lead it a little bit that way, and get a lot more accurate rotation on it. For what it's worth, in the experimental design, it would have been a lot more efficient in the training part, if I would of had that bracket to chase, to see what a proper rotation rate would have been, I think I could of knocked off a couple of practice runs there, just because I had to bracket it myself, and do it a couple of 3 times to see how it worked out, where as, if I would of had that initially just to say, okay that's how fast you've got to do it, then it would have been a little bit quicker, it doesn't have anything to do with the rating, but it would have cut down on some practice runs for me, although I haven't rotated this airplane before. I didn't see a big tendency to overshoot, maybe a little bit in pitch, that's a fairly rapid pitch rotation, and I might have gotten just a little bit of overshoots going on it, but it apparently was staying well within the desired area, so I don't have a complaint about it.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and/or heading ?**

Ability to Control and Track the Pitch Attitude, these aren't in first and second segments, I assume, you're talking just in general, because the pitch attitude capture, that one took a little bit of work, but then once it was settled down, it became, you know, it's a real no brainer, once you get things down, all you're doing is fine tracking of pitch attitude ... is very easy. Flight path, once I learned different techniques that are going through, on one of them you just keep the attitude right on going, and whenever the flight path comes on you just keep the pull going, because you're going to be below it, and on one of the other ones, I learned just to come up, get the attitude, don't wait for the flight path marker to turn on, and I usually wasn't very far off, so I didn't have to do very much, so just a little technique in stopping it there, but if in the real life, you're going to do one or the other one, I assume, once you find which one is the one you want to do, you're not going to have three different techniques here, and it's fairly easy to learn, so which ever one you have, once you start using only one, it should be very easy. Bank angle on these with all the engines working, was no problem, the lat-dir was fine, I don't think I ever had any problem with that, and heading is the same thing, gosh, it just tracks right along and no problems on it, I can't think of anything new. One, I don't know whether inceptor is in here or not, but one thing I noticed for the first time, when I started doing the small pitch tracking for the flight path marker, in particular, it's the first time I noticed the large breakout in the inceptor. I was making a lot of small corrections right about center, and for the gradient that you're working with there, that breakout was a little high, and I know you're going to do a lot of work on it, but that's kind of an aside. I didn't see it at all during the landings, but I may of had the inceptor out of the breakout, you know, the center position, or I'll call it the detent, out of the center position enough, so, it didn't...wasn't a factor. Today when I was doing the fine pitch tracking, I noticed it in also roll. Okay, we've got something here on heading, and this may be a place to put in. I'm not sure what's going on with the, there's some relationship here that apparently the flight control system is doing something that I don't understand. Are we in the engine-out here, because that's where this really played a factor. Okay, let me just add, I noticed through the engine-out, that soon after takeoff, why of course you need a heck of a lot less rudder than you did when it was on the ground, and so I would tend to have too much rudder in, and often I didn't catch it until I'd already caught the heading bug, so I was tracking pretty well, and then I looked up and said, whoops, way too much rudder, but since I was tracking, I was hesitant to pull...take the rudder out, because I thought that...then...you know, if I'm holding too much, and it's on there, as soon as I let off, it's going to split, but if I just gradually came off, it wouldn't do it, and I didn't understand that, that's a...that's a un...I almost want to say, an unairplane like thing, I've never seen that before, there's something going on there with the sideslip and track, but it was puzzling to me. Engine-out was where you noticed it ? Yeah, engine-out, because that's where I'm using so much rudder and have to take it out, it actually was true other times, I forgot what I was doing one time, and I was

just going move us over with a little bit of rudder like that, and I got the sideslip, nothing moved, and so, like I said, there's...I don't know, I don't know what...it's just a anomaly in what I'm use to seeing, that's all, it didn't, you know...knowing it, actually, it probably is, if anything less work load. In other words, you centered this thing, and if you're off a little on sideslip, ...you know...you just zero your sideslip error, you don't change your tracking ability, that's a plus, but how can that be, I don't understand that, that's a puzzle. Well, if we're going to talk about, okay, let's...that was just a thing because I saw the heading. Let me run down through this, and I'll come back and we'll talk about single engines and stuff in a bit.

**4. Ability to control airspeed during climb (autothrottle off) ?**

Did I do one of those ? Yeah, you did all the manual thrust stuff when you were chasing your velocity vector...Oh yeah, that's right. Yeah, that was nothing, oh I know why I did, because I was thinking, I wasn't working the throttle, you were, that's why I was like wait a second, so, for me it was autothrottle all the time, what the hells the difference there, just one is Lou throttle and the other is airplane throttle. Okay, yeah, there was no problem with that. The flight path vector was moving slow enough, very easy to stay with it, it was very easy.

**5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If Yes, was the task continued or abandoned ?**

Not in any of this takeoff thing, I can't remember any. No, I don't recall any PIO tendency in any of the three. No, so the answer to that's no, good.

**6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

I got ahead of myself there with the breakout thing. As far as the forces and displacements, and Sensitivities, and Pitch and Roll Harmony, I didn't really have a complaint with them, my only concern was that the breakout was kind of annoying, and more than it really hurt very much, I don't think it hurt the performance that much, but it's really a annoyingly large breakout force.

**7. During the Takeoff Rollout, were there any problems ?**

With the exception of the single engine that I'll come back and talk about, I'd say with everything working, no, I didn't see any problem at all, takeoff and rollout.

**8. During the Takeoff Rotation, were there any problems ?**

And again, with everything working, it just takes several passes to learn how much you need, is what it amounts to, something like this is, you know, not having been exposed to this aircraft at all, while this took a few passes while I bracketed what was necessary, but by the end I was feeling fairly comfortable, because I knew how fast it had to rotate, so, I would say after the initial learning curve, I didn't see any problems, but it took a fair amount to learn.

**9. Effects of winds and turbulence ?**

With everything working, sure naturally the workload went up with a strong crosswind, but I didn't see anything, and I think I was keeping things in the desired with everything working, and got to expect the work load to go up. On this crosswind, or did I catch any wing tips on the crosswind except for the side...single engine, we only did refused takeoff, oh you only did, is that right, what the heck did we do to takeoffs...we didn't do any takeoffs with...I'll be damned, okay. See this the beauty of having comments when you're doing the thing, you can remember what you just did, and not what you did this morning. Okay, well...again...I'll come back, as far as the turbulence goes, the level of turbulence is more



annoying, we have pretty fine tolerances on the some of the tracking things there, and the turbulence was almost the limit of what you had for desired, you know, in other words, it goes along, and if you didn't do anything, you just had everything dead centered, you'd just about go from stop to stop on desired with the deflections of the turbulence, and...but still I would say that the turbulence was not problem, and that just has to do with how accurately we were trying to...the task called for, that certainly didn't cause handling quality problems that I could see. Okay, now let's talk about single engine, and single engine without the...without a, what is it, 35 knot crosswind, yeah, without the 35 knot crosswind, as single engine V1 cuts go, I was quite pleased with it, I thought that it was not as nearly as hairy as I anticipated, it was fairly straight forward, the fact that it yawed fine, but I had plenty of time to bring it back. One thing that may have...when you have such a long airplane, and you're yawed very much, you are translated to the right, even though your CG may still be going down, and then when you push the nose back around straight, you then bring your body back, and so there was a tendency, especially the first couple of times I did it, to overdue that, and I'd end up bringing myself past, and then come back, so it's like one overshoot or so, I think that's something...just a...a couple of more passes, and likely wouldn't of done that anymore. So, as far as, without the crosswind, the single engine characteristics I thought were quite easily handled, and with the exception of that, I'm looking at sideslip every once in a while. I didn't see anything really to make a lot of comments on that I didn't want make my Cooper Harper ratings. Now, the other thing, though, when you start getting into the crosswind, it is...that really gets your attention, and probably the single biggest thing that go my attention was: (a) the amount of...that the airplane wanted to roll, it must have...and obviously, has a lot of dihedral effect with such a swept back wing and everything, and so, it really took a fist full of ailerons to keep it from rolling, but the thing that surprised me so much, is especially once you rotated it, how little bank angle it took to touch something, boy that is really critical, and where this showed up, was when I didn't have any wind to rotate, pitch was my primary concern. As soon as we had a crosswind, now my primary concern was, screw the heading, is one thing, keep it on the concrete, my concern was touching a structure, and boy, that makes a very, very, high gain type task, and to the point where I...as I recall this one, I gave a 8 or a 9, because I was concerned about exceeding a limitation of the airplane, and that, looking out the window, especially just did not look like much of a bank angle. I was amazed that we had touched something at that point, and apparently the clearance...once you rotate the clearance on structure, gets less, and it's really sensitive, otherwise I must have been awfully close to it a bunch of other times, and didn't realize it, and that one ... that was really tough, and it was ... one time, as soon as I rotated, I locked right onto the roll indicator, and that was fine, and the pitch went to heck, so then I went to, next time I said, well, I'm not going to let that happen again, and I watched the pitch, hawked that real carefully to make that one right, and unintentionally got the 4 or 5 degrees of bank in there, and touched the damn wing thing, so, all I'm saying is that really...somewhere along the way...going to have a problem with that, I would guess at least, I don't know, how about a guess, at least once out of ten engine outs, you're going to scrape the heck out of something, and probably more, that's going to have to be something that's...would be trained like crazy, and I'm not sure you ever would get that out of there, because it seemed to make a difference whether there was a crosswind or not, so not only is the guy absolutely shocked that one of these things quit, but on top of it he's got to remember whether he had a crosswind or not, to know which one to really concentrate on, because that's the most important, and I just don't think that's going to happen, and with the exception of the rate limiting that I saw on the...yesterday, I'd say that one, and this one are the two things that are real show stoppers, and really have to be...needs some more work somewhere, and because... illucidate which two tasks you think are show stoppers...the task, well, the one that I saw the rate limiting on, yesterday, was wing low crosswind landing, that was, and I saw the rate limiting, now no matter where you see the rate limiting, no matter what you're

doing, I mean, I happen to see it there, because I was working real hard at it, so that one, that's anything that you're going to get into that, obviously unsat., and then this one, while it's not quite as bad as the rate limiting problem, this one I can see bending medal on this, sooner or later you're likely going to do that, if nothing else changes, and...okay, anything else we got down to here, I don't recall, I know there weren't any sustained PIO's, I might have gotten, you know, one overshooter, maybe a couple overshoots, but nothing that I said, whoaaa boy, I'm in a PIO, what am I going to do here, it wasn't anything like that, I don't recall on any of those...talked about that, I could keep it on the runway, even with the crosswind engine out, I kept it on the runway okay, kept it within adequate, but I didn't think I would ever be able to get it down to desired, in any kind of practical scenario short of, where at 169, I know the engine is going to quit at 170, so I'm going to start pushing the rudder, whether you learn, and if you leave it, you know, you're not learning anything, that's why initially I mentioned that I was waiting until I saw a yaw before I went full rudder, you know, it still got adequate, but probably not a practical scenario. Okay, I covered that. I think that will do those. Okay, these will go fast, okay, now, how much more tape shouldn't be a problem. This is going to go fast.

## **Pilot D**

Takeoff and Rotation Climb Questionnaire 22 Jan 97

Okay, Pilot D on the takeoff and rotation pilot questionnaire. Looks like I've covered part of this on the takeoff and rollout, but let's press on, I'll repeat it if necessary.

### **1. Adequacy of Pitch, Roll, and Yaw Control Power ?**

For the rotation it was plenty adequate, but with perhaps exception of the crosswind with one engine out where it takes, apparently takes almost full rudder and full aileron to counter it, at the speed that we're taking off.

### **2. Predictability of Pitch, Roll, and Yaw Responses to Pilot Inputs ? Any special control techniques required ?**

Is good. I don't think there's any special control techniques required.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and/or heading ?**

I really didn't have the feeling that I was controlling pitch attitude. We're either controlling pitch attitude rate, or we're trying to control the flight path, which are both a little bit unconventional for a normal takeoff, it's giving me a little bit of problem. Flight path, ability to control and track, yet it was a little bit busy, I don't think it needs to be nearly as busy as it is for takeoff, tends to increase work load. Bank angle, slight tendency to PIO, have a loose roll mode on the aircraft. Heading, really no big problem, other than what is aggravated by the bank angle control problem.

### **4. Ability to control airspeed during climb (autothrottle off) ?**

Again, I think it's just a little bit busy on those tasks for following the climb guidance ball, it's just a little bit busier than it really needs to be.

### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If Yes, was the task continued or abandoned ?**

Yes. Yes, was the task continued. Okay, the PIO tendencies aren't really divergent PIO tendencies, it's just the fact that the business in both the roll and the flight path command are causing an increase work load. You sit there and you oscillate about the... you have a

tendency to sit there and oscillate about the commanded value, and so the fix for it, is to back off your gain a little bit, I try to stabilize it by using pitch when possible.

**6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Okay, force and displacement on the pitch roll inceptor are not too bad. Rudder pedal is not too bad. Sensitivities, you know, I don't have any complaints there. Pitch/roll harmony, don't have any complaints.

**7. During the Takeoff Rollout, were there any problems ?**

No.

**8. During the Takeoff Rotation, were there any problems ?**

I think the only really problem area I had there was with the crosswind and engine out, as I've discussed previously, that you're in this critical condition close to the runway for extended periods, and have a tendency to get both tail and/or wing tip tailstrikes.

**9. Effects of winds and turbulence ?**

Wind has a big effect with the engine out crosswind. Turbulence didn't seem to be a big factor.

**10. Summary - Good/Bad features ?**

Okay, summary on the good features, bad features I don't like, I was having a tough time following the pitch rate command. Maybe it's a good idea that I... either the performance criteria is too tight, or it needs some tail and... I'm just... really can't follow that thing as desired. Other bad features, I think, are the transition between the use of the waterline for the reference and the flight path for the reference, where you're doing the tight tracking task on the waterline first, and then switching to a tight tracking task on the flight path. A little bit of a problem there, and I'm not sure that we need to have those two tight tracking tasks back to back there for the takeoff.

**Pilot E**

Takeoff and Rotation Climb Questionnaire. 07 Jan 97

**1. Adequacy of Pitch, Roll, and Yaw Control Power ?**

I never reached any limits, any pilot limits, I've never went to any side stick limits or rudder limits so I think as far as a pilot I thought I had pretty in control power in all three axis.

**2. Predictability of Pitch, Roll, and Yaw Responses to Pilot Inputs ? Any special control techniques required ?**

I thought it was very predictable all along except for the crosswind 35-knot engine out crosswind takeoff where you would get an uncommanded roll into the wind once you broke ground because you were holding side stick into the wind, and that was pretty abrupt unless it was uncommanded, I'm obviously commanding it, but I don't know I'm commanding it because I am trying to maintain wings level during the rotation and then as soon as you break ground the thing seems to really want to roll in the direction that you've commanded, so it's an abrupt, unpredictable roll-off and that's on the 35-knot engine out crosswind. Any special control techniques ? I try to anticipate that, but you just don't know when it is going to break ground and therefore I didn't handle it very well.

**3. Ability to control and track pitch attitude, flight path, bank angle, and/or heading ?**

Once I got the first task figured out what I was suppose to do, it worked out fine... Flight Path was no problems, Bank Angle overall, no problems, and Heading... really didn't worry about a heading on any of these tasks, so I won't comment on that.

**4. Ability to control airspeed during climb (autothrottle off) ?**

On the task that I did, I never really manipulated throttles it was all just very by the numbers type take-off profiles, so I have no deferential comment on that.

**5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If Yes, was the task continued or abandoned ?**

The only PIO tendencies I had was when I had misinterpreted the 2010 card and thought I had to capture 10 degrees pitch attitude and when I tried to aggressively capture it I did get into a Pitch PIO. Of course, there are lots of things going on there, I'm transitioning control laws, I am trying to use a flight path to control law to capture an attitude and there are some other things that transitions are going on there as you break ground, but at any rate that's the only PIO and that was an incorrect task accomplishment that I did, so that really doesn't apply to any of the cards. It was just something I noted. So really there was no yes answer to that based on the actual descriptions of the tasks and the cards.

**6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Force & displacement was fine, Sensitivity was fine, Harmony was excellent.

**7. During the Takeoff Rollout, were there any problems ?**

Well, not really except for the crosswind where you did have to work to maintain centerline tracking.

**8. During the Takeoff Rotation, were there any problems ?**

During the 35-knot crosswind engine out, there were problems in that you had to be careful that you didn't over bank the aircraft, and there were some kind of uncommanded roll inputs that we talked about earlier. They were commanded in the sense that, that I had the inceptor over, but they were unpredictable or undesired and therefore not commanded. I didn't intend to do that

**9. Effects of winds and turbulence ?**

I've pretty much discussed that already.

**10. Summary - Good/Bad features ?**

The bad features are the 35-knot crosswind engine out, there is a difficulty in maintaining a wings level attitude and you can if you are not careful overcontrol the bank during that brief mode when you are getting away from the ground. Good features, flight path command law, the gamma dot V, works fine throughout all these tasks. There is really no problem except for the ones already mentioned.

**Pilot F**

Takeoff and Rotation Climb Questionnaire. 23 Jan 97

**1. Adequacy of Pitch, Roll, and Yaw Control Power ?**

The same, just the note that I made with the crosswind and the engine failure, during and right after rotation, you might go back and look at the amount of rudder that was in there. Of course you can look at all the tapes and see if there is anything... any control surfaces close to saturation.

## **2. Predictability of Pitch, Roll, and Yaw Responses to Pilot Inputs ? Any special control techniques required ?**

If you let the... one thing that I didn't really like very much, was this transition in rudder control law, between on the runway and in flight, and I guess it takes about 10 seconds right after rotation, and I thought it made it difficult to track, because I'm having to readjust the rudder pedals, and the control laws changing at the same time, and at the same time, I'm also trying to pick up and track laterally the flight director cue, and right after rotation, that's kind of a busy time, and I'm trying to get everything squared away, and in addition to that, I'm having the control laws change over this decrement of time, and I think we really need to look at that real careful. If you release the rudder pedals, or make a large input, that causes you a... at least slightly down the line, after some very small time decrement, a lateral input, that you have to correct for, and you can get some roll bobbles at that point, anyway, it's annoying to say the least, and I think there's got to be a more elegant way to get through that, that particular phase, and also, again, I think we need to look at the beta cue, lateral acceleration cue, the use of that on the ground and in flight, and square that away a little bit better too. I think that some better cueing, and also the cue being lower around... the pilot being able to pick up the yaw or the lateral acceleration cue, either one in his field of regard, rather than having to raise his eyes up to cross-check at the top of the display, would also be helpful. As far as predictability goes, I didn't have any real problems with the pitch, I think overall the airplane could be a little bit crisper. The yaw response was really... what we just discussed was really my concern, and that does enter into the roll response, like I said, the roll, as I have mentioned before, when you put an input in, if you want to stop the roll, or the pitch attitude somewhere, you almost have to reverse the stick, which kind of makes it pop, makes the airplane pop to a stop, I'd prefer a little bit crisper roll control too.

## **3. Ability to control and track pitch attitude, flight path, bank angle, and/or heading ?**

I think we've discussed most of the issues that... already as far as controlling and tracking these things. The biggest thing is the yaw, and I noticed that mostly with the crosswind and the engine failure, again, no really new comments there except for my taste the airplane could be a little bit crisper. I'd prefer a crisper airplane and let the pilot back off on his gains for passenger comfort, and I think that... also some of the roll, well, we've already talked about the pitch and the roll coupling together with the way the stick is set in the cockpit and I also think the stick could be to maybe friction and breakout band wise a little bit better to and that may improve some of these things that we're seeing.

## **4. Ability to control airspeed during climb (autothrottle off) ?**

Really, most of everything that we've been doing, we've been doing to pitch attitudes, not really trying to control airspeed with pitch, so I don't know that I have a good answer for this. I didn't see anything particularly during the takeoff profiles we did with respect to this that really causes a problem, except for, there are sometimes when, actually for... I don't know, a second or two, which seems like a long time to me, you'll see the commanded flight path vector in the actual flight path vector split on some of these profiles, and you know, we talked about this yesterday, it was one of the questions, and you know, flight path vector, the actual one is still a performance parameter... to a commanded one. I'm concerned somewhat that some of the pilots are going to, really that commanded one is... command and actual, except for when there is a split. I'm wondering if there might be a need for separate

symbology. Anyway, I guess what I really want to state here is, is with manual throttles in the gamma control, I think we need to look at that more in detail too, because now you become gamma on pitch only, and I'm not sure if there aren't some time delays in there, but I guess in my mind if we're going to use a gamma control airplane, when I turn the autothrottles off, it's no longer controlling to the window, or the selected airspeed, but it seems to me like it should still, my throttle should basically give me speed down the flight path or airspeed control, but my engines still... and pitch control should still work together to control gamma. Anyway, I think that the manual throttles and with the gamma control, I think needs to be looked at and considered a little bit more carefully.

**5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If Yes, was the task continued or abandoned ?**

I think with a really tight gain, when you're trying to make very... track a roll attitude very closely. I do think there's maybe a slight tendency that pilot can couple up, there's definitely a tendency to overcontrol, and I would equate it to a predictability problem, the coasting to the stop... and I can't really get the airplane to respond to a crispy... crisply, and I also have problems making very small precise inputs, and so the overcontrolling, I think in some cases, is the pilot didn't back off on his gain. He could couple up and maybe, maybe starting... start towards getting a PIO, I think you can quickly arrest that by backing off on his gain, but I do think that the pitch axis needs a little bit more work in that area.

**6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

I do think the stick could be tuned a little bit better. I think the sensitivity issue... I think for tracking very small roll angles, there may be a little bit of a control harmony and sensitivity issue, it could... part of it could be equated to friction and breakout, but I do think that it takes a lot of effort to track a small bank angle precisely. If I allow it... you know if I just let go of the stick, and I don't perturb in roll when I'm making pitch inputs, it'll pretty much hold a roll attitude, but if I want to correct it by 1 degree or so, if I want to do that fairly quickly, it's kind of hard to do, if I take... if I'm very patient with doing it, then I can do it, but anyway it... I think it could be better.

**7. During the Takeoff Rollout, were there any problems ?**

And I don't think during the rollout we saw any problems except for the one noted already about the... in the crosswind the displaced beta cue is kind of a detractor, and we probably should look at the low visibility stuff, and then a little bit of an angle off, which we talked about probably due to skid angle on the tires, to maintain centerline on the crosswind.

**8. During the Takeoff Rotation, were there any problems ?**

That's still difficult to track the rotation bars real precisely and get desired performance. You can get adequately fairly easily. The... again the, going through the rudder pedal control law transition, is... I didn't really like the way that worked that well, and I think that could use some work, and also if you let some yaw rates develop, you can get into a situation where you get some of those lateral inputs or lateral roll offs, you know, that you have to correct for.

**9. Effects of winds and turbulence ?**

Effects of Wind/Turbulence. We've kind of really already covered the wind, and the... or... in all these questions.

**10. Summary - Good/Bad features ?**

I think we've pretty much covered too.

## **Stall/Turning Pilot Questionnaire**

### **Pilot A**

Stall/Turning Pilot Questionnaire 13 Jan 97

#### **1. Adequacy of pitch and roll control power ?**

There seemed to be plenty ... plenty of each, yes, the... in the stalls, the harmony is disrupted, because of the pitch protection from that high angle of attack protection, the forces go high, while the aileron forces remain low, and that creates some perturbations in roll.

#### **2. Predictability of Pitch and Roll Response to Pilot Inputs ? Any special control techniques required ?**

Is quite predictable and the only special technique really required would be to pay attention to the forces light aileron versus heavy pitch forces.

#### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Pitch Attitude, does ... could be easily controlled as well as Flight Path, and Bank Angle, and Heading in the recovery as the pitch forces were reduced the ... it was easier to control bank angle, although, you can control it within limits, there is some little oscillation, plus or minus 5 degrees around the target, because of the control harmony change as you went into speed, to lower speeds. It would be helpful to have markings on the angle of attack indicator, and also like desired approach angle of attack, and precautionary angle of attack, and also red line or stick shaker.

#### **4. Ability to Control Airspeed during Recovery ?**

Was fine.

#### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ?**

I say there was slight PIO tendency in roll because of the unwanted roll inputs, and the heavy pitch forces, it was a fairly minor item. Nothing divergent.

#### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

The Pitch and Roll Inceptor Characteristics, I mentioned the Force & Displacement is probably adequate for ... in desirable for deterrent...as a pilot deterrent for low speed operation, like I say, the aileron sensitivity seems a little high when the ... when the pitch forces go up.

#### **7. Effects of the Wind/Turbulence ?**

Wind and Turbulence was not a real factor in the tasks, and I'd say that the ... perhaps some increase in the aileron forces would ... would be appropriate when you're in low speed protection, with higher elevator forces might be appropriate, have higher aileron, slightly higher aileron forces.

#### **8. Summary - Good/Bad features ?**

Some of the Good features here is the protection, angle of attack protection seemed to be good, although alpha ... a better alpha indication with scales and color coding as to proper ranges of operation, and the limits ... alpha limits would be, I think would be mandatory for this airplane. For this task it would have been good to have the G meter within normal

viewing, in a position where you could view it in a normal seated position, it was out of view above the top of what you call a window, you had to duck your head down to see the G meter. So, that's all the comments I have on that.

## **Pilot B**

Stall/Turning Stall Pilot Questionnaire 06 Jan 97

### **1. Adequacy of pitch and roll control power ?**

Adequacy of pitch and roll control power was adequate. I don't recall ever reaching the stops.

### **2. Predictability of Pitch and Roll Response to Pilot Inputs ? Any special control techniques required ?**

Pitch and roll response relatively predictable in the recovery there's times where you just kinda have to let directional axis find its own way for awhile, rather than putting inputs in. That's really the only special control technique. Other than that, I found it relatively predictable in pitch and roll..with one exception, I guess I should mention, and that's a minor tendency for roll PIO. That seemed fairly consistent it was in conjunction with moderate to large longitudinal inputs and I attributed it to control inceptor cross coupling. There, since the axis of the control inceptor is aligned with the fuselage and not with my arm, I'm inadvertently putting roll inputs in in conjunction with the large longitudinally ones, and its causing me to have to fight it. I found on pitch down, that I can control that a little bit by using the heel of my hand instead of my entire hand to push the stick down, trying to avoid those lateral inputs. That seemed to help a bit, but there is a pronounced cross coupling tendency. I believe the control pitch attitude, you're fighting the....I was fighting the pitch axis a little bit in terms of hunting for the right attitude and the right force after the stall protection control laws kicked in. But again, it wasn't inordinate and it wasn't enough to consistently kick it into level 2.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Flight path control was somewhat linked to that since I'm really controlling flight path at that point, and the same comments will apply. Bank angle control with exception of the PIO tendencies that talked about was okay within 5 degrees in general. Heading control, again, was relatively good, the only..the problems I got in conjunction with the longitudinal inputs applied both to turning stalls and to where you're controlling angle of bank and to..straight stalls where you're controlling a combination of heading and angle of bank.

### **4. Ability to Control Airspeed during Recovery ?**

I wasn't really trying to control airspeed during the recovery, other than to have an increase, but, there was no control. I wasn't controlling a rate during the recovery so I think that's kinda N/A.

### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ? If yes, was the task continued or abandoned ?**

I talked about PIO in roll .....and what I did was continue the task with reduced pilot gain. I tried to back off a little bit. I did not have to abandon the task to prevent divergence.

### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**



Force and displacement characteristics seemed about right for the control inceptor. I did not have a repeat this afternoon of the problems I had this morning. Sensitivity is ...yeah, its kinda hard to call sensitivity okay when I'm having problems with precise control and angle of bank. But, I think that due to cross coupling , predominately. When I'm controlling lateral axis only, I don't seem to have the same problems. Pitch and roll harmony in terms of mechanical characteristics and sensitivity I think are okay...again, it would be nice if you have the same sort of latch in angular bank control that you have in flight path control with the gamma control law, such that a lack of input in turbulence would pretty much give you straight level flight. Right now that's not the case, you gotta make constant ...relatively constant lateral inputs. And that was due to the wind and turbulence which was the next or turbulence which is the next question.

## **7. Effects of the Wind/Turbulence ?**

Wind, I don't think we had a cross-wind in any of these, it was just turbulence. And it wouldn't have affected me anyway because I'm controlling the airplane with respect to the ground.

## **8. Summary - Good/Bad features ?**

So in summary the predominately complaint I have is the cross-coupling and the control inceptor. And the rest of it look pretty consistently good.

(BACKGROUND: Do you think that could be fixed by tuning the inceptor ?

) Possibly, I don't know. Its hard to extrapolate on that one. You might...canting the axis might help a little bit, for me, but you might want to run it...it might hurt other pilots who may not...who may expect to have to pull to the left. I'm consistently, when I pull back, I'm consistently putting a small right input. And when I push forward, I'm consistently putting a small left input in.

(BACKGROUND VOICES) Yeah, It should probably be mentioned that not too long ago I participated in that Ames 2, and we did look at a variety control inceptors and I did have problems with cross-coupling there. I had not complained about it significantly to my knowledge in the past but maybe I am getting enough experience now with the system that I'm seeing small things like that. It's not ...you wouldn't call them unsatisfactory. And, its very low amplitude PIO. Its not anything pronounced on the order of one degree or so. But, its there. That's it.

## **Pilot C**

Stall/Turning Pilot Questionnaire 06 Jan 97

### **1. Adequacy of pitch and roll control power ?**

Yeah, it was there, it takes a lot to get that 21, boy, you can tell something is fighting you like crazy, because it takes a lot of pressure, and to the point where...you know...I don't think anybody is accidental going to pull that much pressure, with as little forces as you need to fly this normally, in order to get it and maintain it up anywhere near that 21, you're pulling so hard, I can't imagine getting there, not realizing, boy, something is really wrong, why am I doing this, so, that was a good indication there. Now here, again, the task today was to keep it within 5 degrees of bank angle, and all I could say is, that was fairly easy, that's a lot different than trying to get to 5 degrees, or you know, either roll in, or roll out, that's when...it's like balance, some of these things are like balancing a stick, as long as you keep it real small, it's fairly easy, if you get it very big, then you start seeing problems, but for the task that I had of just maintaining wings level, it was easy, no problem.

## **2. Predictability of Pitch and Roll Response to Pilot Inputs ? Any special control techniques required ?**

Predictability, the toughest thing, when you start getting a real high alpha, you can chase that karat all over the place, but I never felt like I was completely out of control and just overshot a few times.

## **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Pitch Attitude and Flight Path, did pretty much what I wanted to. You tend to overshoot as you chase it like I said, but...and I'm talking about at the 21 degrees now. Bank angle, I never had a problem with the straight ahead ones, or the turning ones that I just had to roll out. The technique I was using, it's the same one you use in any other airplane, as you get off the backpressure, and then roll, the straight ahead ones I could just, and the heavyweight one too, I think...there was...I could just get off the backpressure, recovered itself, with the lighter weight ones, and probably I'd have to see, gee I don't remember, but at least the lighter weight ones I had to push to kind of hurry it along, it wasn't doing it quite as fast as I liked, but minimal, minimal, hardly worth talking about.

## **4. Ability to Control Airspeed during Recovery ?**

Ability to Control Airspeed during the recovery ? Wasn't trying to control, I was just trying to get it going in the right direction, of course it did.

## **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ?**

Any PIO tendencies in the pitch or roll axis, okay, what I said holds for all the things I saw, and this, the PIO tendency here, is the only one that I...made a difference whether the engine out, the engine was out or not, and on this one, if I was real smooth and slow, I could get...I could bring it right back, and get the desired performance, but if I hurried it real fast, and got that yaw going, then I would get into a PIO that...it would damp out, but it was several oscillations that I was fighting. It seems like once the sideslip got away, you're in for a ride, because to get the thing finally settled down, it's going to take a little bit of time, and I noticed that when I rolled it fast, I was trying to keep the sideslip zero in the turn, so I was holding a little bit, and then when I would roll fast, I tried just freezing it once, and then trying to...trying to stay ahead and keep the sideslip centered, and that's when I really noticed this anomaly with sideslip indication, I don't know what to say about it, but there I did see a PIO, and even though, I might have lucked out and kept the oscillations within desired, we at [my organization] at least have a thing, if you have a PIO, that's never desired, so, that automatically puts it into a 5, I might have dipped into the adequate on the bank angle anyway, but with the PIO in there...certainly not desired characteristic.

