APPENDIX E

USABILITY RESULTS OF THE PD/1++ TRIAL

E1. INTRODUCTION

This technical Appendix presents in full the Usability results from the Programme for Harmonised ATM Research in Eurocontrol (PHARE) Demonstration 1++ (PD/1++). It includes comments made by the controllers during the trial and at debrief sessions. This appendix only presents the results from the trial and does not attempt any interpretation or discussion thereof. The results are discussed in section 10 of the main body of the report and conclusions are drawn in section 11.

This Appendix assumes familiarity with: Appendix C which describes the measurements made, the planned analysis, and the methodology applied during the analysis phase; and Appendix C which gives an indication of the scale and range of each measure employed in the PD/1++ trial analysis and describes the statistical significance testing. Appendix C gives a thorough description of these measures.

Section E2 presents the results for each of the detailed objectives relating to the usability of the PD/1++ system and concept..

Relevant observations made by the specialist observers and appropriate controller comments from the questionnaires, debriefs and comment sheets have been included throughout. Where comments originated from the questionnaires, the relevant question has been included to provide the context of the comment. The role of the controller making the comment and the relevant organisation (ORG) have also been included, however it was not possible to determine the role of the controller from comments made during the debrief sessions as these were audio recorded.

Each low-level objective of the PD/1++ trial relating to the usability analysis (see Appendix C) is addressed in turn.

E2. DETAILED OBJECTIVES RELATING TO USABILITY ANALYSIS

E2.1. For each measured sector, examine whether alternative airspace structures ie sector 10 and sector 11 versus Hornsea, had a positive impact on tool usage, given the same operating practices.

Number of times ADFL invoked

Role	Comparison	Conclusion	% difference in median	Power
Planning and Tactical	sector 10 vs Hornsea	ORG0 = ORG1	-	0.94
		ORG2 < ORG3	73 %	-
	sector 11 vs Hornsea	ORG0 = ORG1	-	**0.99**
		ORG2 