## **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Inceptor characteristic, I mentioned the forces were nice and high, as I would expect them, and yet it didn't seem to effect my ability to roll as fast as I wanted to, even when I was holding the force, not much else on that, ...

## **7. Effects of the Wind/Turbulence ?**

...and there's not wind and turbulence on the stall, and turning stall, unobserved I guess, and...

## **8. Summary - Good/Bad features ?**

...in general, very, very benign from what I've heard or war stories from previously, it's a vast improvement, and gee these were, you know, as benign stall characteristics as you could ask for, with the exception of that one with the engine out, and a rapid roll recovery, other than that, they were all pretty easy, not difficult. That ought to do it. {Emergency Descent comments} Do you think you'd like to add on the emergency descent ? No, that's...I'll be surprised if you can ever get that to be quick enough, because we were twice the time above 25, and I...you know...as far as I could tell, I was going down about as fast, I might have improved it by 25 percent, but that still wouldn't meet your criteria, you're going to end up with something else on that, I'm sure, but as far as the display itself goes, that's not a bad display, in fact, considering that you had that step in there, it was a big help, because I would hate to try to say okay, at this altitude, okay, what...I should be at such and such airspeed, and go on, I mean, it did take that away, and the predictor helped, there's probably...with a little work, somebody is going to be able to come up with a pretty cook book style recovery, in other words, do this, do this, do this, and then control the predictor up and down with backpressure, something like that, there's probably some magic technique in there that would help it, and in a case like that, if you do have one that works, it's not a bad idea, because this a pretty hairy situation, if you're at 50,000 ft, where your blood is going to boil, and you just lost your pressurization, you know, the odds of your mind being really settled down, and saying okay, what do I need to do now, it's nice to have something that you can at least get started, you know, get the nose down, get doing this, don't go over this bank angle, put this limit on, okay, now you get started, all right, now you've got time to say, okay now, how do I modify what I'm doing to make it better, but to get the initial stuff going, it's almost like bold face procedures, you're rote almost just to get you started, it's a good idea. Do you find having to hold sidestick override the lateral system roll limit ? That's a...that's a good point, that would have been nice, I think if I could have eliminated that, yeah, some kind of an override, I hadn't thought about that, that's a good point, yeah, that was a distraction after a while, only because you're holding it for so darn long, my god. If it was on the left, it would have been harder ? Good point, probably...yeah, but that's...sure...that's why I kept...I put it at 45 and I'd look around and start tracking things, and I've got to say, geeze, I'm back at 35 or 40, I have to put it back in, that's why, yeah, good point, I hadn't thought of that, but now that you bring it up, you're right. You'd recommend a defeat on that ? Yeah, yeah...some kind of a thing that would've...that would've improved it, yeah, it sure would.

## **Pilot D**

Stall/Turning Stall Pilot Questionnaire 22 Jan 97

### **1. Adequacy of pitch and roll control power ?**

I think that was the overwriting impression I got from the stall serious, was that we had plenty of pitch control power, and in fact, you know, the initial recovery is essentially to just let go of the stick in the aircraft, the stall... you know, the envelope protection recovers it at a very nice rate.

### **2. Predictability of Pitch and Roll Response to Pilot Inputs ? Any special control techniques required ?**

It's good, maybe tendency to bobble particularly in roll, so you have to keep your gains low, I think it would be a special control technique.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Ability to Control Pitch Attitude is reasonable. Flight path angle was not applicable. Bank angle tendency to PIO there. Heading, not really a factor.

#### **4. Ability to Control Airspeed during Recovery ?**

N/A.

#### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ?**

Yes, and tended to, in both the pitch and the roll, particularly roll, and tended to compensate by just using a reduced gain, just taking it very slow and easy, which is appropriate for the maneuver anyway.

#### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Pitch/Roll Inceptor Characteristics, all reasonable. Not saying they're optimum, but they were all reasonable and not a factor in the performance, I didn't feel.

#### **7. Effects of the Wind/Turbulence ?**

Wind and Turbulence, we didn't have any wind. Turbulence apparently only had light. It definitely wasn't a factor.

#### **8. Summary - Good/Bad features ?**

Summary Good features, the aircraft is very nice. Recovery characteristics as far as the pitch authority to get the airplane back into the envelope. Bad features are the tendency to PIO a little bit, particularly in roll.

### **Pilot E**

Stall/Turning Stall Pilot Questionnaire 07 Jan 97

#### **1. Adequacy of pitch and roll control power ?**

I though there was adequate both pitch and roll. A couple times I went to the stops just to see where I could get and I felt that the recovery rates were adequate both time. Interestingly that I got, I maxed out the elevators by not going to the stops, so going to the stops a couple times, I was actually, I had already saturated the controls, but I didn't feel like I needed a whole lot more authority, so I thought it was okay, but the fact that you can saturate the controls with just slightly forward stick during the recovery, may indicate that there might be some trimming that might need to be done in the control law where a pilot will still be able to command more authority with forward stick. You don't want to just go slightly forward of neutral and saturate your flight controls and have a whole bunch of wasted stick, inceptor movement, but I think it's fine, I wouldn't... don't think you need to adjust anything.

#### **2. Predictability of Pitch and Roll Response to Pilot Inputs ? Any special control techniques required ?**

Pitch was very predictable. Roll was a little PIO prone in several different areas. I noticed around 17 or 18 degrees angle attack on the straight ahead stall recoveries, I occasionally got a little roll PIO, and also in some of the turning stalls, which would recover, especially with power on, which will recover more rapidly, I would get some roll PIO down around 7 degrees alpha at the low end, so in that case the roll response wasn't as crisp as I would like, also in the tuning stalls, trying to hold 30 degrees angle in bank was hard especially with the engine out, and it shouldn't be that hard, the control law should allow you to be able to pretty much hold an angle of bank without having to work so hard. As far as any special control techniques, I was just fighting to try and hold the angle of bank or to keep from getting PIO. I did find that if I used a more..., on the turning star recoveries, if I used a less aggressive correction to wings level from the 30 degrees angle of bank, it would not tend to

PIO, but if I used a very aggressive roll recovery to wings level, I would PIO, so obviously I would tend to not be quite as aggressive not to get the roll PIO. The roll PIO is probably plus or minus 1 or 2 degrees and probably around 2 hertz.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

For the stalls, I don't know if that's a really easy one to answer because I was trying to close on a speed deceleration rate and not necessarily a pitch attitude, and what had to happen was you had to use the pitch attitude to close on the deceleration karat flying a flight path control, control law, so we're not really finding the control law as it's optimized to be flown, but it's.... the pitch attitude is still easy to control, but on that task I am trying to close with deceleration karat at times especially on the power on ones I seem to have a little bit harder time closing on the 1 degree per second deceleration. Flight path, we didn't really ever close on the flight path on any of the stalls, so there is really no comment there, it was all basically attitude type flying. Bank angle, I have already mentioned it was difficult to hold 30 degrees angle of bank, also I would have to hold rudder in, and when I would roll over to the 30 degrees angle of bank I would get a side slip, uncommanded side slip that would required constant rudder pressure to rudder pedal input, to negate, so that shouldn't happen either, we need some type of an aileron rudder interconnect type function to null out the side slip when you roll into an angle of bank. And the interesting thing is when you roll into the angle of bank, if you do nothing, the side slip stays there, in fact the side slip will stay there forever. Heading, we really didn't close on heading at all, so it's not a factor in this evaluation, so flight path and heading we really never tried to close on.

### **4. Ability to Control Airspeed during Recovery ?**

Again this question is kind of non-applicable, basically I am just trying to push the nose over to some, indeterminant body angle and let the aircraft recover, so due to recovery, you're not really trying to control airspeed or you are not able to accurately close on that, so that's not really applicable, I don't think.

### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ?**

Yes in Roll, No in Pitch. If yes was the task continued, or abandoned ? There is never a question being diversioned, there were very minor roll PIO's, just kind of nuisance, and basically if you reduce the pilot gain, you will exit the PIO.

### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Force & displacement ? Fine Sensitivity ? Fine Pitch/Roll Harmony ? Fine. No problems on any of those. Very nice inceptor characteristics in my opinion.

### **7. Effects of the Wind/Turbulence ?**

No effects on these tasks. If the turbulence was making the speed stability a little bit worse, I was aware of it, perhaps it was, there really... because of the nature of the task where you are really kind of high gain trying to enclose on the deceleration karat, I don't know whether the turbulence was exasturbating that or not.

### **8. Summary - Good/Bad features ?**

I think it stalls pretty nice, or I think it approaches the stall very nicely... approaches the high angle of attack condition. A couple times I released the stick and let it recover on its own and it always seemed to want to recover on its own so there is no tendency to release the stick and have it want to go into a higher stall condition, or higher angle of attack. Diversely, at times I went full stick motion, no deceptor, was very aggressive to the stop, and

I got no ill effects, there was no tendency to have a alpha spike, or something like that. So basically, you could either, you could... recover from doing nothing, just releasing the stick to go in full force stick aggressively and you still got a recovery. The bad features we talked about the roll PIO, the occasional roll PIO, and the difficulty in holding the angle of bank, and also the speed stability when you are trying to get the higher angle of the attack, the Gamma Dot V doesn't seem to want to make it easy to close on a 1 degree per second deceleration. That's all the comments to those questions.

## **Pilot F**

Stall/Turning Stall Pilot Questionnaire 23 Jan 97

### **1. Adequacy of pitch and roll control power ?**

I think it's fine, there was one issue that came up, and that was about how much pitch rate could be initially generated at, right at the stall, and I think using forward stick we could generate about 3.4 or 3.5 in the condition that we looked at. I would recommend that, I guess the Milspec says 4 degrees per second squared as a minimum, I think this was something that probably should be looked at in the TIFS, so that you get some tactile feedback too, you know, there's not the... it's not a real airplane, so, it doesn't quite have the urgency in the simulator, than it does in a real airplane, and also the pilot doesn't get a lot of the tactile feedback that he does in a real airplane as far as sensation of G and that, and I think that probably this should be continued to be scrutinized, and probably looked at in the TIFS also, for what it's worth.

### **2. Predictability of Pitch and Roll Response to Pilot Inputs ? Any special control techniques required ?**

Again, a little bit of a tendency to couple roll inputs with pitch, and the same thing that we talked about pitch, or I mean roll tracking all along. If I want to track plus or minus two degrees, and I'm very patient, I can do that, if I want to really hold it right on the roll attitude, and I'm pretty aggressive with the tracking, or trying to track that I can get some... I can see some over controlling and the technique is just to back off on the gain a little bit.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

During the recovery you do go through at 15 degrees where you have transition from releasing back pressure to a push, I didn't really think that was a big deal. We've already really kind of talked about the roll phenomenon.

### **4. Ability to Control Airspeed during Recovery ?**

We didn't really... that wasn't really a metric that we tried to control to, we basically were just flying AOA throughout this maneuver, so.

### **5. Were there any PIO tendencies in the Speed, Pitch, or Roll Axis ?**

And again, I'll make the same comment about the roll, you definitely can overcontrol on roll, if you back off on your gain a little bit, you'll stop doing that. I'm a little bit hesitant to say that it's a PIO tendency, but it is leaning towards that direction of slight PIO.

### **6. Pitch/roll inceptor and rudder pedal characteristics: force and displacement, sensitivity, and pitch/roll harmony ?**

Nothing that is basically the same as we discussed previously on the previous question.

### **7. Effects of the Wind/Turbulence ?**

I didn't really see anything significant there.

**8. Summary - Good/Bad features ?**

I think we've kind of covered that.

## **Climb/Cruise/Descent Pilot Questionnaire**

### **Pilot A**

Climb/Cruise/Descent Pilot Questionnaire 15 Jan 97

#### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

There's plenty of pitch and roll control power, that is not a problem.

#### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

There is...in some of the very precise pitch control tasks where precise vertical speed is required, it's...requires some very fine touch on the pitch attitude, and which requires scanning, the pitch, or the flight path vector symbol on the head up display, and sharing that with a scan on the altimeter, and vertical speed indicator head down, because the...often times the display for vertical speed on a head up display is too coarse, and the altimeter often times is...seems to be quite difficult to read, especially very near the target altitude...seems.

#### **3. Ability to Control and Track: flight path, bank angle, heading ?**

That is affected by the head up display to a large extent, most of the problems encountered in these controls, in these tasks were based on available information for a control input, rather than the control itself. A vernier input on the flight path control, blip it to the nearest tenth of a degree, or less might be appropriate, and along with the digit rolling... digits on vertical path information, flight path angle to the nearest tenth, or perhaps hundreds of degree for supersonic flight, and combining that with a blipping a trim button or would give you better tracking. Bank angle, the ability to control and track bank angle, that would have been approved by, could be improved by a track hold feature, of which would allow the track to be held once the...essentially at wings level condition existed for a reasonable wings level, was existed for a certain period of time, the same thing goes for the vertical axis and altitude hold, function where basically zero vertical speed was held for a certain time period, then altitude hold function could be invoked until the pilot directs otherwise, the track hold function would help the heading a little bit. One of the things that seemed to be apparent in this simulation was, the sidestick detent for roll, seemed to be light compared to the forces on pitch and roll, in other words, it was fairly easy to get out of the detent and command a...some kind of roll input, and which causes small heading change, and so, your attention is diverted to controlling roll angles, a fair amount of your attention is diverted to that. That could be improved upon.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

[This] didn't seem to be a problem in spite of the large amount of friction in the throttles, accel-decel cue seemed to be working, essentially, effectively, except...perhaps when large vertical speeds were involved, then it seemed to not work very good. The high rates of descents, 4000 ft a minute, the...holding...was it holding airspeed, I think, it was off, and so that, you can still hold airspeed, but you just had to disregard the accel-decel cue on the HUD at times.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

For speed, no, I don't think there were, Pitch, can't say that there were necessarily... there were overshoots and undershoots of desired vertical speed, but I wouldn't really call them a



PIO, same thing with roll, slight roll deviations that were undesirable, then again, I wouldn't call them a PIO, so I guess the answer to that question is no.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

I think I touched upon the fact that when heavy... the forces are, and under some conditions are, relatively heavier for pitch, and when you are requiring fine tuning of roll, the detent coming out of the center detent in roll seems to be very minimal, and it's fairly easy, at least it was easy for me to get a roll input, when I really didn't want it. I think it was because the lower... the combination of forces of pitch, pitch force being somewhat high, slightly high, and the roll force being high, but the detent being quite low, I don't think, I had a tendency to fly with the left wing down, I'm not sure whether it was the ergonomics of the sidestick, or whether it was just a display where we had an asymmetry in the... a fact that we had airspeed displayed on one side, and nothing on the right side of the... on occasion, on the right side of the flight path vector, might have been a visual thing or it could have been ergonomics, so I had to fight consciously to keep from doing that. I think the lower... what appeared to be a lower detent breakout force for roll, seemed to be effecting that. Pitch and Roll Harmony seemed reasonable.

#### **7. Effects of the Wind/Turbulence ?**

It seemed as though you can fly hands off in some of the vertical speed tasks, and see a variation in the pitch, in the flight path vector and the airspeed... and vertical speed, so you had to constantly, be fine tuning that particular aspect of it to stay within tolerance.

#### **8. Summary - Good/Bad features ?**

Some of the Good and Bad features. The good features are the... I like the ability to see the margins you have on the inlet unstarts, that seemed to be pretty effective in avoiding an unstart, and I think you need that kind of a cue, and they also need a good... good G, well, if you're doing simulations, you need the G more than you do, if you're really flying the airplane you can feel the G's, and you restrict yourself to something that's... the airline passenger would not... would want to... would feel good about, or would not alarm a passenger, so, you would automatically restrict a lot of your inputs based on the seat of the pants feel, but for simulation, it might be good to have a G meter, it probably displayed what you did have, but I'm not sure that the vertical tape G meter was the best display in the world. I can say I mentioned as a bad feature, I think... I suspect that the detent for roll is just a little weak, and perhaps that was letting me get out of the detent when I didn't want to. Pitch detent seemed to be fine. The display features, the vertical tape features, trying to hold altitude, interpret very small altitude deviations on the altitude vertical tape on the HUD, is very difficult, and also the resolution of the vertical speed, seemed to be lacking and would be good to have digital vertical speed displayed at the top and bottom, and/or bottom of the vertical speed indicator to help read that out. The displays they used for the descent, the profile, the normal descent, and the emergency descents, they were usable tools, but for the most part, they would be somewhat strange to most pilots, and one of things that perhaps would be a good, to do, would be to look at pilot performance with an airspeed indicator, that would be equivalent for what we have on most airplanes today, a Mach indicator with a programmed barber pole, and a clacker, so that you can see immediately and exactly how much margin you had, some indication of... some knowledge, some prior knowledge, or perhaps maybe a indication, on the altimeter of the knee points, where you go from a constant airspeed, a variable airspeed, variable keys to, constant keys barber pole, would be of value to kind of cue the pilot in, but, hey, you're coming up on a knee here, you need to be alert and watch the airspeed, because you could overshoot, or undershoot. I think that's all the comments I have, the rest of them are all made as I went along.

[Not sure why, but the pilot answered the same questions again]

**1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

There's plenty of control power, both in pitch and roll, however, there was an observed tendency at high altitude heavyweight to... began to touch the boundaries of PIO rolling out aggressively from turns, because of the time delay involved in the control response, and the tendency to overshoot the desired control, or desired bank angle. There seems to be a large amount of overshoot, 10-20 degrees on roll at high altitudes heavyweight, high speed, so, less apparent and not a problem down at low altitudes, intermediate altitudes and as you get to lower, and lower altitudes, it becomes less of a problem, in the mid altitudes it's not quite as noticeable. At 64,000 ft, it seems more apparent. That reduced the Cooper Harper ratings in terms of roll control, and high altitudes. Light... high altitudes, lightweights, seemed to be slightly less apparent, and not as much of a problem.

**2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

In terms of predictability, pitch was always predictable, however, the roll response was somewhat unpredictable in terms of, at high altitude, as was said before, the large amount of anticipation that had to be made in terms of rolling out on a particular bank angle, you actually have to stop the roll with opposite input, if you want to precisely roll out. The very lower altitudes, 3 or 4, or 5 degrees at the most bank... coasting when you center the detent, was noted, that's sort of normal.

**3. Ability to Control and Track: flight path, bank angle, heading ?**

Was good, and with the exception that... again, the comment... suggestion is made that a submode of longitudinal control, which could be an altitude hold, when you're maintaining very close to zero, very close to zero vertical speed, in addition, bank angle, when you're close to zero bank, in constant track would be, a feature would be... would be good when the stick is in the detent. Bank angle control was, again, hampered to some degree by the... assumingly in a very small detent around zero, and the bank angle was affected by turbulence and so forth, it did not seem as though, especially at high altitudes, that the bank angle was being maintained constant when your hands were off the stick, and it seems to me that's the basis of the control law.

**4. Ability to Control Airspeed (Autothrottle Off) ?**

The main comment there is the friction of this particular autothrottle quadrant is fairly high, so there's a large effort... there's a significant effort in overcoming the friction, it's a bit of a distraction, the Cooper Harper ratings that I gave tended to ignore that particular aspect of the simulator, and assumed that you would have reasonable friction in the throttles.

**5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

I didn't see any in terms of speed and pitch, however, in roll at heavyweight high altitude, there was a slight tendency towards a PIO, it was not divergent, but could be noticeable by other pilots who are being quite aggressive with the controls.

**6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Like I say the Force and Displacement, the sidestick, if grabbed and squeezed, and used in that manner, would tend to mix the inputs inadvertently, and on occasion where aggressive controls are being applied, in pitch or roll you'd get some cross talk in terms of the inputs,

the... it's possible that the detents and forces could be redone slightly to improve this, the detents seemed to be very small in roll, although, it's certainly noticeable in pitch and roll, but it's quite small, compared to the forces vs. displacement. Pitch and Roll Harmony are reasonably good, with the exception of getting... when you get into envelope limiting where you have to hold a large force and displacement, and say for example, in pitch or roll, then the other axis is out... is non harmonious, at that point, and it's easy to... even more easy to get cross inputs, unwanted inputs in the other axis.

#### **7. Effects of the Wind/Turbulence ?**

They seemed to be affecting, especially roll. I put the stick in the detent, and the bank angle was not being held as precisely as you would expect.

#### **8. Summary - Good/Bad features ?**

I suppose a good feature isn't... if you... in pitch at least, if you just keep your hands off the stick, the flight path angle seems to hold quite, quite well, however, in bank this is not quite as much of a feature. There seemed to be more variable... in variation in bank with your hands off the stick. On the HUD display, it would be desirable to go through the, actually the whole HUD display, and review it to see if meets the... well, to... perhaps investigate the use of the latest, the best available HUD displays that are currently in use on airplanes throughout the world. One problem on the HUD was, where various symbols got overlaid on top of each other, it becomes a little hard to read. The Mach number needs to go out to three digits, Mach number is difficult to see on the HUD, so you have to use the head down Mach number, which goes out to three digits, it works quite well, except for its letters are a little small. So, that's an issue that probably ought to be looked at, is the... is to use a HUD display that is the best available based on current state of the art. Counterpointers for airspeed and altimeter, probably would be better than tape displays, and that's just one example of how that... how the HUD can be improved, but I think, the effort needs to be established on getting... improving the HUD display, I think pilot performance could be significantly improved by... by improving the HUD display.

#### **Pilot B**

Climb/Cruise/Descent Questionnaire 08 Jan 97

#### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Okay, this is Pilot B, these are my comments, at 3:00 on Wednesday the 8th. Pitch and roll control power I never got anywhere near the stops on the tests this afternoon, so that was adequate.

#### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

In general, at high speeds when you are commanding an increase or decrease in G there is a pronounced lag in the G response. So that I will make an input, you'd expect there to be a first order lag in the pitch rate and at a constant airspeed, therefore G, but it's more noticeable than what I am used to in other aircraft. Now the only supersonic aircraft I have ever flown before has been a fighter vehicle, a whole lot less pitch inertia, none the less, there is a problem in that if you put in a little bit of input and expect to see a G response and don't see it right away and you are tempted to increase the input, and by the time it catches up you've got way too much g on. Now what I didn't look at was this effect with set of the pants cues, all in place, you know the motion system obviously can't keep up with this kind

of stuff. So I didn't really look at it with that, and it may be that that damps it enough, it's not a problem, but there is a small problem with predictability and pitch, that anytime you are pulling any appreciable G's or pushing appreciable G's, in high speed flight, means that you have got to be real careful. Kind of exasperating this is the fact that the relationship between pitch rate and load factor is...changes quite a bit at these speeds, so that a very small pitch rate is going to result in a whole lot of G, even more so than people might be used to flying in subsonic airplanes, so we've got to be careful there, and that may even motivate the forces are low enough on the controls system that may even motivate a change in grading it as we get to these higher speeds, to increase it, so you don't inadvertently, I mean if you're grabbing a lunch tray or doing something in the cockpit that ends up bumping the stick supersonic and you move it any appreciable amount you are going to be in serious, serious trouble, so that's probably what it is looking at ultimately. The special control technique there is not to put any high inputs and to be very, very gentle with inputs particularly push inputs, because of the sensitivity of the airplane to unstart. Didn't look at yaw response a whole lot today except in the VMCL and there it was pretty much predictable and relatively linear.

### **3. Ability to Control and Track: flight path, bank angle, heading ?**

Ability to control and track, this is question 3, flight path, bank angle, and heading, with those exceptions, not much of a problem. Bank angle and heading there is really no problem at all, supersonic. It takes so much in the way of pulling to get any yaw rate established on the airplane that you are not going to be prone to do any of it.

### **4. Ability to Control Airspeed (Autothrottle Off) ?**

Airspeed control autothrottle off, not much of a problem in the way of airspeed control, Mach control is a problem. But again, our tolerances may be tight enough here, a hundredth of a Mach is really, really tight at altitude, that we don't need to worry about it as much as we are with the tight tolerance. Yeah, it's a problem in the task that we have, but I'm not sure it's really an operational problem of the airplane.

### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

No PIO tendencies in any of the axis with what I did this afternoon. Some of the VMCL stuff we did this morning, there was minor PIO at very high alphas and low airspeeds when we were exploring what the min. airspeeds were, but nothing this afternoon.

### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

[We] may be a little bit sensitive in pitch at high Machs, the force there is a relatively low, the gradients are light and airplane is relatively susceptible to engine inlet unstart at fairly low forces, so we might want to look at stiffening those up. In terms of harmony, I didn't notice a problem with harmony, but I think that even if we stiffen up the longitudinal it may be okay, because I am spending so much time working on the longitudinal and devoting very little attention to the lateral. I'm not finding myself inadvertently making inputs across the axis so I don't think harmony is a problem and I suspect it may not even be a problem if we stiffen up the longitudinal. Now the forces, by the way, are pleasant, but they may be inappropriate for this mission. I'm not flying an airplane for 2 1/2 hours on autopilot and cruise and inadvertently bumping the stick and seeing what happens here, that's where I have a concern.

### **7. Effects of the Wind/Turbulence ?**

Turbulence just added to the entertainment factor by providing the necessity for inputs. I can't say that it was a real problem though in terms of adding significantly to the work load.

## **8. Summary - Good/Bad features ?**

In summary, it's a relatively pleasant flying configuration up and away. No major problem in setting the...doing the task, with the one exception of the descent profiles, and I should have mentioned this before. The envelope protection occurring at an airspeed that your operationally going to fly routinely is a problem. If I am going to operationally fly at 2.4 Mach and a 2.41 I've got a system that's going to start pulling on the stick. I've got a problem with that, and that did interfere with some of the tests that we're trying to operate in that regime, trying to set a precise descent rate and having the system fighting back on me, so I think if you are going to have an envelope protection system like that you might want to push it out to something greater than what you're operation going to fly. In this case maybe 2.5 Mach. Let's see, other than that, except for that, that test would not have been all that difficult, but that limited us to adequate performance instead of desired. The rest of it was pretty pleasant with the caveat that I mentioned about sensitivity and light forces and gradients in maneuvering. Any questions ? That concludes the comments

## **Pilot B**

ClimbCDQ Climb/Cruise/Descent Pilot Questionnaire 09 Jan 97

[This is the second response of this questionnaire that Pilot B gave. He answered some of these questions in a previous session above.]

## **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Completely adequate, I don't think I ever had problems with hitting the stops or not having enough control power.

## **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Relatively predictable, very mild tendency for, I even hate to call it PIO, it's overshoot in roll, if you get real aggressive in roll, there is a very small tendency to overshoot and make a couple corrections and get a little bit out of phase with it, but it's very, very minor, it's less than a degree, and it's only in response to very high gain inputs. Is that a function, by the way, of Mach number ? No, no it's not, it's just a fairly quick airplane in roll, the roll inertia is well enough that in the gains in the system are low enough, high enough rather, that it's very responsive in roll, and as a result if you get aggressive with it, you can overshoot. But you only see at high inputs ? Yes, only with very large inputs and very high gain, in fact, inordinately high gain fast, for this phase of flight. We're deliberately making the task artificially high, high gain in order to break out some of this stuff. I don't think it effected, I mean I was able to keep it within desired performance bounds to spite that, so we're not talking about anything that's inordinate. Pitch predictability, the only time I had a problem with that, was in trying to control VSI, and it basically, you'll see that in my HQRs, anytime VSI is in control, the HQRs tend to be degraded a little bit, in some cases down to the level 2 area, down into the four, type area. I'm not sure how operationally realistic it is in this airplane to try to hold VSI in manual flight at anytime other than approach and landing, and even then, one could argue that you are flying flightpath, so, you don't really need to do it then, so, I'm not sure how operationally reasonable any of this is.

## **3. Ability to Control and Track: flight path, bank angle, heading ?**

[In] general I could do it within the desired bounds, whenever I had to throw VSI into the task, it reduced my accuracy in the other ones, and that's primarily a scan issue, not primarily a flight control issue. I don't think you're going to do anything with flight control system to make that better, other than put an autopilot in, it's just a matter of where you have to scan. Putting the airspeed tape up did help for this task, but I would be hesitant to ask that tape be put up there in all phases of flight at low altitudes, because it adds a whole lot of clutter to the display, and again, I'm just not sure that this task is a reasonable one operationally. Also, adding to the problem was, I perceived the foreground symbology in there to be slightly out of focus. I always have in this simulator, I don't think it's a matter of tuning it, I just think it's a matter of limitations of the simulator, but the symbology is apparently very slightly out of focus. For instance, it's tough to see where the point of the VSI arrow is, because of that, it's also tough to see very small airspeed deviations breaking out from the acceleration karat because of that, because of the focus problem. These are...I don't have a lot of major things to talk about, so, these are minor things...these are in the light noise.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

Let's see ability to control airspeed autothrottle off. The only issue there was the one I just mentioned, being slightly out of focus with small errors. There was one occasion where we...we got a little bit slower than we should of because I misread the card and thought I couldn't sacrifice altitude, and so we got I think 2 hundreds of a Mach below instead of one hundredth, but I could of recovered that by descending, and didn't. So, controlling airspeed either with pitch or with throttles, I felt was good.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

I mentioned a very slight PIO tendency and roll with high gain inputs. No tendencies whatsoever that I noted in pitch. Very slight Dutch roll tendency when you rapidly recover from a 30 degree angle of bank type turn. This is the type of maneuver that would be extreme, if you had people, particularly people walking around in the airplane like you're going to, for a lot of the flight regime. Despite that, though, I was able to excite the Dutch roll and maybe got one or two oscillations. It was damped relatively low frequency as you'd expect and it didn't interfere with precise control because I let it go, because the magnitude of it was low enough that I wasn't real concerned about it, so, I just kind of let it go until it stopped and it damped itself out after a couple of overshoots.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

I did use rudder pedals a little bit today and rolled them out and into the turns just to help a little bit, I think also because it is a habit for me in the airplanes that I have flown. It does tend to help in this airplane, it helps the precision a little bit, both in the roll in and the roll out, and I felt the force displacement characteristics were fine, very small inputs. As far as pitch and roll, force and displacement I thought was okay, very pleasant, sensitivity was pleasant, pitch and roll harmony was pleasant. The force gradients are quite low and as I mentioned yesterday, probably bear looking at it a little bit to see if they are appropriate in terms of envelope protection. For the cruise...for the up and away phases, the climb cruise and descent. In the approach and landing phase, I think they're fine, it's up and away that I am concerned about, it's the inadvertent inputs, both in terms of structural problems and in terms of passenger and crew comfort would concern me. I'm not convinced there's a problem here that bears fixing, it's just a caution that I think is worth looking at.

#### **7. Effects of the Wind/Turbulence ?**

Turbulence had the most effect as you would expect at the lower speeds, in fact the last test that we did, the turbulence transients were outside of the desired band, I thought on a couple of occasions and they happen so fast that you're going to be real hard pressed to correct for them before they've already influenced your vertical speed, but again I'm not sure that's a realistic task anyway, but that's what degraded me into level 2, decidedly in the last test, and again if I could have given half grades, I probably would have rated it even lower than I did.

## **8. Summary - Good/Bad features ?**

In summary I haven't seen any show stoppers today, I've seen some things I didn't like, I commented on the overspeed protection happening one knot above your operational limit speed. I think you typically have two speeds, one is an operational limit and the other is a cleared limit, and I think the overspeed protection ought to be somewhere in between those two, not balanced...not pushed to one end of that band. Other than that, relatively pleasant. That concludes my comments.

## **Pilot C**

Climb/Cruise/Descent Pilot Questionnaire 16 Jan 97

### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

[Descents] I couldn't have used 5 percent of what was available, so it certainly was sufficient, that was not a problem.

### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

[Descents] Yes, it was all quite, roll and yaw were all very predictable, nothing has changed on that, and the pitch was not too bad, there was a definite, I was noticing the large breakout force in pitch, and that might tend to give a little bit of an overshoot, I was getting some overshoot, but my biggest problem was I was having to concentrate on the speed control very, very accurately, and with the mechanical characteristic of the throttle, it kind of made it a, not a...that contaminated the whole evaluation quite a bit, but in general, I'd say predictability of pitch, roll, and yaw was fine, and with just that one little anomaly there, right about center I could feel the breakout, and it was annoying.

### **3. Ability to Control and Track: flight path, bank angle, heading ?**

[Descents] Boy, it is really sensitive, wow, to put it on a...well, no, on the flight path, sure enough, I'd get quite a ... an overshoot. I probably should be talking about two different things here, because we've...I've been talking about, primarily the descent, and actually we've got climb and cruise in there too. Okay, let me just continue, everything I've said up to now, has been descent, and I'll talk about descent now, and then I'll come back and we'll talk about climb, and be very short, but it probably should divide it up, because the two were separated in difficulty. For the descents on the flight path control, it was very difficult to not get an overshoot in there, and you know, given enough time, I could bracket it, and finally get it back, but usually had that one time overshoot. Bank angle, well, it would have been easy, the only thing that, when you lock on to the flight path marker like that, you can have a degree or two in there of bank angle and not realize it, because the bank index is quite a bit above the flight path marker, and I was using the HUD for everything except the cross check on rate of descent and heading, but not often enough, just because the bank angle index was so far off, and just in one degree, it doesn't take too long before you've got a couple of degrees on the heading off too.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

[Descents] Of course I said that, the karat is great, I love it. The indication on the thermometer error, that's fine. That's all good indications, should be very easy to do, giving a little bit ability to have more of vernier type thrust control.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

[Descents] I can't really say they'd be PIO tendencies, they get an overshoot, and I caused it and all, but not a...certainly no classic PIO big cycles getting...not very many usually, it's kind of a one time overshoot, and then wait, see what I get, and then try one more, and hopefully that would be a smaller overshoot and finally get it settled down.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

[Descents] Rudder pedals I didn't use enough, and didn't really have any, much of a comment on those. Force and displacement, and not using very large displacements on this, but the force and displacement was fine. Sensitivity, I think would have been ... was reasonable and the pitch and roll harmony, no complaints about that. The biggest complaint, two...two...two complaints, (1) breakout in the inceptor, both pitch and roll, is too large and definitely the friction on the throttle, no sense of talking about that anymore, I beat it to death.

#### **7. Effects of the Wind/Turbulence ?**

[Descents] Really shouldn't be any, and I don't imagine that you're going to get a lot of turbulence at 50,000 ft, whatever was put in the sim did not appreciably bother me.

#### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Okay, now let's talk about the climb ... leveling off in the climb, certainly adequacy...for question 1 now...adequacy of pilot...or pitch and roll control, again, couldn't of used 5 percent of it, there was plenty of it.

#### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Predictability was fine too, the display I wasn't particularly happy, this caused me a lot more concern as I was trying to level off on a altitude. Which display ? The display of...actually the primary one was the altitude itself on the right hand side on the HUD. I finally decided I could do better with the round dial down below, so, I kind of used the flight path marker to make a change, then check inside for the altitude, and I don't have anything against tape altitudes, we have it in the F-16, and I use it, you know, fairly regularly, because it's both digital and analogue. It has a little pointer thing ? No, no, doesn't have that, the one that's in our particular HUD is strictly a tape, I would rather have the other, the other one is much preferred, I've flown it a few time, and that ones better, but the one that I'm used to using in, and I have no complaints with that, but with this one, I think probably if there would have been maybe a bigger tick mark, and possibly...and not blue, yeah, and the other thing was...I think there's...of course your HUD is not the clearest, I mean that by itself doesn't negate it too much, but if you put just being a little bit fuzzy, and then just the layout of the numbers, it wasn't...it wouldn't be my first choice, I'll say that, so actually any, the leveling off problems that I had, weren't due to flight control system as much as they were display, and then again throttle. [Other voice: My mother just designed that part.] She did, oh oh, we're going to have to send her back to HUD design school, remedial HUD design.

#### **3. Ability to Control and Track: flight path, bank angle, heading ?**



Okay, ability to control track. Again, that's the ability control, the attitudes and so on, to get it back is not too tough if you've got better indicators, and didn't have the...even with the friction, I could keep it within it, but it was a lot of work, and a lot more needed too, the only technique I could find that worked was walk 'em, in other words, move one, see what that gives me, and then move the other one, and so on, and try to overcome the lack of ability to make very small changes in the throttle.

**4. Ability to Control Airspeed (Autothrottle Off) ?**

Ability to control airspeed, same thing, acceleration carat is great, and the thermometer is fine.

**5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

Were there any PIO tendencies, no I didn't see any...

**6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Pitch, and Roll Inceptor, I've already beat that to death, and nothing new, and comments are the same,...

**7. Effects of the Wind/Turbulence ?**

and again, effects of wind and turbulence at 50,000 ft is really not much of a player. Whatever was in there I hardly even noticed, so, thank you very much.

Pilot C answered this questionnaire later in this test, see below

**Pilot C**

Climb/Cruise/Descent Pilot Questionnaire 17 Jan 97

Pilot C answered this questionnaire earlier in this test, see above

**1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Adequacy of pitch and roll control certainly was more than sufficient. No problem on that.

**2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Well, in general, they were good, especially when I had a display, that all I had to do was fly along a line, and things like that, times that predictability tend to overshoot and a few things, had to do mostly with the rate of climb and descent. The first series, I kept trying to fly it like every other airplane I've ever flown, as soon as I'd see it, a trend start on the VVI, I would make a definite input, and near the end, the last one or two, it suddenly dawned on me that this is a gamma dot command, and likely it could hold the response better than I could, and yes that did in fact happen, so it made all the difference in the world, you know, I've been flying it the whole week, this is the first time that that particular item of the up and away advantage of it came through.

**3. Ability to Control and Track: flight path, bank angle, heading ?**

Well, again, it's quite easy using it properly. It was easy any time when I was just tracking the horizon for flight path, there was only one of the VVI that I was chasing. A little bit sensitive, and as a result I was putting in more commands than I really needed to, and bank angle, interestingly enough, 30 degrees was easier to hold than the 15 degrees, I tended to

wander some on the 15 degree bank task, on the 30 tended to be much more stable, and the heading at the turn rates and so on we had, I just almost waited till I got to the heading in the bank angle, when I rolled out, sometimes it would even drop back one, so, that made it quite easy, so controlling and tracking bank angle particularly at 30 degrees was quite easy, 15 a little more wander, no explanation why.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

Only on one did the, I think it was just one, or maybe two, that the Mach thermometer didn't work, and that increases work load all over the place, because there is no Mach indicated except the small digital one up in the corner, or come inside, and so, that wasn't too great. As long as I could use a thermometer, though, the speed was not inordinately difficult.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

I really didn't see anything that I would call a PIO, that's such bad connotations, and I didn't see anything that I would call that.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Rudder pedals I didn't notice there was much difference. Same story, not going to beat this anymore. Breakout does effect it when you're making very small, fine, tracking corrections, both pitch and roll. The forces and displacements and the harmony, I didn't have too much, didn't have a complaint of about, it must have been reasonable.

#### **7. Effects of the Wind/Turbulence ?**

That might have been on the VVI in particular, it's very sensitive about the 1000 ft per minute ticks, and as a result I would tend to overcontrol, and the turbulence would just get it started, and I would try to catch it, instead of letting the variations kind of average out, and let the flight control system take care of things like that. That's one thing that would get me in there working, and I would end up driving it out of tolerance, and I think that pretty well covered those, good and bad features on that. Is that it ? Okay, yes VVI is, and the one I'm talking about, is the one on the HUD, the arrow, and in general it's very easy to read, I like it that way, what I don't like about it, is it's a long ways away, and this is one of those things people always say, pilots are never happy, and the thing is, if you get a big HUD, which most people really like, that means that some information is going to be a long ways from, usually the flight path marker, that's what everybody is locked in on, and so if they move things in so that it's close enough, then pilots bitch because it's cluttered, it's one of those catch 22 items, but here's a case in particular, that it was a long ways away, it's fairly easy to read, but it was so far away that it was just as easy to come inside, as it was to go all the way over to look at that. Now, add that to the sensitivity of it, which bordered on maybe a little bit too sensitive, and that decreased my fondness of it even more, and going back to the head down display actually was the clue to improving performance. I hate to say it, because like I said, I like the general layout of that vertical velocity indicator on the HUD, but due to the distance away, and maybe a little bit too sensitive. A little bit of variation makes a big difference in the length of the arrow, and so, when you're looking at it, you know, this is a 100 ft per minute...or a 1000 ft per minute, and it was doing a lot of this, where down on the head down, it was just making a small thing, so you see, when you're making corrections, you tend...you see a big motion, you tend to make a big, and you tend to overshoot, so it's just a little too sensitive. I think if the scaling would have been less, that would've helped it, and also when you get motions like that, I don't know what kind of massaging of the data and so on, you know, what sort of filtering in that, but usually there's some kind of filtering on those kind of things, so it's not all over the place, and so that can get in there too. The

only I would say, is that there's something going on, on that, that I tended to overcontrol that a lot more than I did the heads down, and the fact that they were so far away, and that was also true of bank angles, a lot of times we had bank angle wander a little bit, and that's because when you're only talking 2 degrees, you don't see it very much on the rest of the display, but unless you're looking right at the point, a spy point we'll call it, and it was far enough away that it wasn't in my peripheral vision, I had to specifically look up at it, and then come back down, and so that, but like I said, those are tough questions, you know, because you're going to get people with preferences all over the place on that, it's pretty hard. So that would do that, and I wrote up some things that I don't know where they'd be...I can write it up or put it on the tape, probably just as easy. So, I came up with a whole list of things that I saw this week that might be some interest to somebody. Now a lot of these things I've mentioned before, but I just...so, I won't beat them to death, but a couple of things on the task that I noticed, maintaining bank angle is not much, you know, that doesn't tell you very much about the flight control system, in other words, if all you got...if you correct every little tiny item that's...that tells you something that it doesn't tell you an awful lot, the variations you did, the ones that came to mind, and actually you did later on was the bank angle stalls, and then come back to the level, and I would have added a task of capture of bank angle more than once, in other words, like say 30 degrees, or 15, or whatever makes sense when you're that close, then back to zero or 30 to one side, to 30 to the other, it would of given a better feel of what's going on, because there's a lot going on when you get to that high alpha, and I wouldn't, you know, to uncover a problem, I think that might....that's right, a little more maneuvering, and a couple of the others, you know, the whole task was just maintain level, and I've seen a lot of things, that as long as you keep the errors small you don't see much, you let the error get very big, so you have to put a bigger input in, and things bother a little bit. On the offset landing, 250 ft, I mean I know you're trying to find thresholds and stuff, and I, you know, 250 is fine, that's what you're using, might be interesting just to back that up to 300. This is a 300 ft long airplane, that weights 600 and some thousand, and I just thought that was getting to be a little more than you're asking, I know it's an academic question, and so, it's all right, but maybe a check at 250 and then another one at 300, and see how close you are to badness. Okay, we did the TIFS approach, yeah right, oh you did it at 300, oh, I got the idea of 250, 300, you weren't doing it at 250, he was calling it, yeah, he was calling it at 250, oh, correction, yeah, we were off set 300 ft, oh, no, no, no, no, I was talking about making how...how close in are you when you make this correction, I mean you're approaching, well, like I said, it's an academic question, which I don't think too much when we do that. Were they doing it in TIFS, and getting good...ever able to accomplish it nicely, No, That's what I thought. Anyway, you're getting a little bit far out on the task, but that's a minor point. We always use at least a minimal comment card when you do the Cooper Harper, that way you don't forget anything. I know I was thinking of some things when I was flying along, and I tried to put them...remember them for the Cooper Harper, I think...so I put those on, and then doing the comments at the end, are fairly general, and you lose something, and there were a couple of times when I was thinking, oh yeah, I've got to remember to mention that, and that's probably not, you know, that's the way we do it. Or specific things to ask about for each task, you know, what are you really interested in and make sure everybody talks about something like that. Just for mine, that I noticed, for somebody who has not been in one of these gigundess airplane simulations at all, landings first probably put an extra complication in there, I think if I would have done the up and away things, and then come down, I think it might of had a little better feel for the airplane, and the other thing, before...at a minimum, before the landing, what I would do next time, is with the gear down, flaps down, all this kind of stuff, again, makes the maneuvers down low, just fly it around. What does this kind of input give me, yeah, that kind of feel for the airplane would've gone a long way, that's one reason it took so many practices and that's one way to learn how it flies, but probably a few, up and away, the

low altitude, you know, just feeling the airplane would've been worth while, I think it would've been...made a little bit more efficient. Okay, that took care of that, the only things I had contaminants as far as the simulation, I've already talked throttle friction and breakout, no reason to add that, a little bit of clipping on the HUD, you've told me that you knew that it was low, but yes by clipping, I mean I was as close as I could get to the HUD at the eye position, and still I had to look up a little, especially on the...the only thing that really affected me was the localizer, I had to stretch to see that a little bit, minor contaminant on that, though, that's not a big one, and...but the one that was a major one, was the TOGA button position where you have to shut off the autothrottle at 50, and then come back around and hit that, and I would miss it, and that was, you know, take a lot of concentration that shouldn't be a problem. It won't be in your airplane, That's my point, you know, you will have a TOGA button that's handy, I'm sure. On the HUD things that I really liked, I like the accel karat, I like the airspeed error thermometer, that was good, I've already said that I like the general layout of the vertical velocity with the arrow, with the...other than...a little far away. The...using the sideslip on the triangle was very natural, and I liked it except that is again, a long ways from the flight path marker, and I especially on the engine-out, I had to really definitely look quite a ways away to see it, if there was, and I don't know the answer to this, but if there's a way to get the sideslip closer to the flight path marker, you'll help yourself. That's been suggested by previous studies. Yes, that would be worth the task right there, to see how that would...that was my only complaint, and so the sideslip indication; got a good and a not so good, because of...it's a little far away. Does this rotate, or is that always like that, does that rotate with bank angle, or does that only stay level. That stays level in the... That might make it a little more intuitive also, and at a higher bank angle looking at sideslips, to go in there looking at it like this, you know, you know as far as putting... Oh, oh, yeah, yeah, I see what you mean with the bank angle, now that the arrow is up... This wouldn't do that. I think that's likely a good suggestion, you know, my...just...gut feeling is that that would probably be good. Well, I don't know, I've always had actual flight path shown with my flight path marker, and I got to say that I still like that, however, I know with this flight control system that the commanded is good, if you're going to do this, then the fact that you have the dashed one come out to show actual is, hey, I'm all for that. As I mentioned once before, I think if anything I might like to have the actual come out a little bit quicker, in other words, there seemed to be a certain tolerance before it came out, and where that bothered was, again, on the approach, by the time the actual came on, and it always was above the other one, and that's what I had to push over to, I just felt that if I saw that a little bit earlier, I could of made the correction before the error got quite so big. I'm not real crazy about your alpha G or altitude tapes, and that's...and that has to do with the design of them, not the fact that their tapes, because I have flown tapes before that I did like. These just look like an awful lot of extra lines were put in there, and then that one of course having, obviously having blue on your HUD, against the blue sky is...you know...that's self-evident, but I didn't like those tapes as well as many of the other ones that I have seen, because in general, I don't have anything against tapes, but those just seemed kind of busy, and they certainly were along ways away from what I wanted to see. In fact, you have to call up individual ones and so on...could be good, could be bad, the fact that you can get rid of them if you don't want them, is always good. The tailstrike bar, too far away from the flight path marker in...particularly in the landing and what do you call it, the go-around, it's just so far up, I didn't even see it, it was no help, if I hit the tail, I hit it, if I didn't, it was only...kind of luck, it wasn't because I was looking at the tailstrike marker, that's for sure, and to me, I would like to see a track indicator somewhere, when you're flying an ILS, you're doing this with heading, and this kind, you know...just doing it with heading, to have a track marker, really tells you how much, in the crosswind, how far over before you get to see a ... I was kind of surprised to not see a track marker. And the velocity vector doesn't do that, doesn't provide that function. It gets you to where you're going relative to the ground. Yeah, yeah,

yeah, you're right, it does.. You mean a command. No, well, I mean, you know, a command would be nice. Actually what would be nice, would be track hold, that's what would be nice. We all agree. Maybe if I were to have consciously thought before I started, about okay, that's my track, you know, the flight path marker, than maybe that would have done it, yeah, yeah, you're right, I guess that would be true, but anyway, I wasn't thinking of it as a track marker, maybe I should have, but that didn't cross my mind at the time. On the flight control system, the things I liked, the single engine-out characteristics are great, you've got lots of authority, nothing crazy happens that I notice. Of course it's a very, very, tight task in bank angle, but I mean, as far as the flight control system itself went, gee I thought that was. You're right, I don't know, all I know is...when I lose an engine I'd see just, you know, minor deviations, and I wasn't pushing full rudder by a long ways to bring it back, so I mean, maybe the rudder itself was damn near maxed out for reasons that I don't know about, but the way I felt was, the single engine-out task, you know, and the flight path, I'm assuming, the flight control system and all was what was keeping it so small. Of course geometry plays a big part, the engines aren't placed a long ways away, but whatever, that is a characteristic I kind of like. ILS tracking is almost a no brainer, even without my thinking about the track indication. Autothrottle takes most of the work out of there, that's a great thing, and the roll response is way better than I expected. It may be that...that good of roll response for other reasons, you know, failure states and those kind of things, but for whatever reason, the roll was better than I expected, like I said, for such a big airplane. Pretty sluggish longitudinally, but the roll response for input was nice. Some not so good, and here we get into, you know, some tradeoffs again. There were some times particularly with turbulence and so on, and in close where I felt a little disconnected with the airplane, and I don't know how much of that is due to the size and the inertia of the airplane. I don't know how much of it is assume, ism, you know, there's a certain amount of that, and I don't know how much of it was due to the flight control laws. I don't know, I can't break out what it was, but there were some times when I'd see the airplane do something that I didn't think I commanded and it tends to make you feel a little disconnected, not a nice feeling. But like I said, I can think of three reasons why it might not be...what part each one played, I'm not sure. Any particular tasks that was worse on. Down close turbulence in landing, that's where I noticed... Any particular axis worse than the others ? Rudder and beta seemed to not ... Yes, I can't say that I can...there was some of that in pitch that I would feel as perceiving, whatever was there, I mean, it appeared to me that something went on there that I didn't do. I didn't notice it so much in bank angle, let's say, but in the...with the sideslip in the yaw, that was, that was a very definite one, and a little bit of that in pitch, and what I was thinking was, if you're going to have this, it's going to be gamma dot, then it ought to be tighter gamma dot, because for most of the time, it's very tight, in otherwords, you're control and you're actual is very close, but then it gets off, and so the amount of work load you have varies, and you've got to pick up the fact, oh, now's the time when I've got to do it, instead of let the airplane happen, but you see that possibly would just disconnected, the tighter you do this, the more the airplanes going to have to do things that you don't command. What are you pointing to ? The tighter control, the more the airplane is going to have to do things on it's own, and that's going to hurt this disconnect feeling most...quite possibly, see so, that's another one of those catch 22's, a tradeoff, where's the best combination, because you can't have both things, I suspect, you know, this is kind of...I'm really kind of extrapolating here. The sideslip I talked about, there's something there just did not feel like airplane like always, and one thing that I noticed, once you get the sideslip really large, that's when strange things go on, and that's when I started seeing big...even PIO's and so on. I get this huge sideslip, and next thing I know, I started working the ailerons pretty hard, and we would get a pretty good PIO going, likely this rate limit in the roll, that's the biggest, that's probably the biggest safety thing I saw, I mean that's got to be far enough away that you guys aren't going to get to it, or sooner or later, it's going to be a disaster. I mention track hold would of been nice to,

and a couple other things that...just to throw out...and these are pretty obvious, everybody's going to notice it, but a couple of things that made the overall things difficult, one is the tolerance that you're allowed in bank angle, well actually, anytime you're close to the ground, but specifically at rotation. I mean I touched the wing tip, and it was only 4 degrees of bank, and I was really surprised, and I heard Paul say something that he got a nacelle at 2 degrees, boy, that is so fine, I mean sooner or later you're going to get a gust, you're going to get some anomaly in there that's going to give you that kind of thing, you're going to touch something, and I know that's the shape of the airplane, but that is a very, very, large limitation right now, and then the other one is constraint by regulation, that noise thing, boy, that is...you're making these configuration changes in close right at the time you don't want to be doing those things, and the less you can get away from configuration changes in close the better, and I know that that's a problem. Incidental, I was going to ask you, I notice we were doing 3 degree glideslopes, and I'm assuming that's what your setting up your noise ..., there are glideslopes at 2 1/2 degrees, that's going to blow you out of the water. I mean, I'm sure you guys know that. Why are there 2 1/2 degree glideslopes ? I don't know, but I think that would solve a lot of the landing dispersion kind of things, and the 3, I always thought was either for clearance, you know, for another words, 2 1/2 would be the more standard, and then 3 was put in as a lot of the civilian ones, I know for sure, a lot of them are 2 1/2, and you see if you got flat terrain, maybe and so on, then the 2 1/2 is fine, but then if you've got a problem with buildings sticking up and so on, then you have to come in steeper, and also of course, that does help the noise, higher or longer. I thought 3 was ILS standard. Well, it might be, but I know there are a lot... Niagara Falls is 2 1/2. That's right, and Buffalo's 3, I think, yeah, I think there is a difference between those...I'm not sure, but yeah I know, Niagara's 2 1/2, I think, spent a lot of time flying that one, okay, well those are the comments I had to make, you know, you had said when you started, say anything that came to mind. Okay.

## **Pilot D**

Climb/Cruise/Descent Pilot Questionnaire 22 Jan 97

### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Absolutely no problems there. I think the real problem is going to be, that Bruce and I were just discussing here is that, how do you keep the airplane riding smooth enough, how do you make small enough inputs so that you're not banging people around in the back end.

### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Predictability of all responses to Pilot Inputs are good, with the exception of roll, I do have a tendency to... for a roll PIO, and I have to back off, this is the technique I use, but again since this a transport category airplane and everything should be smooth, it's really not a real serious problem, but I think there's a lot that could be done with the lateral control system. I you make... it's very apparent, if you make a step roll input of just a reasonable magnitude, 10 degrees per second or something, and let go, the thing on coast before it snubs down on roll attitude 10 or 15 degrees of bank, which is just really way too loose. Should snub down in a couple 3 degrees.

### **3. Ability to Control and Track: flight path, bank angle, heading ?**

We were not doing any flight path... tracks, we were tracking only H dot, which is quite difficult because of the instrumentation that we're using. The ability to make flight path changes to the resolution that you can read on the scale is pretty good. The one we're asked to do... plus or minus 200 ft per minutes, particularly supersonic, it's a pretty tough task.

Bank angle is relatively easy to control with the exception of the PIO tendency we've discussed. Heading is very easy, particularly supersonically things change so slow.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

Airspeed with the autothrottle off is relatively easy to control. You know, as long as we use a plus or minus 5 knot criteria, it could be improved significantly I think by putting some throttle lead into the chevron we're using for the longitudinal decel, and I do understand the longitudinal acceleration cue as being driven off of airspeed rate, which I think is a good thing, but it does need... it's got quite a bit of lag in it, needs some quickening with throttle.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

Pitch I really not... well, we're not using pitch directly in these tasks, these climb, cruise, and descent task we're using flight path, and there is very little of any tendency to PIO in flight path. I didn't notice anything there. Speed, I have a tendency to oscillate a time or two, because of the lag in the chevron, discussed earlier. Roll, I do have a PI... definitely have a PIO tendency as discussed early, you just have to back off on the gain. They're not divergent, but you just back off on the gain.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

No problems with any of the issues here, Force, Sensitivity, Harmony. Again, as on some of the other tasks, I don't think, necessarily... I'm not saying they're optimum, but I don't think they're impacting the performance of the task.

#### **7. Effects of the Wind/Turbulence ?**

We didn't have any winds that I know of. Turbulence is not a big factor, although I did note that when we were trying to control to the sink rates, within plus or minus 200 ft per minute, the turbulence was almost giving that much variation in the sink rates. So, there was a little bit of effect there, but not much.

#### **8. Summary - Good/Bad features ?**

Summary, like the flight path display, it does have a problem supersonically, that you get real poor resolution in [height].

### **Pilot E**

Climb/Cruise/Descent Pilot Questionnaire 10 Jan 97

[Pilot E answered this questionnaire three times - after completing the "Operations after Upset" block 3, halfway through completing the "Climb, Cruise, and Descent" block 4, and then after completing block 4 in its entirety. All responses are included below.]

Answers after completing "Block 3: Operations after Upset"

#### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Throughout most of the envelope it was fine, the most glaring problems occur in the VMCA demonstration, obviously, at some point when you find the magic minimum airspeed, and of course that's determined by the fact you don't have enough yaw, or roll control power. Pitch power was always adequate, in fact the pitch rate, this vehicle is very impressive at all speeds. We found about between a 120 and a 125 knots of a dynamic VMCA demonstration was about where we could control it, and we ran out of officially yaw

control power, I had full left rudder in with engine 3 failed, engine 4 failed, I had full left rudder, and mostly full left sidestick, and was sustaining a very, very large almost full scale beta deflection, and could not really roll in the proper directions that we did have a heading drift, so, that's obviously... that's the definition of VMCA, so, we pretty much found it. The... on the emergency descent the... there's a real flight controls cliff at about 46 degrees phi, 46-47 degrees where you depart, and you cannot arrest that with opposite stick, so, we're somehow, we're running into a problem there on roll control power.

## **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

One problem there I noticed, a couple problems at higher altitudes, there tends to be a coupling of either roll axis with pitch inputs, I frequently almost all the time I did a pitch recovery, I found myself with about a plus or minus one degree roll oscillation about zero, and it was very difficult to hold zero degrees phi, or wings level. Also, at high altitude, high Mach number, I noticed a problem with anytime you command a angle of bank, there's a awful lot of effort to zero out the sideslip, I generally had to carry, if I was in a right turn, right angle of bank, I generally had to carry left rudder continuously, especially the emergency descent, this required holding left rudder inputs for 5 minutes, just to maintain a zero yaw, and interestingly enough, when I held that left rudder pressure, I pretty much was showing zero degrees rudder deflection, when I took my foot off the rudder, I would get a rudder deflection and a sideslip, so, somehow, there needs to be some tuning done in what I would call the aileron rudder interconnect type portion of the control law, the lateral directional control law, and my special control technique there was actually holding in rudder, to holding rudder pressure, to zero out the perceived yaw based on the beta indicator on the top of the HUD.

## **3. Ability to Control and Track: flight path, bank angle, heading ?**

Flight Path is pretty good for the task we did today. No problems there. Bank Angle was difficult, several times in trying to control 45 degrees angle of bank in the emergency descent I went too far, and had the departure, and we're going to look into that quite a bit, I guess on the data, and just trying to capture and maintain a bank angle, we notice this in the buildup phase for this project, I think Douglas folk's came out, and we actually improved it quite a bit, but I think there's some more we might want to do. Heading control similarly is not as tight as I would like it, because of the susceptibility in turbulence of the angle of bank to wander plus minus one or two degrees. Again, things I've been harping on are ideas like track angle hold submodes, and that type of stuff where if you were within plus or minus a degree of zero, you'd actually command that track and the thing would, would actually hold it, and... or we need some type of a phi... a bank angle hold where if you commanded a bank angle, it will stay there. A better way is probably a initial turn radius hold submode, where you would command a initial turn radius, and it would vary the angle of bank to command that turn radius.

## **4. Ability to Control Airspeed (Autothrottle Off) ?**

That was not really applicable on today's tasks.

## **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

Slight PIO in speed during the VMCA demonstration at the very low speeds, very, very, slight pitch attitude changes would result in fairly significant speed changes, especially if you drop the nose a couple of degrees more you should, you would accelerate fairly quickly, and it was easier to get into a more or less kind of a very large amplitude low frequency speed and attitude type PIO. No real pitch PIO noticed today. Several times I've



mentioned earlier, slight roll PIO's, basically with high altitude, high Mach number, when I was putting in a pitch command. Now, it could be we need to tailor the breakout forces and the lateral axis of the sidearm controller, or maybe some control law tuning you might want to do, but the data will show very slight, almost consistent PIO, plus minus one or two degrees when the pitch input was made. Only one time did I actually get out of the loop to stop the roll PIO, but most of the time I just stayed with it, and I never went divergent.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

The sidearm controller seems very, very good to me, however, one thing to look at perhaps is breakout in roll, and that may be something to examine if we ever have time to try and look at why we're getting this little pitch PIO. The force gradients I think are fine, it feels pretty good to me, the harmony seems really good. Number 7. With the caveat, Number 6... Question 6... with the caveat that there might be some breakout, we need to check on the roll to not couple with roll inputs, with pure pitch inputs.

#### **7. Effects of the Wind/Turbulence ?**

We noticed turbulence altitude would cause a G oscillation of plus or minus about .03, which in the task, we had to hold at plus or minus 1 G, further limits your ability to keep it the desired performance standards, because if you are at .07, and you get a gust that gives you a .03, then you get the .1 G exceedence. So certainly, the turbulence was affecting the longitudinal acceleration. Oh, I guess, the vertical acceleration, rather. The winds were not a factor today.

#### **8. Summary - Good/Bad features ?**

I'm really concerned about the handling qualities cliff, at about 46 degrees angle of bank, at altitude and high Mach number. The departure is uncontrollable, actually we did get out of it on one... one time, but sometimes we just keep rolling over to about 80 or 90 degrees phi and the program will shut down, so, that's something we need to look at, as to why that's occurring. Another bad feature is, we have a... you can only command 30 degrees phi without having to hold continuous lateral force on the stick, and we are trying to hold a 45 degree phi for the emergency descent, so what happens is, you have to hold continuous force in there, and if you get distracted trying to follow the VMO curve it's easy to exceed the 45 degrees and depart, so, we either need to get rid of that on the emergency descent, have some way to disable the 30 phi hold, or 30 degree envelope protection, facet of the control law, and allow us just to command a hands off phi, or we need to put a bank angle limit, so the aircraft will not exceed 45 degrees phi, and then you can just hold whatever you wanted, and it would hold 45 degrees, and that should be something easy to do.

Answers halfway through "Block 4: Climb, Cruise, Descent"

#### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

Not too many comments different than what I made after finishing block 3. I really had no problems with Question 1. There's plenty of Pitch and Roll Control Power able for these tasks.

#### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Predictability, Question 2, is not a problem.

#### **3. Ability to Control and Track: flight path, bank angle, heading ?**

Ability to Control and Track Flight Path, Bank Angle, and Heading ? The only thing I can comment there is on the... when you try to hold a constant vertical velocity, the ability to control and track flight path, is a little troublesome due to turbulence effects on the gamma dot V control law. The bank angle is a little bit difficult to control anytime, as far as holding a zero degree phi, and again, I mentioned before it is something that should be corrected and that obviously leads to heading control also, which requires more work than it should, for mostly... most of these were purely longitudinal tasks, and there shouldn't have been that much effort in the lateral axis.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

Ability to Control Airspeed, Number 4. For the decel and accel, 350 to 250 at 15,000 ft, turbulence certainly was a factor there, and the card, the criteria for the card, indicates no overshoots for desired, but you get... if you want call it a overshoot, you do get a airspeed delta at times, just from the turbulence effects, and I watch that very carefully, and could correlate it to that, the airspeed carat, or acceleration carat would be perfectly level with the wing of the velocity vector, and we still would get better, or one knot or so delta around that target speed, so that is a factor in that card, trying to make those criteria.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

No real PIO tendencies noted today, on 5.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Again, with the purely longitudinal task, at times you would excite the lateral loop, and again don't know exactly if that's a breakout problem with the stick or some control law tuning.

#### **7. Effects of the Wind/Turbulence ?**

Comment on that already on the task that required the lower altitude tasks. The turbulence was more of a problem as far as intercepting the airspeed without an overshoot.

#### **8. Summary - Good/Bad features ?**

Pretty much the same as I mentioned earlier as far as on these tasks, basically the effect of turbulence on the gamma dot V control law and the lateral directional control law is probably maybe a little more of an effect than I would like to see, and the ability to control flight path in these constant VSI climbs, is probably a little harder than it should be. Good features, most of decels are level, accels and decels, were very, very, minimal pilot input to hold within desired altitude criteria, certainly an altitude hold submode would have made it a Cooper Harper of one.

[Pilot E answered this questionnaire a third time at the completion of Block 4: Climb, Cruise Descent in a later session below.]

Climb/Cruise/Descent Pilot Questionnaire 29 Jan 97

[Pilot E answered this questionnaire twice in earlier sessions above.]

Answers after completing "Block 4: Climb, Cruise, Descent"

#### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

There was no problem there, plenty of power available, in fact very, very, sporty roll rates at Mach 2.3 and Mach 2.4, almost like a fighter, so it's, you have plenty of roll control power, and similar pitch control power.

## **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

I didn't make any yaw inputs, but pitch and roll seemed predictable, no special control techniques required.

## **3. Ability to Control and Track: flight path, bank angle, heading ?**

Flight Path, for the turning... for the climb, the turns during the climbs, this was at transonic, it's difficult to control the flight path to the tolerance is required for the plus or minus, a couple 100 ft used to have a 1000 ft per minute climb or descent. There's no real guidance there, and it's just counting by it's guess where to put the flight path marker, so, that's kind of difficult. Bank Angle, also difficult to control, because it just doesn't like to capture a bank angle, nor does it like to remain in any particular bank angle, including zero, so, it's just hard there. Heading, it's difficult to control heading because the bank angle doesn't like to stay at zero, but not real difficult, especially the high altitudes, high airspeeds where it takes a lot of bank angle to get much of a heading change.

## **4. Ability to Control Airspeed (Autothrottle Off) ?**

For the Mach 2.3 heading changes, I notice a real poor predictability in speed control, it took at one point to regain just a little bit of speed, it took about a 1 degree, a minus 1 degree gamma at full throttles, and had to give up 800 ft to regain a hundredth of a Mach, of .01 Mach, whereas other times in that same task, just slight power additions would increase the Mach, so I didn't quite... this is wings level, so, I didn't really understand it, I made a lot of comments on that task in particular.

## **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

No PIO really in speed, but none really in pitch, but roll, whenever you're doing a aggressive phi capture, you'd get about a 3 to 4 cycle, maybe 2 hertz, plus or minus 1 or 2 degree roll PIO, and the more aggressive you are, the more significant is that PIO, it did not go divergent, and if you get out of the loop it damps pretty quickly.

## **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

No real comments there, I've made some in the past. Force and displacement were fine, I though it worked fairly well all the way around, and no real coupling, or tendency in any of these tasks for any pitch inputs to excite or to cause any roll... uncommanded roll inputs.

## **7. Effects of the Wind/Turbulence ?**

For the climb, cruise, and descent, none noted.

## **8. Summary - Good/Bad features ?**

No real good features, the... it would have been nice to have a little bit tighter control of the gamma dot V for maintaining a vertical speed, and also for maintaining altitude during a turn, it did tend to wander a little bit, we weren't probably enough of a delta between commanded and actual to trigger the ghost flight path marker, so, I was not holding altitude like I thought the airplane should, even though the commanded gamma was on the horizon. Similarly the bad features I've noticed... I've mentioned about the lateral axis, and about the one task, with the .23 Mach and a speed predictability.

## **Pilot F**

Climb/Cruise/Descent Pilot Questionnaire 21 Jan 97

### **1. Adequacy of Pitch and Roll Control Power (as applicable) ?**

For the maneuvers that we did today, I didn't see any place where we were running out of control power. I guess that's basically it.

### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Yeah, my preference would be for the airplane to be crisper, I really have a hard time getting the airplane to respond to the last little bit. In other words, if I'm trying to acquire 1 1/2 G's, as I... first of all, as I approach that, I have to approach it cautiously, I guess that's the best way to put it is, is I have to approach everything that I'm trying to capture cautiously, more cautiously than I'd really like to do. It appears that there's a tendency to overshoot, because when you release force on the any of the control, the aircraft in that axis continues to coast for a little bit. That's basically it, we talked about that a lot during the flight. The yaw response, that might be worth looking at a little bit more, I guess my initial reaction is that I would recommend that we look at the use of yaw, versus lateral acceleration, and the difference between those two, and how they are used in cockpit by the pilot, and how timely the inputs are that they provide. Certainly, lateral acceleration rates and yaw rates, and yaw dispersions are coupled together or related, but there seemed to be a lack of, I could not... for a yaw rate developing or a lateral acceleration rate developing, it seemed to take a lot longer for me to recognize that, than it would in a conventional airplane. Having said all of that, to back pedal a little bit, I guess, part of that could be also in the gaining between... for the display, that you're using for the yaw, and so, making an assumption that it's the use of yaw, instead of lateral acceleration may not necessarily be an appropriate comment, because you could have the same problem that we're seeing here with the lateral acceleration cue that was not properly tuned. Anyway, I think that it's worth looking at this. When I talk about the overshoots in the axis, we definitely saw that in pitch and roll. It's a little bit harder for me to see that in yaw, because the only indication that I have in yaw is the yaw... the split roll marker, but it did seem like when I would put a rudder input in, the lateral, or the yaw indicator would move, overshoot slightly, and then come back to where it was, so I generally were just getting one overshoot. That's about it. Special techniques, again, reducing pilot gain as you're approaching the area that you want to look at, is the technique that I used to compensate.

### **3. Ability to Control and Track: flight path, bank angle, heading ?**

Ability to Control and Track Flight Path, actually, I think overall the ability to control flight path is pretty easy, with the noted predictability comment that we had in number 2. As far as tracking flight path goes, it's pretty easy to track flight path, the easiest way is, is just to reduce pressure on the stick, like we talked about in the rapid descent, it works real nice in that, when I put in roll controls, or I move the throttles, I don't have to worry about the pitch, the flight path stays exactly where I want it, and that reduces work load for a lot of the tasks that we did today by a fair amount. Bank angle control, again, I would say that it's fairly easy to control bank angle, the one... again the predictability that coasting the crispness of the airplane, we already talked about. I will note that there's a tendency, or initially there was a large tendency for me to couple a roll response with the pitch response, because... and I believe based on the limited experience that I had in this sim today, that that was a function of ergonomics, ergometrics, and it was something that had a fairly steep learning curve. Towards the end of the period, I don't think I was doing it as much, at least I didn't feel like I

was having to pay as much attention to it, I'm going to be interested in seeing what happens this afternoon going back into the sim. Tracking bank angle is real easy if I release the stick, again, because of the crispness of the response, and I think this is more so in bank angle than in pitch, I have a tendency sometimes to get into a lateral PIO, because I would turn up my gain because I wanted to stop the pitch exactly where... not the pitch, the roll angle exactly where I wanted it. I'd put in a roll input, I'd be rolling there, and then I'd reverse the, actually front in the other direction to try get it to stop, and then I'd end up going in that direction for a while, and so I did have a tendency to couple up with the aircraft and roll control a little bit, and I would just note that this could be a function of several things. And even the perceived crispness of the airplane and predictability of the airplane could be a function of tuning the controller a little bit better. So, you know, we're getting into the area where the tuning of the flight control system and the tuning of the stick controller, both have a lot of how the pilot perceives the airplane. The reason I say this is, I can give you observations and feelings that I have, but unless we really went in and started breaking down things and looking specifically for what was the cause by the flight control, and caused by the stick, I'd have a real hard time breaking that out without doing a specific task. Heading control was real easy as a function of bank control, again, the easiest way for me to track any of the flight path, bank angle, or heading, is to put the airplane where I want it, and then release the stick, and again, simply because I feel that way, leaves me to believe that we could do a little bit better, there's a slight tendency for me to couple up with the controller and the flight control laws that we have.

#### **4. Ability to Control Airspeed (Autothrottle Off) ?**

We didn't really do a whole lot towards this task today, most of the airspeed controlling that we did was controlled by flight path, by gamma, for the rapid descent, for the VMC, that we looked at. So, I don't know that I really have a lot to say about that. As far as controlling airspeed with pitch, it is responsive. Again, and this isn't just a function HSCT, in any airplane when you go to control airspeed with pitch, it's not the quickest way to control airspeed sometimes, and you have to be a little bit patient with it. Having target pitch attitudes that you know that are going to work, or that you think are going to work, are going to be important for that, and you know, we kind of hunted around and looked at some things, and experimented with some things, particularly on the VMC today, and... but pretty much, I would say that the ability to track an airspeed, once you've captured it, is pretty good with pitch. Capturing it with pitch, there were quite a few times today where I was really hunting for a pitch attitude, and again, part of that, I think if you flew the airplane day in and day out, you'd get a little bit more familiar with basic pitch attitudes.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

Most notably what I saw today was a tendency to PIO and roll more than anything else. It wasn't a real bad tendency, and again, I don't know how much of that is a function of stick dynamics. If yes, was the task continued with reduced pilot gain, this is the second part of question 5, or abandoned ? We didn't abandon any of the task, because of lateral PIO, and basically, yeah, just reducing the gain. One good thing about this airplane is, is that at any other maneuvers that we did today, I could just release the stick in the lateral axis, and I'd be within 5 degrees of where I wanted to be, and then I could come back in and slowly adjust it. None of the times today did we have enough of a PIO where I had to release the stick. I don't want to infer that. There was just a slight gain reduction and I don't think it was really any big deal.

#### **6. Pitch/Roll Inceptor and Rudder Pedal Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Force & displacement, I think the displacements and the force gradients were fine. I think perhaps, if you played with the force and displacement gradients on the sidestick controller, I think actually you could of maybe optimized it a little bit, for this particular simulator. I think also that the ergometrics of the side controller and this airplane and the tendency to couple pitch and roll inputs, probably should be addressed. Sensitivity, again, that gets back to the friction and breakout issue, and I think that maybe the lateral PIO might be a function of the ergometrics, and also maybe a little bit of friction and breakout being likely. Might be adjusted a little bit, I don't know. It's really hard for me to comment on Number 6 here, because we didn't really do a lot specifically looking at that, where you're really going to isolate those things out. Pitch and Roll Harmony, I don't really have any comments on that, for small inputs, again, between ergometrics of coupling the two together, and the friction in breakout band, we probably could look at a little bit more, but for the most part, I didn't really... I don't think I have any trouble, control harmony.

## **7. Effects of the Wind/Turbulence ?**

I don't think we really had any Wind/Turbulence, so Number 7, there's no comment for that.

## **8. Summary - Good/Bad features ?**

I guess, just to highlight one of the things that we already talked about, I think the cueing for yaw or lateral acceleration, probably needs to be looked at, and I would say that there's not a real strong immediate indication of what rudder I need to step on when I have an unstart or an engine failure, and I think that would delay the recovery. Let's see, the other... there's something else I wanted to say as far as features go, oh ugh, one other thing that I would just note is, on the display with the unstart envelope and the concentric rings, for the task that we were doing today, and you know, we were thinking about it, and using that, it actually worked fairly well, better than I was really anticipating it working. I don't know that it's really, totally intuitive, it's intuitive in the sense that, we know that it's going work that way, and when we start to push the airplane over, we see that concentric rings work, and so, you adapt to it fairly easily, but I don't know that it's the most intuitive way that we can display that information. I would be a little bit concerned, there are a lot of rules, and I don't know them all off the top of my head right now, but there are a lot of rules that concern engine operability, and I think that we need to really look at engine operability at the correct rules as they apply as far as the envelope, the airplane within it's flight envelope and not having problems from an operability standpoint, and what the flight envelope is for these engines to operate. In other words, I'm not so sure that if I went out and did an engine operability program on a current generation subsonic airplane, if I pushed over .6 G's, and the engine coughed, I don't know if that would be certifiable. So, I think this is an issue that we need to...really think about, I'm not saying it's not do-able, or anything else, I'm just raising this as an issue that we really need to investigate early on. Certainly, flying an airplane with the engines like this, up at altitude at the high Mach numbers, all the current generation military, well, the older generation military airplanes, I don't really know about the Concord, but the older generation military airplanes, their engines were very sensitive, at the corners of the envelope like this, and people knew that, and the military got around that with training. Regardless of what you do, and how good the engines are, there's definitely going to be some training issues, as far as an HSCT type airplane would be concerned. Let's see, is there anything else, we did talk briefly about the rapid descent or the emergency descent, and there's some issues that need to be discussed there. Overall though, I think the airplane is very controllable for that, it's just a matter of performance numbers and how we're going to do all of that, but that's all I have.

## **Approach and Landing Questionnaire**

### **Pilot A**

Approach and Landing Questionnaire 15 Jan 97

#### **1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

Hey, we did not do... we haven't done crosswind landings yet, so, I'll skip that, that's question 1.

#### **2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

Any special techniques required ? The straight end landings all required a substantial amount of thrust increase in the flare, 2 or 3 knobs, to permit the gamma law to make the flare properly, if you did not use an increase in thrust or decrease the thrust, you've got a hard landing, and in addition to that the gamma command versus actual tended to split out, and also resulted not getting what you commanded in a hard landing. Other than that, the landings were within adequate to desired, and then most of the variables were in either landing long with a smooth landing or landing in the box with a slightly firm landing, and either desired or adequate, if you... in most cases, and there was no roll anomalies noted in the straight-in landings, however, in the offset landings where high gain roll tasks were required in realignment with the runway, and also minor corrections in the flare... during the flare, a PIO tendency was observed and if you maintain your hand on the stick, the cab motion seemed to create body motions that tended... encouraged full stick travel, and the lag in the roll response tended to also encourage a PIO, so, we had numerous case where we had to just stop the simulation to prevent a crash. The... so the rating for that one, and the Cooper Harper for the lateral mode in that case was a 10.

#### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Longitudinally was fine, other than the... as noted before, it does help in the flare if you add thrust to permit the system to comply with your flight path vector commands. Bank Angle Control was fine until you got into high gain tasks in the flare, in which PIO is observed. I don't believe we had any problems with heading... headings or the pilot's approaches.

#### **4. Ability to control airspeed (autothrottle off) ?**

I believe was satisfactory, the throttle being used is slightly stiff, but in spite of that we can still hold the speed within prescribed limits, with the... under all the approaches even with manual throttles.

#### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

None in pitch, but we did notice a divergent roll PIO that could be stopped by, or prevented by simply making a correction and taking your hand off the stick, which is not a real... realistic thing for pilots to do in the landing flare.

#### **6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

I think perhaps, the detents are a little too low, turning of the stick, perhaps, needs to be looked at again, not sure whether they're too light or too heavy, but... or maybe it's just the control law itself that's the problem with the PIO in the lateral axis. The Sensitivity, it seems

to me that there was some what of a lag in the roll response, which tends to roll PIO. Pitch and Roll Harmony seemed reasonable.

**7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

As I have said before, the aggressive lateral corrections led to a lateral PIO. The sink rate control, once... the, once... once it's learned what it takes to arrest the sink rate, basically, added thrust to supplement the normal flare, the... that seemed to be satisfactory, however, it is not necessarily normal to be adding thrust in the flare, most, and maybe this airplane is... has this characteristic, and this would be required, but it seems unusual. Tendency to float, there wasn't any tendency to float, except when on occasion when the sink rate was quite low, very close to the ground, you close the throttle, and it would be quite a while before the airplane would settle in. No problems with nose lowering. Special techniques required, I guess would be the added thrust in the flare, and for the PIO problem we encountered, technique there, would be to make corrections, and release your.. .release the stick, rather than keep your hand on it.

**8. Approach vs. Landing - which was more difficult, and why ?**

I'd say the landings are much, are more difficult than the approaches.

**9. Effects of the Wind/Turbulence ?**

Were mostly effected holding airspeed, because the airspeed was wandering around a bit, and required a lot of throttle activity.

**10. Summary - Good/Bad features ?**

Good features seemed to be mostly in the ILS approach where everything seemed to be straight forward, corrections and however the PIO's and the added thrust for flare seemed to be undesirable features.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

**11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

It is a question of how close in to the runway this happens, and what automated features are engaged, it's probably acceptable if the autothrottle is engaged, and under those circumstances, the thrust... the forward feed and the pitch... into pitch, helps maintain your glide path and maintain your speed, so there's very little pilot work load with that situation, with manual throttles on, then it takes more work, and if there's no forward feed, then you have to pay attention and adjust your flight path angle when you start ballooning above the path as the flaps extend, and also if you're at manual throttles, then you can be caught by surprise, and have the airspeed reduce excessively on you as the flaps extend. It would be preferable if that transition occurred at a higher altitude, like a 1000 ft or so, and seven, eight hundred ft, you have at least 3 miles, 3 or 4 miles of stabilized approach.

**12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition.**

Okay, I would think that you would want to have a stabilized, ideally, you'd like to have a stabilized approach. If you're doing manual throttles, you really ought to have that, perhaps, manual throttles would be a non-normal event in this airplane, but in that event, the automatic flap transition should occur, perhaps, with the gear down, or with... at a 1000 ft, or



something in that, among those lines, there's 750 ft, no lower than, no lower than 750 ft... the stabilization of the flight path can occur.

**13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

Most of the adverse characteristics... the main one is doing manual throttle operation where it can take you... can take you by surprise, and one of the problems is you, if your attention is diverted elsewhere, the flaps can be transitioning and slowing you down, before you realize it, and it's a possibility that you could get... so, there's no annunciation of how these flaps move. I assume that, perhaps, there would be a flap indicator that you could watch, but maybe there needs to be some annunciation of this flap transition, it needs to be done manually.

**14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

Decelerating Approach and Landing

I think having an automatic flap transition that occurs at 400 ft on the approach automatically, with this... it can be a serious... serious problem for this airplane, because if it doesn't go as planned, and if the procedure is to go around and plan another approach, you've gobbled up an awful lot of fuel droning around at low airspeed, perhaps, with the flaps out, and a high drag configuration, certainly, at low speed, and so, part of your situation... unless a failure allows you to go ahead and land, as is, which or may not allow you to take tail clearance, may cause you to make an approach at higher speed. May not... may well not be acceptable, have a similar situation with existing aircraft, where you can extend the flaps late in the approach, and not have them come down properly, that's still a possibility. Perhaps, it's not all that much different than any of today airplanes, but the plane is very critical as far as droning around low altitude, gobbling up lots of fuel, can't afford to spend much time troubleshooting problems, in a terminal area.

**15. Was the airspeed decay profile used in the decelerating approach acceptable ? If not, what characteristics did you find objectionable ?**

The only thing I saw was that apparently, past the threshold, it's slightly higher airspeed, 5-10 knots higher than normal, and the other characteristic was that the... you came across the threshold, or came through 50 ft with quite a low power setting, and in order to do the flare, it requires power, so, having to spool up the engines in a timely way, can create a problem if the pilot is distracted and waits a little too long, then time delay in this engine spool up can cause a problem for arresting the rate of descent. Perhaps the spool up needs to be done earlier, and at some point the airplane needs to be on top speed and spooled up to normal approach speed. I guess, while, each time I offer comments, the next question.

**16. Please describe any suggested improvements you may have to the decelerating approach procedure.**

I'd like to see an early configuration, and at a 1000 ft, certainly no lower than 750... thousand ft, and the decel profile should allow, should be such that, the last... at 200 ft or so, the... no lower than a 100 ft, the engine should be spooled up to stabilized approach speed. Higher, if you need to add thrust in the, than the engines can spool up, other than that, it seemed perfectly fine, I like the idea of a higher approach speed, the airplane flies better, at higher speeds you can see better... your angle of attack is not as great, less use of fuel, so, there's a

lot of good things about flying a fast approach, as long as you staying fast as long as you can, and precede in staying clean as long as you can.

**17. Do you find either the decelerating approach or the nominal approach profile to be more acceptable than the other from a piloting standpoint ? Is so, why ?**

Personally I would... when you say a nominal approach, you're talking about a automatic reconfigure and autothrottles ? If autothrottles are used, used and programmed properly, then I think you can... you can, you configure at a lower altitude and there's no particular problem with that at all, you can also, in addition, you can, as a alternative you could reconfigure at a higher altitude, and fly the... fly a decelerating approach, and especially if it was with autothrottles, that would also be fine. It's a fact that if a decelerating approach is made, and then I think that it had to be some minimal altitude where the engines are or the speed is stabilized briefly, and the throttles are spooled up, and in anticipation of having to flare, plus unless it's found later on, that thrust is not, added thrust is not required for a flare.

We didn't do crosswind landings yet, so, I won't comment on that.

[This pilot answered this questionnaire again following crosswind landings below.]

**Pilot A**

Approach & Landing Questionnaire 16 Jan 97

[This pilot answered the initial set of questions in this questionnaire earlier.]

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

There doesn't seem to be a problem with the control power, however, the... there are problems with crosswind landings. The first one is that, as cross control, as pilot gains get increased when the crosswind correction is applied, there's a very strong tendency to get into a PIO. In order to avoid this, it can be avoided by very careful avoidance of any roll inputs during the crosswind correction, and this requires quite a bit of conscious effort, and tends to detract from the ability to arrest the sink rate, in terms of the ability to provide enough rudder to align the airplane with the runway, there is enough rudder, however, the... it's not really desirable to... it's not advisable to remove all of the yaw error on landing, because the... this creates an excessive amount of drag, and a considerable amount of thrust requirement. There is, in terms of, along these lines when a lot of, on the crosswind correction is applied, it's very critical that thrust be increased preferably ahead of time to allow for the engine spool up to help in the flare, and as you flare, a considerable amount of increase thrust is required, especially when you're at the same... if you're at the same time correcting for the crosswind. In terms of the timing of the crosswind correction, the... the later the correction comes in, the more chances of successful landing, the... if the rudder is kicked out, or the crosswind correction applied too early, then considerable amount of thrust is required for quite a extended period of time, this also tends to create more requirement for roll corrections, which leads into a PIO tendency. That completes number...Question Number one. Let's see we're going to...

Crosswind Landing Procedures

**18. Did you prefer Procedure A (decrab initiated at 50 ft) or Procedure B (forward slip initiated at 200 ft) for performing the corsswind landings ?**

A normal procedure on subsonic airplanes is to establish a wing low correction that probably... in the area of 100 ft, and so 200 ft would be a little early for me, I would prefer

to start that sideslip later, and the... for this particular airplane, an attempt was made to determine what procedure works best for this airplane, and it seems as though, as mentioned before, the later the correction is applied, the better off you are, and so, you tend to have a sort of a combination forward slip and decrab at the last minute, actually what it really boils down to is, is probably a decrab in the flare, and it seemed as though the most successful landings that I attempted were, actually decrabbing after the flare had been initiated, and this was influenced... this technique was influenced to some degree by the problem with the PIO and the lateral axis, the longer... the longer the airplane spends in a side slip, the more likely it is that a PIO would develop, because of the lateral inputs that are required, and so for that reason, I tended to prefer delaying the crosswind correction until the very last minute.

**19. Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ?**

The way the control laws are set up right now, the roll PIO would prevent this, and some technique given, if that could be solved, then if that could be eliminated, then perhaps, more attention could be placed on providing an optimum procedure, which would probably be a late crosswind correction with, which occurred after the flare was initiated, and after the thrust has started increasing, and if then there was not PIO tendencies, and the roll was tuned, so that that was not a problem, then perhaps that could be achieved, but the overriding attention was on the... trying to avoid the PIO, so that then the landing could be achieved.

**20. Please describe any suggested improvement you may have to either of crosswind landing procedures.**

I guess I maybe of already covered that, the late... the nature... the aerodynamic nature of the airplane is such, that the drag increases dramatically when a lot of rudder is applied, so, and that requires a lot of thrust requirements, so that this airplane will likely be just by it's very aerodynamic nature is going to have to have a late correction, and it will have to have a thrust increase in the flare, and this may, perhaps, this could be easily tuned through an autopilot, I mean an autothrottle, which would provide the proper amount of thrust, for a normal flare, and then closing the throttle as at the appropriate time, in the flare. This could be the most likely scenario. This could also perhaps be done manually, but certainly, the more crosswind... the more crab that could be tolerated at touchdown, the less of a problem this would be. If you could touch down in a 5 degree crab, then the problems with added drag due to rudder, would be reduced considerably, and so, actually, a crosswind landing gear would be perhaps well suited to this airplane, I'm not sure it's practical though.

**Impact of Aeroelastic Dynamics**

**21. Please describe any adverse effects that you perceived as a result of the aeroelastic dynamics.**

22. Of the maneuver tasks that included a comparison of the aeroelastic dynamics, which was most adversely impacted by these effects ?

**HUD symbology Issues**

**23. Was the appearance of the actual flight path symbol (triggered when flight path angle error exceeded the threshold value) helpful or more of a nuisance ? Would you suggest any modification to the logic which triggers the appearance of this symbol ?**

Well, I suppose I used it under certain conditions, when you're trying to fine tune a landing flare, or a tracking task, it... I guess it was helpful to know that I was not getting the commanded path, however, I'm not... I'm a little suspicious that it might produce some, under some conditions, confusion, on the part of the pilot, as to what to do with that. It's conceivable that a very aggressive pilot could be closing on the actual gamma and have the commanded gamma making large excursions, but I think it is important to know where your actual gamma is going, and, however, I suppose that you really don't know this in existing airplanes, so, it, I guess, in summary, it was... I did use it on occasion to fine tune my command inputs, and knowing for instance, the actual gamma was not what I was commanding during certain phases of flight, flare, and the accelerations, and so forth, and I guess, having flown the airplane... for someone... if someone has flown the airplane, and it gets to understand where the splitouts occur and what they're most likely to be, perhaps, they could be anticipated. In that sense, perhaps, it would take some of the mystery out of landings and other maneuvers by knowing exactly what your commanded is doing. Ideally, it would be best if the commanded gamma could be achieved all the time within reasonable tolerances. As far as, would I suggest any modifications to the logic which triggers the appearance of this symbol ? I think that this, perhaps, several scenarios for the breakout of this symbol, might be evaluated in the future, and the future simulation, and further experience with this might suggest some modifications to the logic. The logic that was used in this simulation seemed to be reasonable.

**24. Was the tailscrape indicator symbology presented on the HUD useful during execution of the go-around tasks (4086 and 4085) ?**

I guess I'd have to say no, because... mainly because on the approach... during the approach I was concentrating on the flight path marker, and during the flare I was to continue to flight, concentrated on the flight path marker, and on adding thrust, the thrust required for a flare... continued to concentrate on that, and at 30 ft or the go-around altitude, I started the go-around, added thrust, actuated the go-around switch, and at that point was intent upon getting a positive rate of climb which requires looking at the flight path marker, calling for a go-around, or calling for gear up, and then establishing a flight path of 12 degrees, so I seldom looked at the waterline indicator marker, and consequently, I can't say as I used the tailscrape indicator at all, or even... not sure I even saw it, although others did.

**Pilot B**

Approach and Landing Questionnaire 07 Jan 97

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

I haven't done cross-wind landings really. So I guess I can't answer that yet. They were adequate for the landings that we've done so far.

**2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

I haven't done a whole lot of yaw inputs. Pitch and roll...roll is not so much an issue. No special control technique required. Pitch is an issue in the flare. We just started talking about that a little bit. I have a problem in predicting the affect of fine pitch inputs and rapid, particularly rapid pitch inputs, in the flare. But, I don't recall having to this extent previously. Basically, what's happening is.. I'm putting in initial pitch input into arrest the sink rate to get it close to desire for touchdown and then trying to fine tune it. And what I'm finding is that there's such a large split between my commanded pitch input and my actual flight path that I'm having problems in predicting for rapid inputs, where to command the.....where to put the commanded indicator in order to get the desired performance that I want. And what's

happening is that I'm either floating a great deal consistently or I'm landing hard consistently or both. And when I say hard, I'm dropping between 4 & 5 feet per second. So I'm able to consistently get adequate performance. But whereas previously after 3 or 4 landings I was able to pretty consistently get desired to the best of my recollection. I'm at....not able to do that anymore. I think one of my landings today was in the desired range and all the parameters and the rest of them were in the adequate range. So, I'm seeing a fairly consistent trend here. I guess I can't tell you for sure if its ground effect or control laws. I can tell you that I'm seeing a lot of splits between the commanded and actual gamma ..down low and to the best of my recollection its more than I've seen in the past. In any case I'm having a problem with the ..with control. Which kinda leads to the next question.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

(a) Flight path is a problem down low in the flare for me. (b) Bank angle is kinda of a nuisance. It isn't so much a problem as it is a nuisance. In that there's no true bank angle hold mode in this control law. The bank angle hold up in a way as a soft bank angle hold, in other words, what happens is, if you set it 10 degrees angular back and then reduce the inputs to zero or let go of the stick, it would hold 10 degrees angular back until you get a gust upset and as soon as the gust changes the angular bank by a couple of degrees it wants to stay at the new bank angle when it changes. So it seems like the bank angle is holding whatever it had last until it got an upset. Whether it is commanded upset or whether its a natural upset. So there's no true bank angle hold mode as a result of which you have to constantly put in lateral inputs in order to maintain any bank angle. So, what would be nice to see is a true bank angle--a hard bank angle hold mode, and, as I've mentioned before a latch near zero plus or minus 2 degrees or plus or minus 3 degrees where you will not change the commanded bank angle at that point. (c) Same thing for heading, its no real problems with it. Its just a nuisance having to make the lateral inputs. You don't have to make those inputs longitudinally because of gamma dot V.

### **4. Ability to control airspeed (autothrottle off) ?**

Ability to control airspeed I think is fairly easy. We've got the right control laws from what I've seen on the acceleration carrot it looks real nice. So, no major problems with that. It increases work load with the autothrottle off , but you'd expect it to. But the display is certainly helping you.

### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

I didn't note any PIO tendencies in pitch or roll.

### **6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

The force and displacement characteristics on the side stick and the rudder pedals occurred about right. (b) Sensitivity was okay. (c) Didn't note any problems with pitch and roll harmony today. Minor tendency to couple the axis in pitch and roll. In other words, when I'm making a pure pitch input, minor tendency to inadvertently make a roll input. Certainly, nothing is severe as what I saw yesterday. Its fairly minor.

### **7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

Runway line-up is a problem on the offset landing task, you would expect it to be, that is the whole idea behind the task. Definite problems in sink rate control. Definite tendency to float for me. Much more so than I recalled in the past. No problem with nose lowering. (b)

Special control techniques consisted of basically trying to set the attitude that you want in the flare and try to avoid any large inputs just prior to touchdown. Whereas previously I felt like I could finesse the sink rate just prior to touchdown, I no longer feel like I can do that here with this ground effect model. So, you gotta pretty much set what you want and if you get lucky, and you get the right one, you'll get in a box, if you don't --you won't.

**8. Approach vs. Landing - which was more difficult, and why ?**

Of course, the landing was much more difficult than the approach for reasons I've just discussed.

**9. Effects of the Wind/Turbulence ?**

The effects of turbulence is just to add to the workload. We didn't have any cross- winds to speak of today.

**10. Summary - Good/Bad features ?**

In summary its a pretty solid level 2 configuration. I don't think there's any longer any doubt that I know whether its level 1 or level 2. Its very solid level 2. And I think previously I thought it was borderline level 1 or level 2. Up and away it very clearly level 1 like it has been.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

**11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

The automatic pitch reduction is acceptable. I've got two problems with it. One is the longitudinal flight control system does not adequately compensate for it. . In that you get some heave and you always go a quarter to a half a dot high in the absence of any compensating inputs. That doesn't make it unacceptable it just a nuisance. The other problem I had with it is from a certification stand point. I believe that most regulatory and customer pilots are going to have a problem with large configuration changes below 400 ft which is what we're talking about. And to do it at 150 ft where things moving on the airplane externally, I think many pilots are going to find unsatisfactory. And I think its more than a 50% type thing if you got 1 out of 5 that find it unsatisfactory, you're going to have a problem. Because, one of those people is going to be on your regulatory team or on your certification team from a customer...so., you ought to be looking for numbers more like '9 out of 10 pilots like it' before you feel comfortable about doing something like that . I got..I've happen to be one of the ones who have a problem with it from a regulatory stand point. I would suggest the initiation altitude of that flap transition be higher if you're going to make it automatic.

12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition. The timing is fine. I don't have any problems with the amount of time it takes to ramp the flaps in. That's about right.

**13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

I think I've covered the adverse characteristics that I perceived.

**14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

In my opinion it is not acceptable for use in a commercial transport. I don't believe that you can train pilots for any failures contingencies associated with such a practice, unless you can guarantee ten to the minus ninth that the flaps are going to go where you say they are going to go. And that's both flaps or both sides of flaps unless you can guarantee they are going to go where you say they're going to go at that point. I don't think you can train to this...to failure contingency. Somebody is going to miss understand what's going on.

#### Decelerating Approach and Landing

**15. Was the airspeed decay profile used in the decelerating approach acceptable ? If not, what characteristics did you find objectionable ?**

Allright...with decelerating approach...I found this more acceptable. I didn't have a problem with the airspeed decay profile and with auto throttles on. I don't think you are ever going to certify it with auto throttles off ....because I think the pilot is going to attempt to, to...ignore airspeed and concentrate on flight path and as a result at which you can get really really slow and not notice it. Until it's too late.

**16. Please describe any suggested improvements you may have to the decelerating approach procedure.**

I made some improvements on this while we were doing it and that was up the power setting to 10% for this profile.

**17. Do you find either the decelerating approach or the nominal approach profile to be more acceptable than the other from a piloting standpoint ? Is so, why ?**

I think we all understand that this profile is artificial, because you got a canned set of environmental scenarios so you setup a power setting. Ultimately you'll want to have some sort of a profile on an auto throttle.

#### Crosswind Landing Procedures

**18. Did you prefer Procedure A (decrab initiated at 50 ft) or Procedure B (forward slip initiated at 200 ft) for performing the corsswind landings ?**

Haven't done crosswind Landing Procedures, so I'll avoid that.

**19. Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ?**

**20. Please describe any suggested improvement you may have to either of crosswind landing procedures.**

#### Impact of Aeroelastic Dynamics

**21. Please describe any adverse effects that you perceived as a result of the aeroelastic dynamics. We didn't do aeroelastic today, so, I won't mention that.**

22. Of the maneuver tasks that included a comparison of the aeroelastic dynamics, which was most adversely impacted by these effects ?

#### HUD symbology Issues

**23. Was the appearance of the actual flight path symbol (triggered when flight path angle error exceeded the threshold value) helpful or more of a nuisance ?**

**Would you suggest any modification to the logic which triggers the appearance of this symbol ?**

I felt like the actual flight path symbol was helpful today. In that...particularly in the flare, and it gave you some lead as to what was really going on , but, although I needed it a whole lot more today than I recalled needing it in the past, because of the amount split that I saw there. There was times when I saw a full velocity vector width of split between the actual and the commanded. Which is more than I recalled seeing in the past. Upwards of between 1 and 2 degrees a split for an extended period of time. I..for some reason don't recall seeing that in the past. I think the logic which triggers it is fine. I just wish that it didn't appear quite as often . It may be that the commanded symbol is too quick. But the idea of making it quick is to show you where the actual is eventually going to go. The problem is there's lots of times in a dynamic scenario where it takes one heck of a long time to get there. So, you really need it more than...you needed more of input that you thought you did ...to get it where you want, so, I think that's worth looking at.

**24. Was the tailscape indicator symbology presented on the HUD useful during execution of the go-around tasks (4086 and 4085) ?**

Haven't done go-around yet so I can't talk about that one. So, that should finish up the questionnaire.

Pilot B answered this questionnaire later in this test, see below

**Pilot B**

Approach & Landing Questionnaire 07 Jan 97

[This is the questionnaire following the Block 2 testing that Pilot B did on the 7th of January in the afternoon. He answered some of these questions in a previous session above.]

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

The adequacy of roll and yaw control power for cross-wind landings was, I'll say was marginal. Particularly in roll, in terms of actuator, I met the rate limit quite frequently. Times when I'm feeling it, times when I'm not. Yaw control I'm feeling like I putting in most of the rudder to drop it safely for 35 kt cross-wind.

**2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

Pitch predictability is okay, roll and yaw combined predictability in response to inputs is tough. Its a lot of work associated with that.

**3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Ability to control flight path is somewhat degraded in cross-wind landings. It seems tougher that it was before, I know there's increased CL beta and that may have contributed to it , I don't know, but it sure seems a lot tougher than it was. Bank angle control particularly was more difficult.

**4. Ability to control airspeed (autothrottle off) ?**

I don't recall doing any autothrottle off stuff.



**5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

Minor PIO tendencies in the roll axis. I commented on that.

**6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

Pitch and roll inceptor characteristics were okay.

**7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

Runway line-up problems big time in cross-wind landings. Sink rate control problems, there was a tendency to float and corrections with the sink rate. And problems in nose lowering in cross-winds. Special control techniques is just to minimize the inputs to try to avoid the....saturating the rate limits.

**8. Approach vs. Landing - which was more difficult, and why ?**

The landing was more difficult than the approach for reasons I've just discussed.

**9. Effects of the Wind/Turbulence ?**

Turbulence makes things tougher. The cross-wind is a bear in this airplane.

**10. Summary - Good/Bad features ?**

In summary particularly at 35 kt, we're right on the ragged edge of control. I might question whether this configuration is certifiable with the techniques, that I saw and the amount of workload that is necessary. In any case the forward slip technique is doable. The decrab technique is, I think is .. arguably uncontrollable. Certainly the way I was conducting it, which was to start it right after 50 ft. Again, if we try to do the same task in degraded weather conditions at night, that sort of thing, I think it will be real difficult.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

**11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

Yeah....comments are pretty much the same that I had from earlier. I think there's two problems associated with that. One is reliability. Changing things that low. And the other is, is being at a low altitude with things moving on the airplane that you're not directly controlling. I'd prefer to see that earlier.

12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition. I'd prefer to see the initiation altitude earlier. The timing is about right for in terms of how long it takes to clear.

**13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

Adverse characteristics, the sight picture is changing once you get down low. The necessity to correct for heave at that point adds another control task into the picture. Particularly in cross-winds and an already high workload scenario.

**14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

And in my opinion this automatic flap transition at this low in altitude is not acceptable. I don't think training is an issue here.

#### Decelerating Approach and Landing

**15. Was the airspeed decay profile used in the decelerating approach acceptable ? If not, what characteristics did you find objectionable ?**

**16. Please describe any suggested improvements you may have to the decelerating approach procedure.**

**17. Do you find either the decelerating approach or the nominal approach profile to be more acceptable than the other from a piloting standpoint ? Is so, why ?**

I talked about the decelerating approach in the morning session.

#### Crosswind Landing Procedures

**18. Did you prefer Procedure A (decrab initiated at 50 ft) or Procedure B (forward slip initiated at 200 ft) for performing the crosswind landings ?**

I prefer, much prefer a forward slip and that I think that the decrab was unacceptable now. By the way I don't recall believing that it was unacceptable previously to this cycle 3. And I'm wondering whether the increase of CL beta or ground effect or both is contributing to my perception, that, I no longer think it is acceptable to do a decrab in this configuration. The problems...are predictability and roll response, weight limit, saturation, PIO, and loss of control.

**19. Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ?**

I feel that I can land the airplane reliably in the simulator, and the simulator condition, this is question 19 now. In the 35 kt cross-wind, I'm convinced that in the present configuration, I wouldn't want to hand it to a FAA pilot to demonstrate to him in a certification roll. I have a problem with this. I don't think its easy enough that you can hand it to a customer or to a regulatory pilot. Cause the workload is way, way too high for that.

**20. Please describe any suggested improvement you may have to either of crosswind landing procedures. Suggested improvements.**

I think that the ARI [aileron-rudder interconnect] needs tuned. So that there's less coupling between the lateral and directional axis and I think we have a symbology problem. I think we have a problem with guidance as far as where to put the nose, where to position the nose of the flare. The requirement to concentrate on the sink rate control on the longitudinal axis detracts from your ability to control lateral directional. I think that if we can make that easier by tuning the presentation of the velocity vector in a dynamic situation. And, I guess I don't want to suggest how to do that, but right now when I move the stick in the flare I get a wide separation between the commanded flight path indicator and the actual flight path indicator. The commanded flight path indicator is too quick, its not giving me real time information, so its largely useless. When I get in a real dynamic situation, and the actual flight path indicator doesn't give me predicted information as far as where its going to go in the near future. So, I guess I need something in between those two. I'd like to see, we either need to relax the limits on bank angle, with respect to wing tip or nacelle strikes through changes in geometry, or we need to provide steerable gear, or we need to provide an improvement in the

flying qualities to allow, maybe more decouplings like I said of the two axis to allow reliable cross-wind landings at 35 kt.

#### HUD symbology Issues

**23. Was the appearance of the actual flight path symbol (triggered when flight path angle error exceeded the threshold value) helpful or more of a nuisance ? Would you suggest any modification to the logic which triggers the appearance of this symbol ?**

The appearance of the actual flight path symbol was helpful, although as I just said it's not really enough. There is so much lag in that because of the inertia of the vehicle that you don't have a reliable predictor as to where it is going to go in the near future, and it takes too long to catch up with the commanded indicator when you get down low, so I don't really have anything to guide on. The modifications I suggest to the logic on this is to give me either a quick and actual flight path or a lagged commanded flight path, or maybe merge it into something that is neither actual nor commanded that is something in between that's used for in the dynamics of the flare.

**24. Was the tailscape indicator symbology presented on the HUD useful during execution of the go-around tasks (4086 and 4085) ?**

The tailscape indicator symbology was useful, although not a whole lot and the reason being is you're concentrating so much on that flight path indicator that you're only peripherally looking at the tailscape indicator with respect to the water line. In fact I had to go through one go around before I realized having been prompted that the tailscape indicator was only valid with respect to the water line, it had nothing to do with the flight path indicator. I am not sure how to fix that either, because if you put the tailscape indicator down low, it's going to be in the way, so I am not sure you could, maybe you could flash it when you get close, you need to provide some peripheral queue that you are getting close to scraping, to make it more useful. Although, I've got to admit that I did see it peripherally and once after two or three times looking at it, realizing what it was telling me, I was able to use it a little bit. Primarily what it was a training tool, I learned that when I saw it, when it got close, that I needed to back off on the aggressiveness of the Go-Around, and once I got a feel for how aggressive I could be in the go-around I think that's what I was using more than that indicator.

#### Pilot C

##### Approach and Landing Questionnaire 13 Jan 97

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

**2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

For the ILS approach, it's got predictability of Pitch, Roll, and Yaw Response to Pilot Inputs, and for the level part of the ILS and the glideslope, and localizer down to, near the end of segment one, the last couple hundred feet of segment one, things change, but up to that point, the predictability was fine, I had no complaints with roll, pitch, yaw, and it was quite, quite easy to keep desired performance, and I think the times that I saw the...only adequate performance, was in the very end of segment one, when things were starting to happen, and that would get me out to the adequate, and either the pitch or the localizer. So, pretty much on the approach, I had no problems, the real problem came in when you come in real close on segment two, the very end of segment one, and throughout segment two, the

roll actually felt all right, and the only reason I got out of desired on, and yaw, the reason I got out of desired on that, was because I was concentrating so much on the pitch, that I just let the displacement left and right go, because I could see I'm still on concrete, so I'll accept that, if I can just make this pitch behave, and...but the predictability in pitch and so on, says to pilot inputs, but there were things that went on that I didn't put in, and sometimes I put something in and I didn't see the response I expected out of it, so, the predictability in pitch, in the nominal in segment two, was poor at best.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Ability to Control and Track, oh, I see what you mean, Flight Path, well, that's what it said, it's the...the glideslope is the hard thing, to try to keep the flight path and keep it all one continuous path as opposed to ballooning, then sinking below, and so on. I even went as far as to change technique, and try starting out low so that when I got the balloon that I knew was coming, it would bring me back, but at the same time, the balloons also was getting attitude changes, and it was just too many changes for me to process, and I would end up with surprise touchdowns, and almost all of them were long, because I really hesitated to pushover as hard as I had to that close to the ground, knowing I was going to have to rotate at the last moment, or at least felt like I was going to have to rotate at the last moment to keep arrest to sink, and with wheels that far back, that's asking for trouble, I know. Ability to control Bank Angle, it was doing what I wanted, I didn't have any complaint with that, and same thing with heading, as long as I had just minimal amount of concentration on either one of those, there was no difficulty.

### **4. Ability to control airspeed (autothrottle off) ?**

It takes a lot of practice, and I don't think how much practice I ever could get, would I ever be able to keep it completely in the desired, which I think was 5 knots, when you push over, and have to make large throttle changes, I would then start chasing the airspeed, and about the time that I'd almost get it under control, we'd go through this big, goat rope here with the attitudes and ballooning, and now I can't concentrate enough on the airspeed, so, I would get off again, but the...I'm not sure on the...when I was...just say, pushing over from the level part of an ILS, when I pushed over, and then tried to capture, I would get more than 5 knots off, and part of it may have been, you have to make a large input, and there seemed to be quite a while before the acceleration karat moved, now I don't know whether that's due to just engine response being slow, or whether it had to do with the dynamics of the display, in other words, maybe the display was too far behind, but I do know that it would get me started, and if...and you can have a PIO in a throttle, and I felt like I might have been doing a little bit of that, I was just chasing the airspeed a lot, and I'm not sure whether, like I said, engine response or display, but it was a factor everytime I made a big throttle change.

### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ? Were there any PIO tendencies in the Pitch or Roll axis ?**

I didn't see anything in roll, and the problems I was having, I think I was overcontrolling in pitch, but I don't recall anything that jumped out at me, and said, boy, I think that's a PIO, it's...you know, you're getting a lot of oscillations in there that you're driving, but I think I was overcontrolling, so the PIO tendencies I recall on the scale, they often say...unus...undesired motion, and yeah, it would have been from overdriving, but I don't recall, certainly there was no...a PIO in there that was a full cycle that was expanding, in other words, if there were any cycles there, they were converging, anyway, and it's hard to tell, you know, with so much going on, there...you know...however you want to define some of these terms is the problem.

## **6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

Okay, as far as Pitch/Roll Inceptor and Rudder Pedal Characteristics, Force & displacement, all felt fine to me. Sensitivity, I didn't have any complaint with, I felt like I had sufficient authority and everything, and the pitch and the roll harmony was okay, the airplane feels more responsive than roll, than it does in pitch by quite a bit, but the harmony as far as force harmony or displacement, harmony didn't jump out at me as, oh boy, that's...that's all messed up, it was within a reasonable boundary, there's quite a...quite a variation you can have there, and still be quite useable. Just as an aside, the only thing I noticed the whole day, was on one of the approaches, I seemed to pick up more breakout force in pitch, as it went through center, in other words, if the quote, detent kind of a feel, I really noticed having to push and it break loose, but it was only on one pass, and other than that, I didn't notice it. If it was there, well, I just didn't notice it, but on one of them I did see...it did appear to me, to be different than the other times, and like I say, it was only on one pass, so it makes me think there might have been an anomaly on that particular one.

## **7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

I think I pretty well covered those, but let me just reiterate here. The line-up, as long as things were under control in pitch enough that I could concentrate at all, the line-up was not bad, and certainly, until I got close to the runway, I mean, I'm talking about almost to the overrun, line-up wasn't a problem, gee, I could...the initial line-up was very easy, maintaining a localizer was easy, it's when I got in real busy and so on, that sometimes I let it drift off. Sink rate control, boy, I don't think I ever really sorted that one out, if I was...if I just refused to take anything except a comfortable sink rate, every landing was long, but on these things we usually try to get desired performance if you can, and any time I did that, the sink rate went to pieces on me, so, that was...I consider sink rate very difficult. Tendency to float, I'm not so sure that I was floating as much as, it just seemed on those first few, I always seem to be high at the time I started my flare, and there just isn't anything you're going to do, but land long, so the fact that I landed long, doesn't necessarily mean that once I was all flared, that it floated too much, so, while the touchdowns were long, I don't think it was just the classic, get down, set your attitude, and it floats a long time, it didn't appear to me to be that way, and nose lowering, sometimes I let it drop, but that wasn't due to the airplane, it was more just technique, I mean, if I...if I would of just landed like I had passengers back there, I wouldn't of had a problem lowering the nose nice and smoothly, and so on. The times that I was specifically checking that, it was...it was very controllable and nice. Sometimes after a bad landing, I just kind of kick myself, and just kind of let the nose drop, but that's more laziness, than it is handling qualities. Any specific control techniques required ? I tried, I couldn't find any that I was happy with, and some of them weren't very...weren't very natural, certainly, weren't very comfortable, when you're that close to the ground, you get that ballooning, it is very hard to grit your teeth, and push your...the nose even further down, because the attitude change came in all by itself, and now you see that your high, you've got to push even further down, and that's a bad, bad feeling. I certainly would hate to see something like that. Tim even mentioned, how about when you drop out of the clouds, well, if you've got this stuff going on, the first time you see the runway, and you've got to push your nose down to hit the spot, I don't think you're going to do it, I think you're going to be landing long. So, the only other special control, other than sometimes I just grit my teeth, and except what I had to do, is I tried to come in a half a dot low on the glideslope, so, that when this phenomenon occurred, that, you know, it would put me back to where I wanted to be, but I never did get a...I never could, if I put it low enough where that would have started to put me in the box, I would have been considerably out of the, certainly, desired maybe

adequate on the glideslope tolerances, if we had it, because I would of had to have been, probably at least a dot low to have that little technique work, and of course, that puts me out there, so, it's kind of a tradeoff, it's tough.

### **8. Approach vs. Landing - which was more difficult, and why ?**

Approach and Landing, well, by now you certainly know which was more difficult and why. The approach actually was quite easy, up until the point the thing started to change on short final, and the only reason on the the first ones, the approaches didn't get very good Cooper Harpers, but it wasn't due to the everything up and away, as much as it was when I was getting in close, and if you would have started segment two at 400 ft instead of 200 ft, you would of gotten vastly different ratings on the glideslope, so, there's a little bit of a contamination that gets in there, because what you got for most of the flying is not...is not what you...it gets contaminated by the last couple of hundred ft in there.

### **9. Effects of the Wind/Turbulence ?**

We really didn't have crosswind, the turbulence was in there, there was some, and it, you know, it...it was noticeable and took some work, but I mean it was...it was not a big player. The level of turbulence that was in there did not effect the ratings I don't believe. One comment on that, I suspect it's the turbulence that's making the airplane move around, and I watched that the flight path going right where I want it, but the airplane, it's sure moving around a lot, and occasionally that would bother me a little bit, when I was getting in down low, and wasn't sure what input to put in, and all of a sudden the airplane would do something on it's own, that...that's not a nice comfortable feeling. Yes, pitch is the problem, the turbulence in the lat-dir, I didn't see anything that up...it was affected at all, in pitch, however, the problem about the time that, due to configuration changes, apparently, for something the airplane would start it's heaving and pitching, there may have been something in there that was due to turbulence, and that just added to the already uncertainty, and from about 200 ft on down, my anxiety level went up remarkably in there, just because of these things going on that I wasn't sure how I was going to sort out, and I tried a couple of different...intentionally tried a couple of different techniques, but I never found anything that I was very happy with.

### **10. Summary - Good/Bad features ?**

On that particular one, the up and away, the glideslope, and the localizer control is great, down low, I didn't see any big problems in the lat-dir, the pitch, however, was the problem. Well, it looks like I've probably gotten ahead of myself on the questionnaire here, because now we're going to talk automatic flap transition in approach and landing tasks.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

### **11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

I'd say no, that's too close to the ground to have your nose going down, and even though your still safe, it's not a...certainly not comfortable, and it's something that raises your anxiety and just starts a lot of things going on, so in my mind, I didn't think that was acceptable. Would it be any better if, I mean, it looked like glidepath changed when that was going on...oohhh it did...the control system helped that intact better with that would that be a problem ? I don't know, I'd like to try to see, I mean, I wouldn't try to predict that, I think I'd have to see it, before I can predict that, but that might have...if this...I know why you have to do it in there, if all of this could have gone on, so that I would of had a chance to solve the problem, and then go on in and land, it would not have been, it would have been a non

problem. This stuff happening at 4, 500 ft would not have been the problem, my concern is, I'm close to the concrete down there with this airplane that stretches back to counties away, and I've got to get this settled out so that I'm not making any last minute quick inputs, because that's always been my thing. Big airplanes, when you're down in the flare, there's not a awful lot you're going to be able to correct anymore, you better be pretty well set up, and I was still correcting when I was getting down on that one, and it was very upsetting, and Tim's thing...I don't know, it seemed to balloon, I watched myself go from low to high in a hurry, maybe if I didn't do that, I don't know, maybe...so, the attitude change by itself might not of done it, but I can tell you the attitude change plus the flight path change was certainly not acceptable.

12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition. Well, I think I pretty well did, if it was...and I know it's not a option, but if it would have been earlier from a handling qualities point of view, it would of likely been a non event, if it would have been up further away from the ground, I'd had time to get settled out before I actually got in the flare, and thus, the altitude and the timing are tied together anyway.

**13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

Okay, any adverse characteristics as a result of the automatic, I've already told you both...both the nose dropping like that, and the heaving, and then the combination together makes each one by themselves, would have been tough enough, and to do both, it was certainly adverse to say the least.

**14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

Well, I can't say too much about the training because, you know, I've got a grand total of what, 2 1/2 hours of landing this airplane now, and...but I can say in that much training, it certainly would not be acceptable, and I would be concerned about this, I think too, if you train it, then unless you see it all the time, you might revert to more natural type compensation when you got yourself in a bind, and keep in mind all of this is without turbulence and any anomaly, this was a fairly benign conditions, and it would be interesting, will be I'm sure, when I get a chance to do it with some environmental changes, but with this one, I...you know...it's amazing how many things the pilot can be trained to do, but I would say that in the things that I did, I didn't see anything that was even approaching natural type compensation, that I would want to try to train somebody to do, in fact, here's a interesting point, I'm getting a little bit ahead of myself, I think had I done the deceleration one before I did this automatic flap one, I think that the decelerating approach one, would have started out with better characteristic, or better Cooper Harper ratings and so on. It is a...that was a much more natural type of flare and landing then the nominal was, and after working so hard and trying all these things on a nominal, when I got to the deceleration, I was kind of thinking that I still had to do some of those when actually that was hurting me, and that's one of the problems when you get into training things out, you can teach people bad things, as well as, you know, maybe it'll work, in this particular instance, this is the way to do it, and if that's what they see most of the time, that's probably what they're going to want to do another time, and when that might not be the appropriate thing to do, if that makes sense.

Decelerating Approach and Landing

**15. Was the airspeed decay profile used in the decelerating approach acceptable ? If not, what characteristics did you find objectionable ?**

That was very acceptable to me, the only thing that came in as a surprise, and had a, and probably thought about it a little ahead, they've certainly been fore warned, the first time I tried the flare that was working before, and it didn't work, and it was a surprise. What was the difference, and the difference is, that apparently the airspeed is a little bit lower when you initiate the flare, on the decelerating one, did you say, and as a result, you don't have as much cushion there, and so the same flare, I was rotating and continuing down, so in other words, what was a reasonably timed flare on a nominal was a late flare here, because I just didn't have as much, you know, the airspeed was dying off, and I just didn't have as much to catch it with, so, then I said, ah, ha, I think I've got it, the trick is, make a little more natural, and the next one was a little bit, the other thing was, when I kicked off the autothrottle, I was also retarding the throttle on this one as I had on the ones before, and you see, that set me up, you see, that's why I'm saying, if I would have done this one first, it would have been a much more even flow type of learning curve, with the other one, that...that set me up to do some things that actually hurt when I came to the deceleration point. I didn't see anything that was objectionable, that's very reasonable, as I mentioned, keep in mind now, there were no...there was not turbulence, and gustiness on this. If we are really close to, you know, if speed is going to make that much difference, then possibly, you know, a last minute wind shear is going to put you in world of hurt, it could be, I don't know, I'm just postulating here, something I'm sure we'll get a chance to see, but, that would be my only caveat. In the conditions that I saw, that was not objectionable, if there was enough to flare there, and in fact, it allowed me to be a lot more accurate on my touchdown without having a lot of floating. Okay, in other words, it did appear to be about the right speed for those conditions anyway, and I know, usually when you've got gusty conditions you bump the speed up and all that, but all I'm saying is, for what I saw, I didn't see anything that was objectionable.

**16. Please describe any suggested improvements you may have to the decelerating approach procedure.**

I'm not sure that I have anything, again, going back to in the conditions that I saw, I didn't have anything that I can think that was real bad, oh, one...now that I mentioned...the only thing that I saw that I had to concentrate a little bit on was, the flaps change there somewhere, and you're commanded flight path marker and your actual one split, you've got to be aware of that and aggressively put your actual one where you want it, because on the first couple, I was a little bit lazy in catching that, and as a result, they were just a little bit long, and I think that was the difference between getting the long adequates, and later on getting the desired was, I just wouldn't let myself balloon, so they took that little out, that was the...maybe the minor compensation I had to put to give it a 3, but that would be the only thing for somebody to stress, is okay, when they split, make sure that you put your actual and down right now, don't wait for it to come down by itself, I guess is probably, because you know it will, I mean, you know, sooner or later, it's going to come down, but that will just get you enough extra altitude, and you're probably going to land a little long.

**17. Do you find either the decelerating approach or the nominal approach profile to be more acceptable than the other from a piloting standpoint ? Is so, why ? Do you find either decelerating or nominal profile to be more acceptable than the other from a piloting standpoint ?**

And that's what this whole conversation has been about. I much preferred the decelerating approach, and it just...it's more natural, I can fly it more accurately, and if that would meet the noise criteria, then it would be hands down winner, as far as I'm concerned, and for all of the other reasons that I talked about. The rest of the things are on crosswind, and they're all



last on cards. Unless there's something else, any questions in particular, did that make sense.

Pilot C answered this questionnaire later in this test, see below

## **Pilot C**

### **Approach & Landing Questionnaire 14 Jan 97**

Pilot C answered this questionnaire earlier in this test, see above

#### **1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

I don't think I required full throw on anything with the exception with trying to recover from giant PIO in roll, but that was...I think I had the power that I needed. It was some other problem that caused the PIO, and then once I got going in the PIO, then I hit the stops, but I'd say that the control power in both roll and yaw was sufficient, don't really have much to add...most of this approach and landing, I covered so much yesterday, I don't really see too much to increase here. Effects of winds and turbulences, the whole section on the cross-wind, and the turbulence, other than just making the airplane bob around, as it's trying to hold it's gamma, I didn't see the turbulence on the standard ones as being a problem. The standard...approaches and landings yesterday, certainly weren't and today, every once in a while, there was a big one that came in with a cross-wind step and I don't know, if that's what I saw close to the ground or not, then it was pretty big, but in general it didn't seem to really have that large in effect, it was more just a kind of rumbling and heaving and so on, and it wasn't a big deal. Let me come down here to cross-wind landing procedures, anything else I have to say about the wind and stuff will come out in the rest of these questions.

#### **Crosswind Landing Procedures**

#### **18. Did you prefer Procedure A (decrab initiated at 50 ft) or Procedure B (forward slip initiated at 200 ft) for performing the corsswind landings ?**

Considering the fact I got into a giant PIO and had two wing hits on the ground, Procedure A was undoable for me if I got it...if I got the PIO started it was...I was losing control. On the ones where I didn't get to the threshold where I got into the PIO, the performance was actually, surprisingly good, as I mentioned before, if it's not on tape somewhere, in most airplanes, if it is considered okay as far as flight manual kinds of things to do, this Procedure A, which is wing low, that's the one that I would prefer, I much prefer that, I can do it in airplanes that I'm not as familiar with, and it works, and so, I'm much more comfortable doing that, and in this case it appeared, that until I got into...as long as I avoided a PIO, it was a more precise way of putting it down. Unfortunately, if I got the inputs going to a point where the PIO started, of course, then pretty soon, it was divergent definitely and pretty soon I was going stop to stop and ended up with a bank angle that caught a wing tip and thinking two different situations, and one of those were practice runs, but that's immaterial, it was there whether it was practice or not. In one data run, I felt the beginning of it, but luckily I was close enough to the ground and was able to back out of the loop enough, I assume that was it, that I could...continue the landing and did make the landing. As a result, when it came time to choose Procedure A or Procedure B, I had to cross Procedure A out for the potential for losing control. My comments about wing low and so on were correct, my labeling of Procedure A, is decrab, was wrong. Up until this point, I've been talking about the wing low, which unfortunately was Procedure B, I didn't read the description. Another very interesting thing, it was easier for me, and this is going to be something we'll want to investigate with a couple of standard landings, but it seemed to me

to be easier to put it in the desired box for and aft with the crosswind than it was without the cross-wind, and the only thing I can think of that's apparently different, is the amount of drag that's on the airplane when you are using this wing low procedure, that that was something that helped me put it in the box for who knows what reason, but that's just an observation, I'm not sure what that means. As far as the decrab method, that one always takes more time to learn and takes better judgment, better knowledge of the airplane and how it responds, it always seems that way to me. You decrab too soon, you pick up drift, if you decrab too late, you'll land in a still in the crab. You have to time it right on the money, and that's one of the reasons why I never cared for it too much, but in this case I could straighten it out, I had the authority to do it, but due to where I was, left and right on the runway, several times I did not get it to the adequate lineup, I still landed in a crab, because if I would have decrabbed anymore, I would have drifted not only out of the box, but I was even concerned of drifting to the point where it wouldn't be on the runway. One side line here, and this is a contaminant, I notice that I always had this drift to the left, no matter which direction the wind was coming from, the airplane was doing a nice job of staying on localizer initially, and then we would just pick up this little bit of left drift in either case, and later on we discovered that it was just a touch out of...the rudder was just a touch out of trim, and my comment was, if it's that sensitive, then probably there should be a big indicator of trim position on this, because that could of played a part, I noticed that it was much easier to land with the wind out of the left than it was out of the right, and even after the touchdown, I was having a hard time just...the rollout keeping the aircraft on the runway with the wind from, here we go again, the wind from the right, but with the wind from the left it was not such a big deal, and apparently I'm surprised that such a small amount of rudder trim would have such a large effect, but there was a definite difference between the difficulty with a left or a right crosswind, so I suspect there was a contaminant in there somewhere that in either case, I was never very happy with the crosswind landings using the decrab method, even though I think I did end up getting adequate performance, this is at the 25 knot level, I think I got some adequate performances in there. It was not my favorite, to say the least, I could make it work.

**19. Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ?**

Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ? Again, at the level of proficiency I have right now, using the decrab method, I'd have to say no, I was concerned about it, I can manage to barely keep it as far as position on the runway, and I could not keep the heading under control to the point, and when you're off on heading, you're talking about loading the landing gear, so you know, it's very important, even if everything else was adequate, the fact that it wasn't lined up is a show stopper, I think. So, I'd have to...to 19, given my level of proficiency and using decrab method, I'd have to say no, it might be something I can learn later on, but I sure don't have it now.

**20. Please describe any suggested improvement you may have to either of crosswind landing procedures. Any suggested improvements,**

well the suggestion is being brought up about...what do you call those trucks...stirrable trucks, or whatever, B-52 kind of things, and that would...I would suspect, that would make a ton of difference, and that would...I would think that it would improve the capabilities immensely to have something like that. The only other thing I had heard, and this is getting more analysis than I usually do in an evaluation like this, if in fact the PIO was what I was seeing before, that I saw before, was due to rate limiting, than if we can stay out of rate limiting, I'm not so sure of what maybe then the 35 knot would have been able to do, I can't put a rating on it, I'm just suggesting that that might have, because I felt a lot more control

with the wing low method than I did the decrab method, but of course, once you start getting into a PIO that's going to get your wing tip, why then that's no longer a player, but if you were to do away with the rate limiting, than that, very well, might have than an improvement that I could suggest.

#### HUD symbology Issues

**23. Was the appearance of the actual flight path symbol (triggered when flight path angle error exceeded the threshold value) helpful or more of a nuisance ? Would you suggest any modification to the logic which triggers the appearance of this symbol ?**

I would say, I thought it was helpful because when the flap deconfiguration was going on, I had to revert to the actual flight path symbol, or I would have gotten, I would have landed longer than I did, which was already pretty long, so, by having the actual flight path symbol shown, than I could make the correction that was necessary. The other thing would be, if you don't do that, and this is what I'm more used to, and that is, just have it be the actual flight path all of the time, I never really felt the need to have a commanded and an actual before, if I could only have one, I certainly would have the actual one. The fact that, if they were off by a certain amount, than I got the actual, well, okay that's fine, that would be my, probably, my second choice, but from my point of view, what I've seen so far in the short range, see, I've flown an actual flight path symbol now hundreds of hours, and I've flown this one just a couple of hours, but my first thought on it, is given a choice, I think I would just as soon have the flight path marker be the actual on all of the time, and I understand that there is some, as I recall with the gamma dot, there was some other consideration in there, but it escapes me for the moment, that I'm just kind of given free thought ideas here. Would you suggest any mod. to the logic which triggers it ? No, probably if anything, I might even have it come on a little bit quicker, because it seemed as though there was...by the time it came it on, there was quite an error between the two. I think possibly even having it, if you're going to have this split one, I think everything else being equal, I'd probably would prefer having it come on with a smaller error from the commanded one. Minor point, it's not a giant difficulty.

**24. Was the tailscape indicator symbology presented on the HUD useful during execution of the go-around tasks (4086 and 4085) ?**

Well, considering that I scraped it when I had the indicator, and I didn't when I didn't have the indicator, that probably takes a little elaboration, I guess that's what this next part probably is for. Apparently, I started out without the tailscape indicator, and did not have any problem. As it turns out, apparently, I was coming fairly close to the tailscape, but of course I didn't realize it because I didn't have an indication of how close it was at that point. So, when we put it on, I thought oh, that will be nice, but one thing that I was surprised, is even though that's a different color, and it's red, white, it's...you know, it should be, just jump out and grab me, I was more concerned about the not touching down part of the phase to the point, watching the flight path marker, which is incidentally quite a ways from the attitude and tailscape indications, that it's pretty far up on the HUD, that I honestly did not see the tailskid marker, in other words, when I hit, the first time I looked up said, oh, oh, there's the waterline on the tailscape, and I never saw it. The only thing I can say is that it might be more useful if it were closer to the flight path marker then I would have seen it, as it was, it was out of the scan and...a couple of times, I thought the marker did not come on, and of course after you scrape the tail once, you're a lot more sensitive to watch for it, but considering the number of times that people are going to have to go around in this condition, you're not going to see that very often, you'll see it in ground sims, every six months, or whatever it is, but it wasn't anything that obviously that helped me during this

particular, the way it's mechanized and so on, the way the task was presented, it didn't help me at all. And incidentally, as I mentioned, it may be on the tape some place else, in general, throughout the approach, pilots tend to be success oriented, they are going to land, and to suddenly have to go around at a 50 ft breakout or certainly at 30 ft, is a real shock and it doesn't, the recovery and initiation of the go-around does not come in instantly, there's a lot longer delay, now here I knew the task was to go around, and this is different than what you would see in operational use, so, I know you have to do these kinds of things for the test, but just in a practical point of view, I suspect people are going to touchdown or they're going to scrape the tail more often, if they really, honestly have that fuel truck on the runway that everybody likes to use as a reason to go around. I think the surprise and shock and delay in initiating the go-around is probably going to cause you to touchdown or tailscrapes more than this particular test would show, that we were flying. I think the other thing, possibly that might have brought it at the...waterline does not grab your attention, and so even if you were to...when you're looking down to where the flight path marker is, even if you were to see the tailscrape marker, unless you go right and start looking at the waterline, it's not something you're going to pick up in your peripheral. I think, there is probably a better...it's not a bad idea having a tailscrape indication, but I'm not so sure that that's the one that I would use, I think I would use some indication of nearness of tailscrape, that was close to the flight path marker, I think. I think that's going to be lost. It's hard to say, you know, making what, 5 passes of this, it's not a lot of data points to work with, but I think if I were to try to improve the tailscrape indication, I would use some symbology that was closer to the flight path marker, because at this point, you're waterline is pretty high, considering where your flight path marker is, so you're looking at something up here, so it's got to be something peripheral, because you are locked on to the flight path marker. That would be the only thing I could suggest, and of course that effected the rating and once you scrape the tail, you scrape the tail, you can't disregard that. It did effect the rating quite a bit on that, however, I probably was closer. Oh, one other thing on it, when you get this close, the last...your last correction for the landing plays a big part. If your last little input was to lower the nose a little bit, and now you've got to reverse it, there is so little time between that initiation and an actual touch of something that, if your last input happened to be a nose up, then you're in great shape, but if your last one happened to be down, that can make all the difference in the world on this go-around, and as I mentioned before, the only thing that I had that was kind of a contaminate on this, is the TOGA switch was in a very unnatural place and it was difficult to push the autothrottle, come back around and push the TOGA at the same time, and trying to put the power in, and at the same time, I'm trying to bring the nose up. That's just kind of a side comment, that's sort of contaminated some of...this particular part of the task.

## **Pilot D**

### **Approach and Landing Questionnaire 23 Jan 97**

#### **1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

I think we have adequate control power, in fact I was tending to over control initially on the decrab maneuver.

#### **2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

I was getting some large roll overshoots initially, pitch is fine, and yaw, it just takes a very high force to get up to the desired values, and it seems pretty well damped, but the rolls seems fairly, lightly damped, as I have noticed... noted in several other places with respect to the test here, and I was getting some large roll overshoots, and with a high dynamic, high

speed dynamic maneuver that the low altitude decrab requires, I was getting some, initially I was getting some geometry strikes, so, special control techniques, just have to really learn to take it slow... as slow and easy as you possible can from 50 ft, and try to undershoot, if anything, in any case, okay, enough.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Flight Path is relatively easy to display, is this... I'm speaking with respect to the approach now, the display is very good, very accurate display, with a high resolution flight path, depressed pitch line, and very expanded scales on the glideslope and loc. A little bit of work load associated with the terrible scan involved. Bank Angle, ability to control and track, I still have a tendency to overshoot, and PIO on bank angle. Heading is quite easy to control.

### **4. Ability to control airspeed (autothrottle off) ?**

It significantly increases the work load, I think with some practices, I could keep it within... keep it within desired. A couple things might help, one is, is there is a lot of lag, in the longitudinal acceleration cue, which tends to make you PIO on airspeed. The other thing is that the flight path, and the airspeed tape are a little bit fuzzy, and just a little... there not real sharp, it's just a little hard to see small airspeed errors, I think either larger scaling on the airspeed error tape, or a crisper display would definitely help on the airspeed control. Most important, though I think, if we could take that lag out of the longitudinal cue, using some washed out throttle.

### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

Yes, in roll for me, and the tasks were continued with reduced pilot gain. On a couple of the decrab maneuvers we got some strikes, so they were abandoned at that point.

### **6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

No real problems with Force, Displacement, Sensitivity or Pitch/Roll Harmony that I could see. Again, I think I've commented earlier, I don't see any big impact on the performance from the controllers. Maybe they're not optimum, but they're plenty adequate, rudder pedal forces get a little high for the decrab maneuver, and/or the forward side slip, but I think that's appropriate.

### **7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

Don't have much of a tendency to float, no problems with line-up. Sink rate control, it's... I'm adequate most of the time, a little bit of a problem there, I think it's... you know just a matter of resolution on the flight path display. Nose lowering, no real problems, I had... we stopped the simulator a couple of times, as I was kind of forcing the nose onto the ground during the crosswinds. Any special control techniques required ? Not a control technique, but I was moving the visual glideslope intercept point down the runway from where the electronic glideslope tends to bring you, to kind of move my nominal touchdown point further, up closer to the desired area, compared where as with the, using the electronic glideslope, I almost had to do a two segment approach to get it in the desired distance.

### **8. Approach vs. Landing - which was more difficult, and why ?**

Landing is definitely more difficult. The approach is fairly easy, good display as mentioned earlier. Turbulence is not an effect. The commanded gamma display is very nice for the approach, the scan pattern for the approach is a little bit off.

### **9. Effects of the Wind/Turbulence ?**

Except for the crosswinds, we didn't have any winds. Turbulence, it's not a big effect, it's there, but you just learn to ride it out. The crosswinds are definitely a big effect, particularly on the low altitude dynamic decrab maneuver.

### **10. Summary - Good/Bad features ?**

The display is very... has high fidelity, you have the capability of flying very accurate approaches. The flight path display during the flare is pretty good. The decrab, it's easy to see how much you have to decrab, a little hard trying to tell exactly where you're going to touchdown. Bad features, maybe the high rudder force, although I think they are appropriate. Okay, bad features on approach and landing, as far as the approach, I think the poor scan pattern as mentioned earlier, is one. For the flare and landing, really got several. The new vehicle is much harder to flare and land than the previous vehicle. It feels like, if you want to start your flare at 50 ft, it feels like a very high pitch rate is required to keep from touching down hard. Another bad feature was that the electronic glideslope, I don't think is tailored to the right position for the desired touchdown point. I had to actually move my visual glideslope point down the runway about four or five hundred feet to help get into the desired touchdown box. I think that's about it.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

Okay, continuing on with the approach and landing questionnaire. The automatic flap transition in approach and landing tasks, this is excluding the decelerating approach, I haven't done those yet.

### **11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

Yes, I think it's required, you need to get the attitude down for flare and landing, and the fact that it's actually moving is almost transparent, which is maybe a shortcoming of the display, it really doesn't seem to bother you.

12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition. I think historically we've liked to have flown stabilized approaches at least for the last few hundred feet, and this kind of goes against that, it doesn't seem to be a big impact as far as flying qualities go. I think I'd, as a pilot, should just be more concerned about reliability issues of the system.

### **13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

It does require pretty careful tailoring of the feed forward into the pitch attitude, to keep the aircraft from ballooning or sinking, as the flaps go out. They didn't have it quite perfect this time, but it was plenty adequate. So, I think that's one adverse problem that you're faced with that. The other, of course is, are there any reliability problems, having that transition taking place at such a low altitude.

### **14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

Well, I don't want any failures down there, so, I don't agree with that. I think you need to have ten to the minus nine flaps, if it's going to be acceptable, or the... actually the results of

any flap failure would be ten to the minus ninth, as far as pressing on, and making an acceptable landing. Thanks.

## **Pilot E**

Approach and Landing Questionnaire 08 Jan 97"

### **1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

[skipped]

### **2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

Okay, I haven't looked at the questions, I don't think they're very appropriate, but we'll go ahead and press on. The predictability... Yes, there's no problem with predictability and I don't really recall any special control techniques.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Flight path in the turbulence requires a little bit more work than it should, I would like to go set a gamma and just have it hands off, and you can't do that, the same with bank angle and certainly heading, it does wander heading, so it takes pilot compensation for all of those, I think we certainly have the state of the art to improve that quite a bit by putting the mission earlier track angle sub modes, altitude hold submodes, that kind of stuff in the actual control laws.

### **4. Ability to control airspeed (autothrottle off) ?**

No better than it was before as a backside airplane and it does take a lot of compensation on the manual throttle approach and that detracts from your glideslope and localizer tracking capabilities. Certainly the HUD helps with the acceleration carat and the airspeed error tape and those are I think essential to help us to maintain fairly tight control.

### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

### **6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

I commented on this yesterday, no problems. Force and Displacement, Sensitivity, Pitch/Roll harmony is all fine.

### **7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

On one of the tasks, the manual throttle... we said the manual throttle approach had too much problem at lineup... on the decelerating approach with auto throttles, for some reason I had... when I took over command of throttles at 50 ft or thereabouts, between 150 ft, I had problems with lateral lineup, and end up lining up slightly out of the desired box to the right each time and we are going to look into that. I had no other problems with that on the other landing tasks. Sink rate control ? Yes, I had a real problem with that as far as meeting the desired criteria with dynamic ground effects model we currently have it's very hard to project your flare performance. Several times I actually leveled off and floated outside the box and when you level off you're really in a bind because if you drop the nose at all to break your level off, you are decelerating, you are going to land firmly, if you don't, you're going to slow down, you're going to land firmly, so if you overcontrol the flare even slightly

and level off, you're really in kind of a bind, and with the power response of the engines with lag from idle, basically with the throttle you can't really save yourself with the power application, so you're really kind of in a mess. I never felt that I really had good control of the flare today and it was not predictable. Any special control techniques required ? Well I would like to find what special control techniques I should use to better and I have not discovered them yet.

#### **8. Approach vs. Landing - which was more difficult, and why ?**

The landing is far more difficult, I think the new dynamic ground control effects model has really made it difficult to have consistent flare performance.

#### **9. Effects of the Wind/Turbulence ?**

No wind today. I did this morning, but turbulence certainly effected both flightpath angle and the track and kind of a nuisance mode where you're just kind of drifting slightly around the flightpath angle and in and around the desired track and it just requires constant compensation.

#### **10. Summary - Good/Bad features ?**

The bad features I've talked about are the lack of the more sophisticated submodes to the flight control law which requires continual pilot compensation in turbulence and also the flare performance being not very predictable at least for me I could not get a consistent flare performance or landing performance. The best landing where I felt that I was most in control and did just what I wanted and I really liked it ended up being adequate performance I landed about 5 ft per second, I landed in the box, that's the landing I felt the most proud of, but I just... the airplane did what I wanted it to do as far as... I felt like I had predictable to do and commanded what I wanted, but still without the ground effects we've been used to in the past, it landed firm, but certainly we've got to figure out a way to more consistently predict the performance of aircraft in the flare.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

Okay, these are continuing questions for the automatic flap transition in approach and landing tasks (excluding decelerating approach)

#### **11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

Talking about the automatic reduction in pitch attitude, and was it acceptable. Well, it's acceptable in that... we've got it tailored now with some control law modes we made in the fall when the Boeing folks came here to Langley. We've got it so that... we don't get disturbances on the glidepath when the flaps come in. However, I'm still of the opinion that that large reconfiguration that low to the ground in a backside airplane that has problems with a flare anyway, is probably not the thing we want to do, so, I don't particularly like that huge reduction, what I consider huge reduction, pitch attitude occurring that low to the ground. So, is it acceptable ? I don't really think so, certainly we've done a lot to make it a lot better as far as being transparent, as far as glideslope performance, but certainly when you flew it manual throttles you saw huge drag coming in about 200, 300 ft which required a large power addition, but you couldn't predict when that was going to hit you, and so typically you get slow at about 200 ft above the ground which I don't particularly care for either, so I'm still having my reservations about this automatic flap transition.



12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition. I think certainly needs to be further out on glideslope and I don't know if having it come in over 40 seconds Vs 18 seconds is better or worse. I guess my feeling would be to have it higher up than have it come in more quickly to get it over with, but that's a real WAG right there, it could be the 40 second is not bad, certainly the higher up on the glideslope the higher above the ground we do it and get a stabilized final approach the better, and that's some problems we're going to face with noise and the like, so I know it's not an easy situation, but I don't think we've optimized this whole thing yet.

**13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

Well, the main thing is the huge increase in drag, when I say huge, a noticeable increase in drag requiring a power advance low to the ground, certainly the things you could anticipate that would be bad, would be if you're in auto throttles and the auto throttle failed to respond properly the pilot could get underpowered very quickly and end up landing short, and you don't want to do that in a 500 million dollar airplane. If you have to fly manual throttles than it just complicates the back side nature of the approach. So, what's happening is you are changing the attitude and putting in a lot of drag low to the ground, I just... I think we need to be careful about that.

**14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

My opinion is that it's not a good idea to do this, however, we may have no choice, and if we have not choice, than what we need to do is to work as hard as we can to minimize the effects of it. I think... I mean I don't even know if it's possible to look at the noise reduction kits for the aircraft's engines, obviously I've looked at them, I'm sure they must not be suitable alternative, but I'm... I'm of the opinion that if we could find some way around this, it would be good. So I guess, basically I'm saying, I do not think it's acceptable, however, if we are forced to do it, then we just need to work a little bit harder to mitigate the effects as much as possible.

**Decelerating Approach and Landing**

**15. Was the airspeed decay profile used in the decelerating approach acceptable ? If not, what characteristics did you find objectionable ?**

The profile was okay, I've flown a number of decelerating approaches in other unpowered vehicles in my career, but the problem is, is that we are trying to land this aircraft at a particular spot on the runway and the target is fairly tight tolerances, so if you are decelerating all the way, you run into real problems with being able to have the proper energy at the threshold, and I think perhaps what's happening to us today is that once we get into around a 100 ft we start decelerating more rapidly than is really acceptable. I found myself landing a couple times, we were under power and I landed at high attitude short and firm and also the high attitude is indicative of a low speed. I landed slower than the nominal approach on each landing, so it maybe that we need to spend a little bit more time figuring out a more optimal deceleration schedule and I think what we want to have happen, is that we want to have it decelerate as slowly as possible as you get closer to the ground, in another words, of course that makes the noise problem more significant, but I don't think when you want to come in with a fairly significant deceleration rate as we approach between 200 and 100 ft. That's the characteristics that I just find objectionable.

**16. Please describe any suggested improvements you may have to the decelerating approach procedure.**

Well, what I would do is try to move the... I would try to make yourself as stabilized on the approach as possible, as high up on the glideslope as possible and I would think certainly we should be in a situation by no lower than 200 ft when we are at a fairly stabilized approach, but the backside nature of the aircraft, I think we were considerably, you are gonna set a pilot up for mishap, if we have this thing decelerating below 200 ft, if the pilot doesn't catch that deceleration, you get a gust of wind, you get anything that... slow spool up time of the engines, anything like that, that could occur, you could find yourself landing a little bit short and little bit firm. So we need to be more stabilized with the power on the airplane and stabilized at a higher power setting lower to the ground. These engines at idle have a very... what I consider a fairly lengthy spool up time, and I think for a transport aircraft that is very dangerous to be in a situation where you are unspooled and low to the ground and in the transport flying I've done, in the airline flying, that's been a situation you don't want to get unspooled low to the ground especially if you end up getting a little bit slow. We need to be up on the power more as we get below 200 ft.

**17. Do you find either the decelerating approach or the nominal approach profile to be more acceptable than the other from a piloting standpoint ? Is so, why ?**

Well, I think there is negatives to both of them and not very many positives. The decelerating approach, and again from my navy experience, that was one of the things that we did not want, was a decelerating approach. An aircraft carrier landing is similar to this and that we were trying to make a target approach landing at a certain point, obviously the real world may not be so concerned with landing between a 1000 and 1500 ft, but nevertheless, we don't want to land long, with the airplane landing at the speed we will be landing at, so, decelerating approach in this situation is a real trap and can get you way underpowered, low to the ground, and slowing down at a rapid rate, and you can dig yourself a hole from which you can't retrieve yourself, especially with slow spoolup time of the engines. That does however get the autoflap transition at a higher altitude. If you stick with the nominal approach and you do the autoflap transition at a lower altitude you now find yourself putting a lot of drag on the airplane at around 200 ft which I don't think is very good either and that has it's inherent problems. The auto throttles make both approaches better, but my question is that auto throttles may not always work and I think we're kind of setting the pilot up to fail on the landing at some point down the road with these two approaches. So, I guess I find both of them objectionable for similar reasons in that we are low in the approach, we are not at a proper energy profile that I would like to see it. That's the end of the questions for this morning.

Pilot E answered this questionnaire again later in this test; see below

**Pilot E**

Approach and Landing Questionnaire 09 Jan 97

Pilot E answered most of this questionnaire earlier in this test; see above Okay this is a continuation of the pilot questionnaire for approach and landing for Pilot E. Most and questions were already answered on the first page.

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

I thought there was basically enough of both roll and yaw control power. Interestingly, I seem to have a much easier time making landings with the wind from the right than with the wind from the left, although, my recollections that I had pretty much full rudder in with the

right crosswind and with the left crosswind I did not, but I had much better performance on the right crosswind as far as heading deviation, so it could be that for whatever reason I was not using enough yaw control power with the wind from the left, but it would be interesting to see if any other pilots have any clear cut differences between right and left crosswinds. On the 35 knot crosswind landing with the wind from the right, as I mentioned just a second ago, I did feel like I had almost full rudder pedal in there, so, I think if you were to check the data on that and see just whether the rudder was saturated or not, conservatively I was commanding almost full rudder, so that's something we should look at on the data.

**7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

The only other question to really comment from today's work was question No. 7 Flare and Touchdown. On the circling approach with the 35 knot headwind I felt like it was an easier... the flare problem was much easier, of course with 35 knots, our ground speed is quite a bit slower, by 35 knots obviously, and gives you more time to have in the actual landing zone to make your corrections. We've seen this in other programs where you have rapid decelerations in the flare and your opportunity to land is brief due to high deceleration. With the headwind in the slower groundspeed, you do have more time to kind of judge the sink rate and I think... I felt much better on the landings into that stiff headwind than on normal, nominal landings without a headwind, so that might be something worthy of note that it seemed a much easier task with a 35 knot headwind.

**18. Did you prefer Procedure A (decrab initiated at 50 ft) or Procedure B (forward slip initiated at 200 ft) for performing the crosswind landings ?**

I certainly prefer Procedure B, the forward slip, mainly because you can get most of the crab removed prior to working that flare task. I think at 50 ft, trying to solve the flare problem with these dynamic ground effects currently modeled which we've discussed makes it harder to do the flare, I think having to set the flare and rapidly take out about... oh, shoot, almost a 12 degree or so crab angle, without overcontrolling that plus establish your bank angle into the wind so you don't have a downwind drift. I think it's asking a little bit too much of me at any rate to do that all well, the short two or three seconds between 50 ft and touchdown. I think the forward slip is definitely the preferable procedure for being a much more controlled approach.

**19. Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ?**

I think that it can be using Procedure B for me, and I think it involved just some training and practice. A practice... a learning curve... there was definitely a learning curve in evidence here, I think I was doing better as I practiced more. Also today... yesterday when we were doing the 25 knot crosswind landings, from personal point of view I was feeling very poorly and was not performing as well as I normally could. I felt a little bit better today and I think I did a little bit better in 35 knot crosswind landings than I would have done yesterday. That's just an editorial note to be considered with all the other data, but any rate, I think 35 knot crosswind landing is achievable. For me assuming the winds always from the right.

(Please... that was just a joke there...)

**20. Please describe any suggested improvement you may have to either of crosswind landing procedures.**

I have to sleep on that one and think about it, certainly, I think the forward sideslip that I mentioned is a better technique, there may be some symbology improvements we can make to help make it more obvious to the pilot when he has aligned the fuselage with the runway

centerline, that's one possible... I think in the HUD conference we had in September, I think there were some suggestions made along those lines that we have not implemented on this assessment. Other than having to be sure you add power when you put in that big rudder movement because of the extra drag and I think I was just doing that almost subconsciously, I don't have any other improvement techniques right now without thinking about it more.

#### HUD symbology Issues

**23. Was the appearance of the actual flight path symbol (triggered when flight path angle error exceeded the threshold value) helpful or more of a nuisance ? Would you suggest any modification to the logic which triggers the appearance of this symbol ?**

I think it was extremely helpful. I like the way its modeled right now. I'm closing always on commanded gamma, but I like to have that actual gamma available for two reasons: (1) To let me know if I need to make slight adjustments in my commanded gamma based on the delta between the two. (2) I think it would certainly show very quickly any type of control law breakdown. I've actually experienced that in flight and the appearance of the actual gamma would have much earlier alerted me the fact that we had an control law problem. So, I certainly am very much in favor of the way it's implemented and I would like to see it remain.

**24. Was the tailscape indicator symbology presented on the HUD useful during execution of the go-around tasks (4086 and 4085) ?**

It's interesting, until it's really called to my attention by Dave Raney, I was not really noticing it, I was so intent on the actual placing my flight path to stop my sink rate, and I didn't really notice it and in fact I really didn't notice it all in the very first one at the box when I was very, very aggressive and ended up getting a tailscape, so when it was called to my attention, I did seem to notice it, but at times I got... one other approach... I got wrapped up in my stand pattern and kind of didn't pick it up. When I didn't have it and I knew it wasn't there, then I tended to be much more cognizant of the fact I can get a tailscape. So, it's kind of a reverse result of what you would think would happen. I did not ever get a tailscape without it because I was very, very aware that I needed to be very careful and I would stop my rotation, actually to allow the aircraft to fly away from the ground before I continued it. So, in my case, the fact that it wasn't there seemed to be more of a cue to me to not ignore that tailscape problem than when it was there, however, that was all brought about by the last run I did on the set of runs with the tailscape indicator there. Certainly, I think we should have it, it could just be for other pilots, it may pop up into their scan much more quickly and I think the tailscape problem on the low altitude go-around certainly warrants further investigation and it certainly is a clear-cut problem that we have identified, so I would definitely leave the tailscape indicator on the HUD.

#### Pilot F

##### Approach and Landing Questionnaire 21 Jan 97

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

We won't address because we didn't do crosswinds.

**2. Predictability of pitch, roll, and yaw response to pilot inputs ? Any special control techniques required ?**

We already kind of talked about the pitch control, i.e., the gamma control, and how the actual commanded flight path differ. That causes a large predictability problem, we saw that

on the last data runs that we did, and then again when we were doing the manual throttle runs also, when the actual and the commanded flight path vectors split, it's hard to anticipate how quickly they're going to come back together again, and you need to be able to anticipate that in order to really set a command gamma position, and I do think that that's a real issue here, and I think that's going end up being an issue in other places too, I think it's just an issue in general using gamma control. The roll and... you know, the tendency to couple pitch and roll is still here, and the predictability issue of pitch, roll, and yaw, will pitch and roll coasting to a stop, and not being real crisp and the response of yaw getting an overshoot. Those are all the same here, the technique is basically just to reduce your gain, there is definitely a learning curve here, being slow and more patient, and starting to back off on your inputs when you're trying to capture something early is basically the technique that you use to correct for the predictability problem. I don't want to say a problem. For predictability not being quite as good as I would like to see it, and it's something that's very intuitive to correct for, you know between this morning and this afternoon, I could definitely see a learning curve where it's becoming more internalized as to what I expect from the airplane.

### **3. Ability to control and track pitch attitude, flight path, bank angle, and heading ?**

Flight path control particularly on a decelerating kind of approach, I don't want to say is difficult, but work load and compensation that's required, both increase because with the balloon, you see a split in the flight path marker, and the commanded and the flight path marker actual. Down near the runway, with maybe some small corrections or it seemed, my perception was sometimes even without correction we were getting a split between the two, and when you have the split, it's hard to control, I mean in essence you're not really commanding to the flight path at that point, and we've already talked about the predictability and the delay. Bank angle, the comments are the same as I've made before, and heading, I think was the same as I've made before. Again, you just need to be, for the captured task, you need to be a little bit patient, and make small inputs, and just let it kind of drift over there. You go hands off, and everything pretty much stays where it's at, so all of that makes it pretty easy.

### **4. Ability to control airspeed (autothrottle off) ?**

We consistently, with the flap configuration... reconfiguration, on the approach and landings, with manual throttle, saw a dispersion of 5 or 6 knots, and I think with a little bit more experience I would do better at compensating for that, but... and that is a fairly tight task, and as I mentioned before operationally, I probably wouldn't quite fly exactly that way, but again, I think this is a function, I would like to see this with a different display, and a different set of throttles in there, I think that it would make a big difference in your ability to control and track the airspeed through the reconfigurations and the initial pushover, and I think that's effecting your results a lot, maybe by a level of flying qualities, because I think we were basically level 2 on those tasks, and I think you may still be level 2, but I think we'd be a lot better off than it would be closer to level 1 or maybe even level 1 in that area.

### **5. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

I don't think I really saw any PIO tendencies for the tasks that we did this afternoon. Do you recall any, no, okay.

### **6. Pitch/Roll Inceptor and rudder pedal characteristics: force & displacement, sensitivity, and pitch/roll harmony ?**

I don't think I've changed any response from the general comments that I made earlier today on the up and away stuff that we did, there's still a tendency to couple roll commands when I'm trying to make a pure pitch input, a roll that's greatly reduced, due to familiarity with the sim, I do think the inceptor could be tuned a little bit better, but before I would tune it, I would try to get the ergometrics right, so that you're not coupling up between the axis, and I don't remember that I have any real problem with the harmony. I guess on the approaches where your bleeding off airspeed, I think that it is hard to get consistent performance, particularly in gamma at sometimes, and again we've already kind of covered that in the predictability. I don't know that this is really particularly the right place to bring it up, but while I have it on my mind, when you're flying manual throttle, and you're flying a gamma control, you've taken something as we've discussed before we really started this, you're decoupled basically, normally to control gamma I use pitch, and I use power. Now if I take the power out of that, the airplanes ability to control gamma is only based on what it can do aerodynamically, and that causes a little bit of a... I guess ending consistency or predictability problem, or what's a better word to use, I guess, I'm not so sure that this becomes consistent with the idea of using just pure gamma control when the autothrottle is disengaged, because now the airplane is still going to try to do it aerodynamically if it can, but I think that's why with the decelerating approaches, we're seeing a difference between commanded and actual gamma, and that difference, it's not a consistent predictable difference all of the time, based on deceleration rates, climb rates, descent rates, and where the power is set. And now it makes it a order of magnitude harder for me to control gamma, in some respects, than it would with a traditional airplane, and a HUD with just a flight path vector that's actual, and I think this is something that needs to be looked at throughout the entire envelope.

**7. Flare and touchdown: any problems with runway line-up, sink rate control, tendency to float, nose lowering ? Any special control techniques required ?**

Problems with runway line-up, sink rate control, tendency to float, nose lowering, and any special control techniques required. I don't think the nose lowering was a problem in this airplane, in this simulation, I mean. Tendency to float, again, there were a couple times where I put the commanded flight path vector on the horizon, and we... because the actual is now lagging behind it, we touched down fairly firm, and there were other times, where I would put the commanded flight path vector slightly below the horizon, like maybe a quarter to a half a degree, and I would not get consistent results, even though, or at least I perceived I didn't get consistent results, even though I didn't have a split between a commanded and actual flight path vector, and I'm not so sure what the tolerance is before the two of them split apart, but in the flare mode, it doesn't take much of a tolerance. You can see larger disparities, when you're down in the flare mode, when you're talking about very small rates anyway, so, I'm not so sure, maybe if you had the actual commanded up full time, if you would have seen a delta, but it just didn't trip the threshold to be displayed, I guess is what I'm trying to say. Sink rate control, you know, unlike a traditional airplane, where you can just release backpressure, at least my perception was, is if I wanted, if I over rotated the airplane in the flare or the round out, I had to actually bump the nose forward to get the gamma back where I wanted it. This is not, you know, we've seen this with the F-16, and like so experimental, like I used to demonstrate this in the Lear jet, that's not the most natural thing that pilots will do, fixed pilots tend to fly the airplane with force, and generally if you over rotate in the flare, what the pilot generally is used to for flying all those other airplanes, and is just to release back pressure, or just to hold what he has and his airspeed will bleed off, then he'll start to settle again, and with the gamma control, at least my perception was, is I actually have to bump the nose to get the, or bump forward to get the gamma back to where I wanted if I over rotate. Line-up, is okay, with the visual here, and also at Ames, line-up tended to be a higher task, or a higher work load task than I would generally expect it to

be, and I don't know if that's a function of visual, or function... I guess I don't perceive it as being a function of flight control problem, or flight control system, and I can use, you know, the flight path vector, and also the flight path vector relationship to the waterline, and the relationship of those on the end of the runway to help with the line-up issue, but it is more tasking than just when I go out and fly a regular airplane, although traditionally, at least for me, the line-up problem takes more work in the simulator, than it does in a real airplane. Sink rate control, again, just to add a little bit to that, the sink rate, going through ground effect, and the variability of that, along with maybe some predictability issues, which we've already discussed. Hitting the box with the appropriate sink rate, it's a fairly small box for a fairly big airplane, and fairly big higher speeds. I think the task is appropriate for what we're doing here, and even if we're dipping into level two flying qualities, I'm not sure that... I guess I think we need to look at the big picture, because I do think that there are airplanes out there now a days, doing the same task, might not do real well, I'm not saying that they wouldn't be level one flying qualities, but I'm certainly... certainly there are airplanes out there that would make it a fairly high work load kind of task to hit this box. One thing that most of the traditional airplanes, or transport category airplanes now a days, that we have out there flying, are that the approach speeds are a little bit lower. So, you know, a small error in the touchdown generally, I guess, you have more time in that flare portion, than you do in... at the higher speeds to hit the box. Let's see, I was definitely using the gamma symbol today in the flare, try to make the box, I was using it, just kind of interpolating, or looking at my rate of descent from 50 ft down, to try to get the... just a small negative gamma right at zero radar altitude kind of thing. I was integrating that visually, and also using the information the airplane had to give me. I'm not so sure that that's the best technique to use, and that's not necessarily the same technique that I used during the Ames evaluation, and there definitely is a big learning curve as we progress through the session, I started being able to pull in, and use more information on the HUD display. This HUD display is not a lot, but it is different than what we used at Ames, and not only the display quality, as far as the clarity goes, but the symbology, and it takes a while to kind of get used to the symbology, so, that could be... there could be some effect there.

#### **8. Approach vs. Landing - which was more difficult, and why ?**

The landing is more difficult, it's a higher work load task, and requires more compensation.

#### **9. Effects of the Wind/Turbulence ?**

I think we had some light turbulence in there, and I didn't really see any big of effect on that.

#### **10. Summary - Good/Bad features ?**

I think we kind of covered them along the way here, I just think we need to put a lot of thought into the gamma control in the first place, and the second place, the issue of commanded and actual, I think we need to address, and make sure that... that it's well thought out. The other thing that I noticed, too, it seemed like I was getting the split between the commanded and the actual a lot more today, than I remembered getting at Ames, and I don't know if that was a function of, you know, where it breaks out, or... yeah, different, okay.

Automatic Flap Transition in Approach and Landing Tasks (excluding decelerating approaches)

#### **11. Was the automatic reduction in pitch attitude that coincided with the automatic flap transition acceptable ?**

I think it's okay, there were a couple times when I really noticed the big change in pitch attitude, even though I was gamma based going through the flap extension, and... you know I think that there's more to look at it here, but all in all I think the simulation handled that pretty good. Now we're just talking about the nominal approach and landing here, so.

12. Please describe any changes you would suggest to the initiation altitude or timing of the automatic flap transition. Well certainly, I think we all could have it with desire to have the flap transition occur up higher, and the airplane would be more stable. Not... I guess I think the jury is still out on that, I'm not so sure that what we have here... as long as we meet the reliability, and everything else, as far as, because this has to occur, or you're going to hit the tail, so it would be a, I guess a fairly, the system... it would have to show a level of liability as far as ten to the minus seven, or a ten to the minus nine or a ten to the minus tenth kind of stuff. I don't know, I think I'd have to look at this more, particularly here, to really come up with a definitive decision on what I thought about the initiation altitude. I guess overall in the simulator, it seemed like it was pretty... that you could handle it fairly easy to get through that transition. Although, I do... I do think that effects your touchdown dispersion, I think simply because it is a dynamic maneuver that you probably, it might even be interesting to look at some approaches without the... actually that might be very interesting to look at, some approaches without the automatic flap transition, and compare them back to the approaches with the flap transition, to see what the delta in performance is, and see what comments you get back from that.

**13. Please list any adverse characteristics you perceived as a result of the automatic flap transition.**

I guess that's why I say it would be kind of nice to look at, some without the transition, I'm not so sure that there are anything that I would really list as adverse characteristics at this point, except for, if there is a problem the crew... this might have to be a system that has enough redundancy and reliability that it's not going to fail, because if it did fail, or at least if it did fail, you're going to have to show that the crew can take the airplane around, and safely do it, and you know, not have a strike and not compromise safety in any way.

**14. In your opinion, is the automatic flap transition acceptable for use in a commercial transport, assuming that pilots are trained for any failure contingencies associated with such a practice ?**

You know, that's really the crux of what 11 to 13 was kind of getting to, and I guess, I don't think that I can definitively answer that right now, I think that in my mind, I'm not so sure that this is not okay, but there's a lot of issues that this is a very complex question, I guess in that, first of all, we generally, I mean, we all know that crews are going to be trained to a certain level that operate the airplane, but beyond that we generally try not to approve airplanes that have to be compensated for by training. In other words, you know, no training above and beyond what a normal aircrew would get, and the way this question is worded, I'm not... assuming that the pilots are trained for any failure contingencies associated with such practice, well, you could train... there's no doubt in my mind, maybe this is a good way to explain it, and this is kind of applicable to 11 to 14. There's not doubt in my mind, that for military airplane, you could definitely train around this issue, and that wouldn't be a problem, but the military traditionally trains around things that a civilian can not train around, because the training programs just are not the same, and the level of safety that you're operating at aren't necessarily the same, the military is willing to train around things... Deficiencies in aircraft, as long as they can meet the mission, and as long... I guess what I'm saying is, what you can train around in the military, and what you can train around in the civilian world, are definitely two different levels, and as far as what you would approve from a certification basis, or from a acceptability point of view of developmental flight test and so



forth, so, I guess in my mind the jury still out on this, I'm not so sure that, I guess at this point I'm not so sure that I see that there is a problem, but I'm not so sure that I can say that there isn't a problem. Anyway, but like I said, so far from what I've seen just from a flying qualities standpoint, not looking at system integrity or reliability, or anything else, for the normal approach case, I'm not so sure that, I mean it doesn't seem to be a real big deal, I guess.

## Decelerating Approach and Landing

### **15. Was the airspeed decay profile used in the decelerating approach acceptable ? If not, what characteristics did you find objectionable ?**

Our current practices and procedures in the FAA, at least from the outside, as I understand them, is that you have to be stabilized by 500 ft on the approach, and I think this is with good reason, I think there have been a fair number of accidents that have occurred, because of a destabilized approach at low altitudes. There are a lot of issues that you have to look at, as far as a decelerating or rateing approach is concerned, you know, for example, environmental turbulence, wind shear, engine loss, other continuances that... it would all have to be handled if you plan on doing a deceleration approach at every airport like this. Additionally, at least the way I would envision this airplane, is you're going to have to have a VFR operating capability. We use VFR modes of operation at all the major IFR airports now, days when the weather is clear to increase traffic flow into that airport, and so, I think for that reason, this airplane has to be able to operate in a visual environment, and you may not always have an ILS or DME, of course, you should probably always have GPS, you know, by the time this airplane would be on-line, so, that may be a mute point. The other thing is, is that a lot of times when you have to do emergency returns, or for other malfunctions, you're going to come back around and land at the airport. All of these factors, I think have to be considered if you're going to talk about doing a decelerating approach. All and all, from what I saw today with the autothrottles on, and I don't remember what ratings that we came up with, I think we flew... basically, okay, 5 and 4, okay, you know, again we're looking at that touchdown box, which is fairly tight, and we got 5 and 4, basically we're talking level 2 flying qualities, for that particular task, although the next question, yeah, now that was for the approach, though. It's definitely not a... with the autothrottles on, it's definitely not a problem for the approach phase, I don't think there's any problem there. For the landing phase, it did seem to make the task harder than just a nominal landing when we were stabilized on the approach, and I think, again, parts of that come, I think just from the fact that you're not stabilized when you start your round out and flare. The whole thing's a little bit more dynamic, and requires a little bit more for pilot compensation. I don't know that there's any specifically one item that sticks out, that there is that, I'm sorry, I'm not sure that there is any one item that sticks out that I necessarily find objectionable, except for that I does make the task harder than... that's about it, I guess.

### **16. Please describe any suggested improvements you may have to the decelerating approach procedure.**

I know this doesn't help out the noise case, but I think it would be interesting to look at doing the deceleration approach down to 600 ft, or 500 ft, or to be stable at 500 ft, and see if that changes your results much. I'm thinking now, the other issue with the decelerating approach too, was that when we did this, the flap configuration started earlier, correct, and that's right, I'm sorry, things are starting to run together here. The other thing that we noted on this, is this is where we were seeing the split in the commanded and the flight path vector, handling it through the balloon, and then towards the later portion of the approach we were doing that, and we were less consistent on the ability to flare the airplane and touch it down, because generally we were touching down with the commanded flight path vector in one

place, and an actual ghosted flight path vector somewhere else, and so what you were having to do is, accept the commanded... command flight path vector someplace, so that the associated, actual flight path vector was really where you wanted it, and so you kind of second order of control out there, if you will, so, that... and that is what... I guess I would call that objectionable. Going back to Number 15, that would be an objectionable characteristic, and then... and that's what did cause the problems there.

**17. Do you find either the decelerating approach or the nominal approach profile to be more acceptable than the other from a piloting standpoint ? Is so, why ?**

I think clearly the nominal approach in my mind is better, and that is because I can use the control system, and the display appropriately, in other words, I'm not getting... I'm still at times getting split between commanded and actual, but I'm not seeing that as often, with the nominal approach the airplanes more stabilized. I start my flare from a known quality most of the time, not from a dynamic decelerating point, but from a stabilized point when I start to flare around out 50 ft. We don't see the split between the command, wow, I already said that, between the commanded and the actual flight path as much, so, that's it, and I think that's as far as we can go on this questionnaire.

Crosswind Landing Procedures

[Pilot F completed the following questions after crosswind landings on 22 Jan 97.]

**18. Did you prefer Procedure A (decrab initiated at 50 ft) or Procedure B (forward slip initiated at 200 ft) for performing the crosswind landings ?**

My preference was to do the decrab maneuver at 200 ft. The 50 ft decrab you have get everything right, or it doesn't work, it doesn't really give you any time to correct things. Out of that I think is a predictability problem, part of that, it's a big airplane, and it takes time to move everything around. I think probably something in between the two would work, like you know, a 100 ft decrab or something. One thing to think about is, operationally, for a manual landing, I think it would be hard to expect a pilot to start to decrab maneuver until he was visual, and so, you know, 200 ft he'd have to start at right when he broke out on a category 1 ILS. Anyway, that is one thing to consider. I think things that I noted with the crosswind is one, now these are perceptions, and as I noted earlier, I think it would be worth looking into a little bit more. It seems as you put in a lot of rudder, like from 35 knot crosswind case, that the last portion of the rudder causes the roll task to be a little bit more difficult. Maybe the roll control becomes a little bit more sensitive or requires a little bit more attention to manage. Another thing that I noted is that I don't feel like I get as much feedback, or very much feedback for the cross control that I put in with a conventional airplane as I start feeding in cross control, I get some tactile feedback because of the throws, and also the forces that I'm having to hold, and I can feel the tradeoff between the forces that I put in, or take out rudder and put in, or take out bank angle, and I don't really get that here. I think the thing that really makes the crosswind landing task... we've split up the axis for the Cooper Harpers, and I guess... I think there is some overlap from axis to axis, in that, I think the flare task because you can't... with a normal crosswind landing, I would fly the airplane down to the runway, and then I would flare, and I would be adding in crosswind controls, and as I bleed off airspeed, I have to put in more crosswind control during the flare, but I also, with a typical airplane, put in the crosswind controls during this flare, but I have this flare portion to get the controls in correctly, I don't have to time the round out specifically with the flight path vector so that I just hit the box. I guess my point is, when I'm in this flare, I can actually level off the airplane, and I can hold a constant pitch pressure, and as I bleed airspeed the airplane will start sinking again, and for the closure task for final formation task, I think it's easier without necessarily having a gamma control law. The other

thing is, if I over rotate in the flare, I have to push forward, I think this something that is exemplified here because you are very busy in the other axis, so that you can't pay as much attention with the pitch axis as you normally do, so you kind of see that maybe, you need to control it... or change your control scheme as a pilot using it, or that maybe there maybe some deficiencies there. One thing that I would note is it, at least what I'm familiar with, I think we have a history that pilots fly the airplane with force, or very sensitive force, and like for example, the F-16 in the landing mode, they change from a G command system to more of a blended pitch, and G command kind of system, to give it the feel of a traditional airplane, and one of the reasons they did that is because if you over rotate it, it was going to hold one G when you release the stick, because that's what was trimmed for, and that means that the airplane would just level off over the runway, so you can't quit from that flare, and let the airplane settle, or just release a little bit of back pressure if you over rotate it. I think they use the same control law when you open the air refueling door, for formation, for the refueling task, because it makes it a little bit easier. So anyway, I think that's something to consider. The 50 ft decrab, like I said when we flew it, basically I felt like the rate that I had to do to bring the nose across to get the heading aligned with the runway, if I still wanted to touch down in the box, was more rate, then I really wanted to, and as I put in a lot of rate, the roll control problem became very difficult, and I think part of that is, is we were seeing some of the Dutch roll in there. We did one Dutch roll on final, and we saw about a full cycle for the rudder input. Let's see rolled right, yeah, or close to a full cycle, and I think what happens is, is if you rate the rudder across, you get that delayed roll, which is part of the Dutch roll that we were seeing, for at least the Dutch roll type response that we saw, and that roll was hard to counteract.

**19. Do you feel that this aircraft can be landed reliably in a 35-kt crosswind using either of these procedures ?**

I think you can land in 35 knot crosswind, I don't think that you are going to reliably, repeatedly, consistently land in your desired performance parameters at 35 knots, I think you can land it on a runway consistently. One thing I think is worth thinking about is, I'm not so sure how much bank you're required to use to land at 35 knot crosswind, but I suspect that it's probably up around 3 degrees or at least that was kind of my impression. As I noted before, pilots tend to use a little bit more cross control than they really need in the cross wind generally. It's hard to get it spun on everytime, and I guess my point here is, if you're going to get a strike some part of the airplane at 7 degrees or 8 degrees, I think we really need to look at our margin, of how much... how close we are to a limit, when we're doing these tasks, and then we also might want to look at how the pilots going to know what those limits are, because those limits change a lot with pitch attitude, and especially if the pilot needs to be... have an increase to learn of some attitudes in the landing phase, we might want to have something to help him out, something in the HUD to help him out maybe, or to observe those limits, unless those limits are something that are easy to observe, or easy for him to recognize. For example, like most transport airplanes, bank angle has some effect on striking parts of the airplane, but not... I don't think as much as it does on this airplane, because most of the engines are either up high on the airplane, or if they slung under the wings, they're up towards... where the main gear are, so there is not as much change in geometry with pitch, as far as striking something.

**1. Adequacy of Roll and Yaw Control Power (Cross-wind landings) ?**

You guys can can look at the strips, I'm not sure how much rudder pedal deflection we had at 35 knot crosswind, but it felt to me like there was a significant amount. I don't think I'm on the stop, but I don't think we were real far off the stop, so, that's something you can get off the strips. For what we did, I think that the roll control and the yaw control was adequate. Another reason why pilots tend to put in a little bit more, I think I mentioned,

when we were flying this in the cab, is that it's easier to take them out, and it's more quickly to take them out. Especially if you're getting some gusty conditions with the crosswind, it's easier to have a little bit more rudder stuffed in generally. Now this is on most airplanes, you know, each airplane is a little bit different, but generally, it's easier for me to have a little bit more rudder stuffed in, because I get a little bit better response, I can respond to gust a little bit quicker with the aileron, it has to take some rudder out, it's easier to take it out than it is to stuff it in, and so we were looking at pretty steady crosswinds today, I think that if you put this airplane into a scenario where the crosswind was gusting, I suspect that you might see some problems, because this a pretty high task to try to get it in the box now, with the gusting, I can see picking up a drift rate pretty... you know over the runway, that would be pretty significant. You know, another thought here, and you know, this is a big airplane, and there's lots of forces at landing and everything else. I'm almost wondering though, if... you know gamma control works real well on an airplane that has a no flare landing, or you just drive it, hold the gamma, and drive it on to the runway. Ideally, I think for the control law that we have here, if it was an acceptable procedure, I think it would be better if you just held the crab, and held the gamma and just flew it into the runway. Now, I don't think you can accept the landings that way, but I guess my point is, I'm wondering if there is not some in between on the gamma, rather than really making it kind of do it, try to do a flare task with a gamma control making it a, you know, a partial flare, like raising the flight path vector to  $1\frac{1}{2}$  degrees and then driving it on, or something like that, and I'm wondering what effect that would have. Obviously, that would have a lot of effects as far as your aeroelastic model goes, as far as your gear model goes, and everything else, but anyway, that's a thought in looking at the flight control system, you know, you could design the airplane to land differently, and that might... that might be an option, I'm not suggesting that's way to go, I'm just saying that, that might be an option to look at, because I think you guys with the crosswind cases in particular, are probably not getting the performance you'd really like to get, and I think with the landing task in particular, that this control law, trying not to make it a flare landing like you do with a conventional airplane, might help you out if you want to stay with the gamma control. If you can't make the gamma control work right, and I'm not saying you have to do that. I'm just saying that just with all the other options, it's something to look at. Let me see if there is anything else that I wrote down here. Oh, I already talked about this in the cab, the more and more I think about it, if I'm flying down final and the airplane is reconfiguring, I'm not so sure that I should really get a transient that I have to respond to. You can probably train through that, and I guess I just kind of feel that we can do a better job at that and probably we should, and I think that's effecting your landing performance too, because you know, the pilot's putting a lot of attention to the flight path control that last two or three hundred feet, and I guess I'm not sure that there is a reason you should have to do that, and I guess we were talking about the stabilized approach yesterday, and it really doesn't fit that definition either. I don't think it's a big deal, and it's a transient that's easily hand-able, that the crew can handle, but I'm just... I guess what I'm really getting at, is in modern flight control design, I would kind of think that we would be designing an airplane, you wouldn't have that transient. If you do have that transient, at least on the last portion where we were doing the go-arounds, I would see a fair... I would have the commanded flight path vector on the 3 degree line, and we would be holding glidepath, and then during that transient area, I would see it starting to drift high on glidepath, and before I got a split, in other words, I add a commanded flight path vector of 3 degrees, no actual flight path vector popping up, but I would see us drifting high in the glide path, and if I started my correction, if I anticipated and said okay, I know I'm going to get this, and I'm watching for it, if when I got that, I'd push the flight path vector over, and deflect below the 3 degrees, I would get a small perturbation, and you know, shortly after that point, then I would get the split between the actual and the commanded, but the first cue that I had, that I was not getting what I had commanded, was on the glideslope indicator, and anyway... Just

one last note, between the go-around cards that we did in the approach and landing cards that we did, there definitely seemed to be a difference in the ballooning effect during the flap transition at 390 feet on down. On some of the landing cards, it seemed like I could almost go through that transition hands off and only get a small perturbation and glide slope, and on the go-around phase, going through that transition phase, it took a fair amount of pilot action to keep the perturbation small, and the first indication of the ballooning was, the glideslope to change, anyway.

[Pilot F answered additional questions in this series later in the test below.]

## **Pilot F**

Task 4069 IAG (TIFS) Offset Approach & Landing 22 Jan 97; Runs 41-42

Okay, I guess the first comment I have is I think there is a pretty good learning curve on how to do the landing, and where exactly you put the flight path vector, I would have put it more to almost like playing a pinball or a video game. Let me back up in saying that, it has a very video-ish game kind of flavor to it at least in my opinion, and the reason I say that is, I'm starting to learn that there is a certain rate that I can use in the round out and flare and also about where to put the flight path vector to get in the touchdown box, when I say box, to get the desired rate of descent. It's still hit or miss, if I get outside of the basic stabilized parameters that I'm kind of looking for on the approach, than I have to work very hard to correct to get back in. Anyway, for this task, I don't think there is any problem flying the approach, making the correction back to land on centerline, laterally and holding the glidepath for that is fine. I'm noticing that I am using a lot different technique here than I did with the Ames simulation that I participated in before. Before, when I made the offset, I would duck under, and then flare the airplane so that I would try to touch into the touchdown box. This time I'm basically leaving the flight path set on the touchdown aim point and just making the lateral correction and then trying to do a very mechanical kind of round out to just kill the descent rate, but keep the descent rate on the flight path vector onto the runway. We'll go ahead and rate it, I guess, we'll do the ILS task first, it gets no different than any of the other ILS tasks that we've rated so far, that as I can see with the autothrottles on. It's controllable, obtainable work or a... adequate performance attainable with tolerable pilot work load, satisfactory without improvement for the ILS portion, and that puts us into level one, and I would say that it's a 2, for both lateral and longitudinally. One other thing that I noticed is, although, if I want to stay exactly on glidepath, I have to work and kind of anticipate through the flap transition. If I just leave my hands off the stick to the flap transition, the airplane... it will stay within plus or minus, half a dot or so, quite easily. I guess what I'm saying is, is that I can turn down the gain through the flap transition and accept a little bit larger excursion still within the desired box, and reduce the work load a fair amount. For the landing task, is it controllable ? Yes, is it adequate performance obtainable, try that again, with a tolerable pilot work load ? Yes, is it satisfactory without improvement ? And here I'm going to look at the descriptors for a 3 and a 4. Minimal pilot compensation required for desired performance is a 3, and desired performance requires moderate pilot compensation is a 4, we got desired performance on one run, and almost desired on the other. We were a half of a foot out of the lateral box of the second one we did. I'm going to have to think about this for a second here... I guess I'm going... again I really don't like breaking out the axis for the rating, but I'm going to do it here, I guess in pitch I'm going to say it is a 4, because I still... in my opinion it takes some gamenship to make the touchdown point, longitudinally and the sink rate both work out, and I think it's a combination of we're using a gamma control kind of airplane which would be perfect for a typical low flare landing, but in an airplane that we are really trying to flare, and I'm not so sure that this

control is optimal for the flare, although, it's something that... I think that there is a learning curve on, and you can learn to compensate for, I guess I would just say it's slightly over minimal compensation for that, and so I would put it in the 4. The lateral task, I'd say is a 3, the airplanes not real crisp, and you have to be patient for it, and start your correction at 250 ft, if you mess up the transition, I have a feeling that you would have a hard time correcting back in, in fact on the second run, I held the heading off for a little bit too long, and it took some fairly larger inputs that I really wanted to make to kind of get stabilized back, and we were a half of foot out of the desired box, so, anyway, I'm going to call it laterally, laterally directionally a 3, and longitudinally a 4.

## **Pilot F**

Approach and Landing Questionnaire 22 Jan 97

[Pilot F answered earlier questions in this series above.]

HUD symbology Issues

### **23. Was the appearance of the actual flight path symbol (triggered when flight path angle error exceeded the threshold value) helpful or more of a nuisance ? Would you suggest any modification to the logic which triggers the appearance of this symbol ?**

I guess, first of all, if there are going to be significant times when the commanded flight path vector and the actual flight path vector don't agree, I think that there needs to be some way to communicate that information to the pilot. Typically, the HUDs... current generations that are out there right now, or at least my understanding is, they use some smoothing routines and basically, what you see is what your flight path is, but there is some filtering and smoothing to it. In this case, we're trying to use a flight path vector as a control instrument, rather than a performance instrument. In the traditional HUDs, the flight path vector is really a performance instrument, and pitch and power, even though the pilot may not be always specifically using that in a cognitive manner, pitch and power still are the control instruments, are which are controlling the airplane to. The reason I say all of this is, I did find it a nuisance at times, the actual flight path vector popping off. I think that it's going to be important if we have actual and commanded flight path vector symbols, that the pilot is very aware of what the difference between the two are. We did see on some, landing tasks, like with the headwind, where at least the pilots perception was, that the flight path vector was not, the commanded was up, there was no actual ghosted flight path vector up, so only the commanded was up, and when it was set on a certain position, during the landing, round out and flare with the 35 knot crosswind, the pilot perception was, is that, he was not getting the same gamma, that he did in a no win situation. And I don't think that that's very good, I think that, not only because predictability and consistency suffers, but if I command a flight path, I expect to get that flight path, and I expect all my other supporting performance instruments; vertical velocity, the visual world outside and everything else to support, yet I've commanded, unless I'm not getting it. I think this a more complex issue than I can just really discuss right here, and I think it warrants a lot of discussion in the community, because really we're starting a... to go into a flight path vector based control system and a display and a control instrument like that, I think there's a lot of, a lot of issues which need to be discussed. I guess right now, I might be inclined to look at varying the trigger point at where the flight path, the actual flight path symbol comes up, and during the aggressiveness at which the flight control system maintains flight path, commanded flight path, and I realize that there's a big tradeoff here between passenger comfort and everything else. I think that this might be something that would benefit a lot from TIFS, because there is a big difference

between even in a motion based simulator, seeing this, and seeing this in a flight environment where you actually feel G in the seat of your pants, and as far as tuning the flight control system to follow the commanded value, and as far as where you want to pop up this actual flight path vector when there is a variation, I think that issue needs to be looked at in a very controlled evaluation, rather than just really basing it on opinion. One thing that I mentioned before is, when the airplane is reconfiguring itself, I'm not so sure that I think from a pilots perspective, realizing that this may not be an easy thing to design to, but basically, if I put a commanded flight path vector of minus 3 degrees, and I'm not getting some kind of an environmental perturbation that's bouncing me around, and I'm not making any input, if the airplane reconfigures itself, I think it should hold 3 degrees, I guess I don't really think I should be getting the ghosted actual flight path vector or seeing ballooning, or whatever. I realize that's a lot to ask, but I guess philosophically, I think we kind of need to decide rather, especially at low altitudes, if that's really what we want to do, rather the flight control system should be more robust and be able to handle that, and I realize that the forward feed past used for the reconfiguration, or for the flap transients, aren't necessarily the final cut at it and they're not necessarily optimized for all conditions, and they may be more optimized for some weights and CG's than others. Anyway, I guess that's about it, I really think that this is an item that deserves a lot more discussion and a lot more evaluation. Let's move on.

**24. Was the tailscape indicator symbology presented on the HUD useful during execution of the go-around tasks (4086 and 4085) ?**

Okay, I got to see the go-around task with the tailstrike indicator, the 30 ft go-around task with the tailstrike indicator up first, and then the second one, the second time I saw the 30 ft go-around, I did not have a tailstrike indicator. I personally liked having the feedback of where the tailscape would occur, and I felt I missed it on the second runs where I didn't have that, and I think it made me a little bit more hesitant to pitch the airplane up, not having it there. Having said all of that though, I think this relates to question 23 in that, the pilots doing a... using the command flight path vector to control the airplane, and he's flying that flight path vector. Perhaps he would be doing this with a guidance cue in the final resolution, and then when he does the go-around, his task, his defined task, is to rotate that flight path... the commanded flight path vector to accomplish the go-around, but the tailstrike indicator is referenced to the waterline of the airplane, and I guess I would think that there maybe more elegant ways to handle this situation, but I guess, and I realize we're trying to be consistent with the takeoff mode too, and I realize that the geometry strike issue is a function of pitch attitude, not flight path angle. There are quite easily... it can quite easily be done to limit the flight path vector, based on limiting and attitude, though, and I'm wondering for the go-around case if perhaps we shouldn't explore putting a tailscape indicator maybe smaller and slightly different shaped or with brackets or something, lower in the display referenced to the flight path vector, even if we keep the one referenced to the waterline out. Again, I think this is an issue that deserves further evaluation. I think that there is a lot of good and keeping displaced consistent between go-around and takeoff, but I'm not so sure that I have enough data here to really say that I, you know, what I think the solution would be, but I think that we could do better than what we're doing, but my preference is to have a tailstrike indicator for the go-around phase. It brings up just a general comment that I have about this simulation and the airplane, it seems like, at least my perception is, is that we're going to be geometry strike limited, or close to being limited, quite a few times during the takeoff, landing, and go-around phase, and especially with crosswinds, gust turbulence and everything else, and I think this is something. I'm sure there are people looking at it in detail, but I think this is something that we really need to think about, both from a controllability standpoint and how much leeway the pilot needs to be able to perform normal flight maneuvers, we don't want him... we need to give him some margin

that's reasonable to work with for different malfunctions, for gusts, for malfunctions occurring close to the ground, for turbulence and everything else, and just for crew error, because there is going to be some slight technical error for any maneuvers that the crews do. In addition to that, if we are even with that margin going to be close, we may need to start thinking about some strategy for making the pilot aware of where those limits are and how close he's getting to those limits and how much margin he has, and again I think this is something that needs to be integrated into the system, it could even be a combination of envelope protection and displays and warning systems, kindly notice there's three separate things, I don't really have an answer for this, but I do think it's something we need to look at in detail down the road.



## **Go-around Questionnaire**

### **Pilot A**

Go-around questionnaire 16 Jan 97

#### **1. Adequacy of Pitch Control Power ?**

There seemed to be an adequate amount of power, although we did get to elevator angles that were basically full-up elevator at times. The elevator required was considerably less, maybe half elevator when a classical approach and flare were made. The conditions were category three, so, there were some special, higher work load during the approach to stay within the ILS bounds, and start a flare while still... still in the clouds or close to it. The visibility was reduced. That's a bit of a distractor, and so it took a few practice sessions to get the practice runs, or runs to get the routine down, but once the thrust and pitch were adjusted as required for a nominal flare, then that left the engine spooled up at 30 ft for example to the point where additional thrust was quickly available, and the pitch to positive rate usually gave about a 20 ft descent (ascent), and an adequate go-around.

2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?

#### **3. Ability to Control and Track: flight path, bank angle ?**

The ability to control flight path was adequate. Bank angle, of course there's... although, PIO tendencies were not particularly a problem in this maneuver, there is a slight tendency to PIO in roll. That leads to the next question.

#### **4. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

None in the pitch axis, however, roll; there was a slight tendency to PIO after the airplane had reconfigured going... descending through the 400 ft level. And... so, in each case, however, the task was completed, and that tendency did not seriously detract from the maneuver.

#### **5. Pitch/Roll Inceptor Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

The force seemed reasonably, as well as the displacement, and this sensitivity was satisfactory, although... in pitch, and roll it seemed to be a bit overly sensitive when the final flap setting was finally set. And that's one of the things that kind of leads to a PIO in the more aggressive maneuvers. Pitch and Roll Harmony was... force wise is probably satisfactory, but as far as roll is concerned, it seemed a bit sensitive in roll, it's difficult to get in and out of roll detent without some jolt in the cockpit.

#### **6. During the approach, were there any problems ?**

Down to 200 ft there were no particular problems, except that on the glideslope, when the flaps reconfigure, they... the pilot sees what is an apparent unexplained deviation from the glideslope, and so, starting at about 400 ft, there is a series of small corrections back to the glideslope that tend to be a very repeatable, and there a bit of a bother to the pilot, and they're kind of a distraction. If you have other things going on, whether your other distractions... there's one more distraction to create a problem for the pilot, and that would be advisable to try to eliminate that kind of a perturbation in the glideslope.

### **7. During the go-around, were there any problems ?**

During the Go-Around, the main problems in the Go-Around were concerned with, not getting stabilized and getting the rate of descent checked to execute a normal flare, and getting a thrust, and actually a thrust has to be added and pitch changed, if that is not done in a timely matter then the go-around... the go-around can result in a touchdown on the runway briefly as you go around.

### **8. Was the altitude loss following initiation of the go-around satisfactory ?**

I guess I'd have to say, yes it was considered... it was about as you would expect for any airplane that's making a touch... a flare, and a go-around from the flare, or a go-around from just above a flare, so nothing particularly unusual except that on occasion, full elevator was required for the go-around, however, this didn't seem to interfere with the go-around commands. On occasion when one of the touchdown to the runway was made... that was primarily because of the improper setup for the flare, and that kind of goes back to the preoccupation with the glideslope anomalies, and the fact that the approach is being made down to CAT III, and it was using raw data.

### **9. Effects of the Wind/Turbulence ?**

I think were somewhat minor.

### **10. Summary - Good/Bad features ?**

Well, a good feature of a flight path vector control law, is that it allows you to select a flight path vector and hold it. Some of the bad features are the... the, I guess, I might mention that the go-around switches and the autothrottle disengage requirement for the flare, are involved. Some rapid fire switch... switchology actions that can be a problem until your fairly used to this particular simulator. I guess some of the bad features might be that the... there's a significant amount of thrust that needs to be added just to get a flare under normal conditions, and another bad feature would be that the glideslope... apparent glideslope deviations during the reconfiguration, and the tendency to... slight tendency to PIO in roll is a bit of a distracter. The auto... the throttles on this airplane... in this simulator were a bit stiff, and that can be a distraction in the flare. That's all the comments I have.

## **Pilot B**

Go-around questionnaire 07 Jan 97

### **1. Adequacy of Pitch Control Power ?**

For the 50-ft go-arounds the pitch control power was inadequate for the metric that we gave. The one thing I didn't try was to reduce the aggressiveness of the initial input, I was saturating elevator pretty quickly, and I didn't try to reduce that, to see if I could get more effectiveness by using less elevator, which is possible if, I don't know if the model actually stalls the tail in this scenario, or if the lift curve slope is non linear at the tail, but I guess it is possible. In any case, I was at the stop, I was saturating the control and I was not able to get the altitude loss within the specified tolerance.

### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

On the other hand I thought the response in pitch to the control input was relatively predictable, I didn't have a problem with setting the pitch attitude, it just wasn't reducing altitude fast enough. No special control techniques, it's almost an open loop test. I am going to the stop-in-pitch until I get the flight path vector above the horizon, hit the TOGA and put the gear up. Of note on some of the 30-ft tests TOGA wasn't registering, and I thought

initially I was hitting it and then it was confirmed later on I was hitting it and it just was not getting registered consistently, and we are looking into why that was.

**3. Ability to Control and Track: flight path, bank angle ?**

The ability to control and track flight path angle was okay and bank angle was okay, the work load was a little bit high, because you are concentrating so much on getting the nose up accurately that the lateral directional suffers just from neglect, but it's not inordinately difficult.

**4. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

I didn't notice any pronounced PIO tendencies in Pitch or Roll. That's number 4.

**5. Pitch/Roll Inceptor Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Pitch and Roll Inceptor characteristics were okay with the exception of hitting the stop in pitch. At that point there is no relationship between force and displacement by definition that's expected.

**6. During the approach, were there any problems ?**

During the approach , yeah there were problems flying the raw data approach down to 30 ft, which was what the task I was being asked to do, it's non mission relatable, you are not ever going to ask a pilot to do that without a flight director and that detracted a little bit from the go-around, it would have been nice to have a flight director so that everything suit cased, I am not dividing my attention between the impending go-around and flying the approach.

**7. During the go-around, were there any problems ?**

I think I talked about any problems we were on the Go-Around, that's questions 7.

**8. Was the altitude loss following initiation of the go-around satisfactory ?**

I think the altitude loss of the exception of the tail scrape that we have the altitude loss was satisfactory in all of these including the ones that were labeled inadequate because we didn't meet the 30 ft required on the test, so we need to talk about that I guess.

**9. Effects of the Wind/Turbulence ?**

Turbulence had an effect in terms of accuracy on the approach -didn't have much of an effect on the go- around.

**10. Summary - Good/Bad features ?**

Summary, 30 ft go-arounds, tailscape is an issue and that the special control technique there is to reduce the gain, don't get too aggressive on the controls once I learned that, I didn't have a problem with it, and the 50 ft go-arounds in this configuration with the technique that I use, you are going to lose more than 30 ft. And that concludes my comments.

[An additional pass through this questionnaire was made on the following day below]

**Pilot B**

Go-around questionnaire 08 Jan 97

[This questionnaire was first answered on the previous day above]

We revisited the 30 ft go-arounds, did some 50 ft for practice, and then revisited the 30 ft ones again. Let's see, summary comments, I was concerned that there might be a technique issue, that if I reduced the aggressiveness of the first input that might reduce the altitude loss, I did, but only by about 2 or 3 feet and it was still inadequate, it was over 30 ft, so if there is an effect there, it is not a pronounced effect, so I think the answer to this, is that 30 ft is largely not do-able, unless there is some magic trick that I haven't found that can be found, but given all that and given that the airplane is very susceptible to aggressive maneuvering down there in terms of tailstrike, the maneuvers do-able, but you've got to be real, real careful about tailstrike. I'm not sure that's a handling qualities issue as much as it is a training and technique issue, once you get a feel for what the proper technique is and get a feel for what it feels like to do the go-around like that, you can do it just fine. I don't remember this, it may have been that we had different geometry constraints than we have now in the past, but I don't remember this being as much of a problem with the Ames go-around task as it is here. I don't recall ever striking the tail before and I've hit it a lot here. Could be my memory, or could be that we weren't concerned about tailstrike in terms of freezing the simulator or anything like that, I don't know, but at any rate, I know that they have, there have been reports of tailstrikes at Ames in the go around. Okay, going through the questionnaire.

### **1. Adequacy of Pitch Control Power ?**

It's adequate, I'm saturating the elevator in the 50 ft go-arounds, I don't tend to saturate it in the 30 ft go-arounds, because the nose is already coming up in the flare, so the problem in the 30 ft go-arounds isn't so much pitch control power as it just being real careful not to scag the tail.

### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Predictability in terms of pitch response it's predictable in terms of tailstrike, it's not predictable, it's something you have to experience, it's not something that is intuitive, that's why the TSI is so valuable. The only problem I had with the TSI is that it's essentially out of your scan. It's a peripheral cue at that point because you are at a high enough angle of attack, that it's out of your area of focus on the HUD. I don't know whether you might want to flash it or, but you need to get the pilots attention in some other way than you are doing, as you get close to tailstrike. Again, with a fuselage this long, it's not intuitive. A special control techniques definitely, I'm into question 2 now, and that consists of just backing off on the elevator input particularly as the nose approaches the horizon, because if you think about it, at the point where you are going to hit the tail is at the point where the flight path vector is above the horizon and the pilot's thinking about the go-around being over at that point, you are not intuitively thinking about tailstrike at that point. It's where the velocity vector is, the velocity vector is going to be above the horizon when you hit the tail, because by definition you are pointed up and your vector is up, so the pilots thinking the maneuver is essentially over at that point, and the times that I have gotten tailstrikes I've been surprised, I haven't been thinking about safety of the airplane in terms of striking the ground at that point, because I'm moving in the other direction at that point, so again it is not intuitive that as you rotate that what's going on at the CG is not what's going on at the tail, and I guess your velocity vector is even forward of the CG, so it's even worse because of that.

### **3. Ability to Control and Track: flight path, bank angle ?**

Not really an issue in these go-arounds.

**4. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

No PIO tendencies in pitch or roll that I noticed today.

**5. Pitch/Roll Inceptor Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Pitch and roll inceptor characteristics were okay. Force and displacement seemed consistent, breakout friction was appropriate. Sensitivity was appropriate to the task. Pitch and roll harmony was okay, I didn't notice any problems there today. I didn't notice inadvertent inputs today, but I'm not sure that the task, it did not, I'm not sure that the task, in other words, inadvertently cross coupling between the axis, and I'm not sure that the task would be prone to showing that, but in any case I didn't notice it. You would think during the go-around I would have noticed coupling, and I didn't. Although, I did notice that on most occasions when I changed my scan to look up for the go-around indicator, that I was not at zero angle of bank, I was at some angle of bank other than zero. So I think what's going on is I'm not really controlling angle of bank tightly in the pull-up, I am more interested in getting clear to the ground and I'm not...once I am controlling angle of bank I don't have the large pitch input in, so maybe that the coupling is still occurring, I'm just not noticing it because I'm not trying to control to it.

**6. During the approach, were there any problems ?**

Problems during the approach that were any different than what I've seen before, that the approach is a difficult one because you are flying raw data, you don't have a flight director, and particularly down to 30 ft you're flying, essentially raw data, you've got a little bit of cue from the visual bit, but not much, so it's a difficult task, but nothing inordinate in terms of handling qualities.

**7. During the go-around, were there any problems ?**

No other problems than what I've noted in the go-around, that is question 7.

**8. Was the altitude loss following initiation of the go-around satisfactory ?**

The altitude loss during initiation of most of the go-arounds was satisfactory, on one of them I got a tailstrike so it's kind of hard to say it was satisfactory. From a wheel height standpoint it was, that again the geometry of this airplane is considerably different than a conventional airplane. You've really got to consider what's going on at the tail as distinct from what's going on at the CG.

**9. Effects of the Wind/Turbulence ?**

Turbulence was a factor in the approach. It just meant that you had to keep the work load up and make constant inputs.

**10. Summary - Good/Bad features ?**

I think we have a training issue here, I'm not sure we've got a handling qualities issue, because I don't know how you get around the geometry of the vehicle. I don't think anything that you do in the flight control law is going to prevent that geometry from effecting you, I'm not sure you want to get real automatic about this because you want to, if the pilot decides to strike the tail, you want to give him the authority to do that I think. That's why you've got tail bump devices on tails, but you've got to find some way of notifying the pilot, I think, that you are about to do that, so that if you don't want to do it deliberately, you don't have to. I think the TSI right now is a peripheral cue, that at relatively low angles the attack, it's like takeoff, it's valuable because that's where you are looking, but on the approach and the go-around you're focusing on the velocity vector and the waterline is well above that. On

the other hand, if you move the TSI down to reference to the velocity vector, I think you're going to have a problem with clutter into this place, so I don't know how you do that, maybe you flash it, maybe that's, when it gets close or when you have a rate, what I have seen done with other indications in the cockpit is when a combination of rate and position reaches a certain threshold, then you flash it. Like we use to do with turbine inlet temperature on the F-14, when the combination of the temperature that it was at and the rate that it was approaching the limit resulted, I think it was a combination of rate product type combination. When it reached the threshold, then you flashed it. You could also look at time to strike, which is a combination of rate and position, is a product combination when your time to strike reaches a certain threshold or below that than you flash it at that point, but you need, that's typically the way you get around peripheral cues and requirements of instant notification, you've got to do something to let the pilot know that it is about to happen. What was the other thing I was going to comment that we don't have cards for ?

(Block three Ripple Unstarts) The unstart cues are excellent, and it is at a phase where I don't think where you are as concerned about clutter as you are in other phases. We've asked for visual up and away primarily to keep the pilots happy that they can see outside and to see weather, but in terms of seeing small targets out there, you're not going to at Mach 2.4 so you can afford to put some symbology up there, and I think the way you have it implemented is fairly good, I'm not sure it is the only way to do it, I'm not sure you couldn't do it with less clutter up there, but it certainly is nice to have something that shows you how sensitive the vehicle is to pitch inputs particularly. The first time I did the maneuver for practice, where you pushed over to seven tenths of a G it got an unstart, so that's really a learning evolution there, and the place to learn it is going to be in the simulator for training. BMCL was the other one, I wanted to comment on. That's more of a demonstration, I think we got 10 knots lower than we expected to, I'm not sure if that's a change in technique or a change in the aerodynamics, but I think we found the speed, I think if we've been even a couple knots slower than a 130 it wouldn't of passed. The technique is a little bit different than what you've go on the card that I was using though, the card targets 0 degrees angle of bank and that's not the way you do it in flight test, and that's not the way I did it there. What you target is right up to 5 degrees, you allow the angle of bank to develop and you try to limit it to 5 degrees. If I had targeted it...if I had targeted it at zero bank angle than the speed would have been a lot higher than that for a successful maneuver. Anything about circling approach ? No, that's pretty much a no brainer, it's almost a instrument approach really, the way it's being flown, you could do the whole thing without a visual. How would we best recreate that or simulate that, do you think ? I'm not sure that is not fair, the way we are doing it, I'm not sure you would want to make it any tougher than it is, because in this airplane, with this class of navigation system you are certainly going to know where you are even in a circling approach and the scales are going to be appropriate, you've got enough display space to put the scales proper and all that. We've done that in TIFS, right now, with current technology, so there is a...we've talked about this in XVS, there is a link between what's acceptable in field of view and a navigational standpoint from a XVS display, and additional supplementary information that you have head down. The more information you have head down, the more you can afford to limit the field of view head up. You can certainly see that here because it is freely limited display, it's more limited than we expect XVS will be and the simulator, yet it's certainly acceptable in the circling approach. I didn't feel it was any big deal, it was certainly no tougher than any of the other approaches we have done. Any specific comments on the inadvertent speed increase, 2- axis upset, or we didn't get that far ? We did the speed increase. The only thing there is what I've already commented on and that's the unstart indicators are very, very useful in that maneuver. That concludes the morning comments for Pilot B.

## **Pilot C**

**1. Adequacy of Pitch Control Power ?**

I've been talking about the go-around here, adequacy of pitch control, yes, it was certainly there, more than was necessary. Predictability, response, and pitch input, it took a little bit of practice, and incidentally a suggestion, for somebody who has never done any go-arounds with this airplane and so on, to know what the response is, and how quick you have to put things in, you might try the first practice one or two, with the whole visual out, not doing it at breakout, and that way it will give a guy a feeling for, okay, I've got to put in this kind of pressure, and so on. It took me about two or three passes before I bracketed what kind of inputs it took, because I had...I was clueless to how hard I was going to have to pull, in fact the first time I think we over G'd it or something, and I think if I would of had the full visual and then just do-able, I would of had a feel a lot quicker, it wouldn't of taken as many...

**2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

Okay, on the other side of the tape I was talking about the predictability of pitch and roll response on the go-around and any special control techniques required, and I was saying for the training purposes that if we would of had the whole visual out, it would of made it a lot...I could of picked up the pitch and roll response necessary a lot better than the breaking out and then have to do it, because you have no idea, when you start, what it's going to take, and its time...after you do a few, it isn't so tough, that if I had the whole visual, I think I could have done it in one or two practices instead of three or four.

**3. Ability to Control and Track: flight path, bank angle ?**

Once I learned the secret of taking care of the pitch and then coming around and using the TOGA switch that I had said on previous places, at least once or maybe twice now, the TOGA switch was in a very awkward position, and so hitting the auto throttle off and then coming around and doing the TOGA at the same time, I was bringing the nose up and pushing the throttles forward, meant an awful lot of things to do, the TOGA switch would have been in a better position, likely would not have...it would have smoothed out that whole transition considerably. Bank angle was not a difficulty. On the ones that were...go-arounds at 50 ft, I didn't see anything, because as soon as I broke out I was given the go-around. On the other hand, for the 30 ft, I had started to correct any misalignment at all and so had some bank angles in there and did a few variations on it, but I didn't see any problem with bank angle, that's for sure, and flight path control, was okay. It just took a little bit of learning of technique that would make it work the best, and I don't know...it looks like...I'm not sure I said anything about it on this part, but most pilots are focused on landing and the fact that here we're suddenly asked to go around, is negated by the fact that we knew we were going to go around the whole approach, and thus there isn't the delay that would normally...the surprise factor that would have been in their head, if it had been a real go-around in an operational world, but you know, we've got to do, what we've got to do for the test, but that's just a comment.

**4. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ? Any PIO tendencies in Pitch or Roll ?**

I didn't see any on this, in either axis.

**5. Pitch/Roll Inceptor Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

Force & displacement, Sensitivities, and Pitch and Roll Harmony are the same as they were all along. I don't know if they are ideal, but they're certainly well within the range, I didn't have any, I have not had any complaints about them, all along, nor did I in this go-around.

#### **6. During the approach, were there any problems ?**

This was the one that where we had picked up the slight drift to the left, but in general the approach itself was a piece of cake, there's not very much on...no, I take that back, at this point we have gotten rid of the drift, because we had centered the rudder better, the rudder trim. Disregard what I said. There were no problems in the approach, it's pretty much a piece of cake. Do notice though, and this kind of applies more to just general than it does to this specific test, but the glidepath indications on this mechanization, at about a 100 ft starts to drop precipitously. Now a 100 ft sounds to me like that's too high to be very much in the way of ground effect, but the glideslope would drop a lot. If I were to chase that, I would of had a pretty good rate of descent going, that I would of had to arrest somewhere along the way, and when your ceiling is right there you see, before, when I had good visibility all the way down, I could shape things, but in those kind of weather conditions, you're not going to want to be below that glideslope anymore than you can help. I mean you make that as accurate as you can, and so the early hold at a little bit glideslope, a little bit high, so that you are a little below the glideslope, is probably not a very good factor, and everyone of these go-arounds, there is not doubt in my mind, I would of landed long.

#### **7. During the go-around, were there any problems ?**

Okay, during the go-around were there any problems ? Well, there was the one tailstrike, that's a big problem, but when I had settled on the technique they are usually...that was sufficient, but this is one of those things that would have to be practiced in the simulator a lot or it's going to give problems in the real world. The good news is, there are very few times that you go around at 30 ft, but on the other hand, maybe if you're talking about CAT III on this airplane, or something that might be a different factor.

#### **8. Was the altitude loss following initiation of the go-around satisfactory ?**

#### **9. Effects of the Wind/Turbulence ?**

Well, certainly didn't help, but I didn't see that as a major difficulty in the go-around.

#### **10. Summary - Good/Bad features ?**

Pretty well covered them, through them. I think go-around, especially on this airplane, would be a great candidate for some autopilot kind of things, flight director...no, automation, in other words, hitting the TOGA switch for the go-around it would have been a definite assist if that would have taken care of the throttles for instance, and started you going...you're going around, you're going to go full power, so that's something you can automate for me, if the TOGA switch whhhhooo, throttles go forward, that would have assisted considerably, and that would then give the pilot only the pitch attitude task, and I think that would have likely been a benefit on this. That would be the only suggestion I have, I think this is an area, and again because it's a surprise, if you're response to this surprise is only, hit that button, that's a heck of a lot better than, oh, if this happens, push this button, bring the nose up this fast, but not too fast now, you see what I mean, in another words, that's one that I think would benefit from automation, and as a pilot I don't usually suggest automation. I think that pretty well does those. Did you have one of these for the circling approach ? Okay, well I guess this is as good a place that I've put on it at anything, because I discovered, and an interesting thing, when I was landing on the other runway, I did not see the problems that I saw on the initial runway, and why will be a very interesting



thing to investigate. I think it is worth while looking at, the feeling of this ballooning, this attitude change. It looked like he was drug in on the visual, when you said, you're white on white. Yeah, well, I'm assuming that the VASI's were correct. Did they work, because he seemed to be a long ways out and I checked the radar altitude and he was only like 300 ft high, and I said, wow, that seems to be awful low to be that far out. Because that's what I was using, I assumed that they were correct. I don't know, but it appeared that he might have been drug in, now I don't know if you want to check that and see what it's like. Well, it's easy to see on the visual too, because you're 3 degree thing was still there, was it not, as I recall, and see where that was. That will tell you where it was. Yeah, I've brought it down to white and red, and of course it's bright red, it's PAPI, or what the hell ever they call it. So, unless the angle was off, that's an interesting thing, because that would make all of the difference in the world. I can believe that. Now when you say drug in, you mean the glideslope was set too low ? I only thought, when he said he's white on white, I said there is no way you can be white on white, he's only 300 ft AGL here, you know, and he looked like he still had a long way to go, so. One difference on that landing of course is that you had a 35 knot headwind. Yes, that's correct, and that certainly made the difference as far as the touchdown, I agree with that. The thing...so that didn't surprise me, the fact that my problem before was that I always landed long, and I got 35 knot headwind and it comes out, that makes sense, but this feeling of doing that, changed, and what I'm wondering is if this glideslope...and I'm obviously trying to cross it out, but this glideslope...when you get close to the ground, you start seeing something on a HUD, start to really drop. It's giving me this feeling that this is what's happening because that's, you see, if the glideslope in fact, here we are, we're around the glideslope and this airplane is going to go right down the glideslope, yup, this happens, that means that you've climbed, and so if this is coming down when it really shouldn't be coming down, it's giving me this feeling, and it is about the time that the flaps, I'm sure the attitudes changing, and it's got to change. At a 100 ft the flaps are done. Okay see, there you go, okay well then, where all this is coming in, and I'm not sure, but I'm seeing this come down, and you see the difference was on the other...I didn't have any glideslope indication, so, that peripheral cue out there maybe have been a mislead all along here. Another thing I discovered about this yesterday, is we never made a conscious decision about it, we are flying the same turbulence feel every single run. You maybe getting the same little gust. What I'd like to do, oh, I see, whhhhooooo, anyway, there is a couple of three things, it shouldn't take a lot of passes, go back to the regular runway, do it without the glideslope, let me just do a visual without any glideslope information up there, let me just go ahead and fly this thing, and if it turns out that I don't get this feeling then I really feel bad because I should have picked that up before, some peripheral thing is effecting my thing here, but anyway, it's worth knowing. We can try that and then try it without turbulence at all, and just see, because if you say we're getting a gust...you know I might have just been getting that time after time, and it was running me long, I hope that's it because that means I told it like it was. Okay, that was the only thing that was different on it, because I couldn't believe how easy it was to land on this one, I said, god this cake compared to what I was struggling with yesterday. Why is that ? So anyway, I think it will be worth two or three passes, just short in passing, you know just a straight-in one, trying it without the glideslope and without the turbulence, just to see if something in there was what was giving me the fits there. I hope that's it. Maybe we should take a look at that tomorrow. Yeah. We're suppose to start take-offs.

## **Pilot D**

Go-around questionnaire

Not completed.

## **Pilot E**

Go-around questionnaire 09 Jan 97

### **1. Adequacy of Pitch Control Power ?**

Yes, I had no... in fact, I was very impressed with the pitch rate of the aircraft, I think we have plenty of pitch control power.

### **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ?**

The pitch rate, actually it's so good, that at times I had to actually slow down my pitch rate to avoid a tailsrape. That was a special control technique I did use. I actually would cue on the 12 degree gamma flight path reference marker without the tailsrape indicator and would be aware of where the waterline was referencing that before I increased my pitch rate to continue the go-around, but plenty of pitch rate power.

### **3. Ability to Control and Track: flight path, bank angle ?**

I've made similarly comments along this before. Bank angle, I tended to... it's just not... it should be better. You tend to oscillate about wings level by about 1 or 2 degrees and I think we can work... I think the harmony of the stick is good, I think the control law can possibly be improved or maybe we do need to do some more work on the harmony so we don't inadvertently trigger a lateral input when you're making an very aggressive longitudinal, but I think, I think the harmony is pretty good, I think it's just... we had the same thing happen at Ames with yoke, and stick and side stick. It's just not real easy to hold wings level in this control law.

### **4. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

For the go-around task, no, neither in pitch nor roll.

### **5. Pitch/Roll Inceptor Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

I think it's excellent for this McFadden that we are using right here.

### **6. During the approach, were there any problems ?**

The only thing I noticed, since we're flying on instruments all the way down to 50 ft or roughly there about it was very... it took a lot of work to control the glideslope in the final stages of the autoflap transition, and I'm not sure why that was because we're suppose to have feed forward compensation to take care of that, but I tended to want to go higher on the glideslope each time, and had to really, really work hard and force the commanded gamma about a half a degree or so below the reference marker and hold it there, and I still would find myself slightly climbing. So, there is some kind of problem going on with these particular cards, 4080, or is it 4085 and 4086, something funny is going on versus the visual approach where the glideslope seems to work out real well, I really had to work on the glideslope at around 300 to 200 feet, and... so I meant to mention that in another comment.

### **7. During the go-around, were there any problems ?**

Laterally, I mentioned just a little kind of plus or minus 1 or 2 degree oscillation about wings level and none noted pitch, except you have a very good pitch rate and you've got to watch out for.

## **8. Was the altitude loss following initiation of the go-around satisfactory ?**

You know, I'm not too displeased with it, I think losing 40 feet with a 384 thousand lb. airplane has got all the other... deficient performance based on the backside characteristics in the like... I don't think that's too bad, we were measuring the altitude loss from 50 ft, but that's where the pilot not flying makes the go-around call, there is a lag between his verbalizing that call and the pilot receiving it and then thinking about what to do and actually executing it. Plus the ergonomics of the go-around button make it a little bit tough for me sometimes to hit it and get the throttles going forward at the same time. So, I think this... probably, I figured about a 1 second delay between 50 ft and when the pilot actually is into the go-around and I figured that's about 12 ft loss based on about a 800 ft per minute or 700 ft per minute sink rate, so you're only down 38 ft when you initiate the go-around and so the go-around is actually taking maybe 25 feet or so, which I think is fine. So, I think the performance criteria for that maneuver are too strict, and I think from when the call is made at 50 ft until the actual leveling out and climb, a 40 ft I think is perfectly fine, I think our criteria is too hard, too rigid on this one.

## **9. Effects of the Wind/Turbulence ?**

Certainly the wind and turbulence do tend to make the localizer glideslope tracking harder than they should be, and I think we just need to get a little more bells and whistles features on both our lateral directional and longitudinal control laws.

## **10. Summary - Good/Bad features ?**

No real bad features, there are features of the aggregate system that make potential for tailscape a viable potential, and that is fact that you have a very, very good pitch rate capability, you also have the tail far away from the center of gravity because it's such a long aircraft, and you can rotate the tail into the runway, so I think we need to spend some time looking at the low altitude go-arounds and determine maybe some optimal techniques to ensure that we don't get tailscape. Review commentary about this task by another pilot:

### **Pilot F**

Go-Around Questionnaire 22 Jan 97

## **1. Adequacy of Pitch Control Power ?**

I think that there is adequate control for the maneuver. I didn't feel like I hit any stops in the stick, I did think that we might hit some rate limits on occasion, but you guys can look at the data, and see if that's true. I don't remember if it was on these runs or not. I will note that, as I noted before, on the first few runs that we came back in doing the go-arounds, it was after we had broke, taking a break, and it took me a while to get back into the normal flare mode, and plus I was also allowing the airplane to balloon during the flap transitions. The flap transitions caused, pilot perception wise, is that the airplane ballooned more with the flap transitions than on the go-around cards than they did on the landing cards. Regardless, I started doing data runs probably before I really had gotten back in the swing of things. The thing that pointed out to me though, is that at 50 ft, I need to do a pretty significant flare maneuver in order to make the go-around work.

## **2. Predictability of Pitch and Roll Responses to Pilot Inputs ? Any special control techniques required ? Any special control techniques required ?**

Actually for this case, I don't know that I really solved too many problems in predictability, you know, basically I could put the flight path vector where I wanted it to be. Again, there seemed, and this a perception, but depending on how fast I entered the ground effect and what the angles were, and everything else, sometimes it seems like on the altitude lost in the

maneuver could vary greatly by the initial setup conditions, but I think that's kind of true with any airplane, it just maybe seemed a little bit more apparent here for small changes, like the slightly steeper glidepath. Again, you can look at the data, I'm not sure that is a perception.

### **3. Ability to Control and Track: flight path, bank angle ?**

Really other than just the normal comments that I initially made about, the airplane could be a little bit more crisp for my taste, but for this maneuver it's not really highlighted that much, plus there probably has been a learning curve between yesterday and today, but I didn't really see any problems associated with this task, with regard to tracking or controlling flight path and bank angles.

### **4. Were there any PIO tendencies in the pitch or roll axis ? If yes, was the task continued or abandoned ?**

And I don't think we saw any PIO tendencies in the go-around, so I'd say no.

### **5. Pitch/Roll Inceptor Characteristics: Force & displacement, sensitivity, pitch/roll harmony ?**

I don't think that, you know, given all the comments that I've made in the past about this, I don't think that there was anything really highlighted in the go-around case, the go-around case, I think in general was more of an open ended task that doesn't require a lot of fine tracking, as compared to doing the landing task or something. I think basically the force and displacements were okay. I still have a tendency to couple roll inputs with pitch for this simulation in the way the stick is installed in the simulator, I think there is a learning curve on that, and I've also kind of experimented with arm rest location and the... a little bit with the seat height within the range of staying in the desired eye height, by changing the tilt on the seat back, and then the tilt on the arm rest a little bit. It really doesn't seem to make a whole lot a difference. I think that maybe the stick being outboard a little bit, I don't know, I think that I would like to play with the stick placement a little bit to look at that. Sensitivity really didn't seem to be an issue on this maneuver.

### **6. During the approach, were there any problems ?**

No.

### **7. During the go-around, were there any problems ?**

Refresh my memory. I don't remember any problems that we really saw except for on the 30 ft ones, there were a couple times when we touched down, but I had, we touched down firmly, as a matter of fact, and I should comment about that again, I think that was a good function of not initiating a proper flare on the airplane, because had I initiated a proper flare on the airplane and then initiated the go-around at 30 ft, we certainly shouldn't of landed hard, and we did, and again I think that was just a matter of kind of getting geared back up, and kind of getting used to the control system again. I think it does note though, that again, I've characterized the flare task as being a kind of mechanical task that requires some gamenship, and I think this exemplifies it a little bit more. My normal scan and everything else that I use in landing the airplane as far as trying to kill off the descent rate and everything else, it requires a lot more attention in the simulator here, and some of that could be the simulation, but I think some of that is, the fact that it's not very tolerant of errors. If you over rotate or if you rotate too fast during the initial part of the round out and flare, then you have to work very hard to correct that during the later portion of the flare, with a typical airplane, I can just kind of release backpressure, and generally make things work out. Part of that could be it, experience with the traditional airplane, and part of that could be, the flight control system and the display. Again, also if we are seeing some differences in

commanded, and actual flight path that aren't really apparent to the pilot on the HUD, my perception was with the 35 knot headwind, if we're also seeing that kind of things with different descent rates entering ground effect, etc., that could be part of the issue, and that could be... a perception on the display could be causing a problem versus there being a problem in the flight control system, or it could be a combination of two, and yet I've mentioned doing some landings with the ground effect model on and off, and I think that's probably a good idea. I'd recommend doing that.

#### **8. Was the altitude loss following initiation of the go-around satisfactory ?**

Yeah, when we did it right, I think it was. You know, going around from 30 ft out there, you need to do a pretty aggressive airplane... pretty aggressive maneuver with an airplane that big, not to touchdown during a go-around, and hopefully if it was CAT III kind of landing, you should be over the runway, anyway, and if you touchdown, it's not great, but it should be something that is do-able, and certainly the ability to go around from low altitudes, touchdown and continue the go-around, the airplane has to be able to have that capability too.

#### **9. Effects of the Wind/Turbulence ?**

We didn't really have to much wind or trouble up on the go-arounds, so I don't know that that's really an issue here.

#### **10. Summary - Good/Bad features ?**

I think we've pretty much covered all of the comments that I have on the go-around, or at least that come to mind right now. Anyway, I think we can do better with the displays, I think we need to make sure that we're consistent with the displays and the philosophy of flying the airplane and the flight control system. Anyway, that's it.

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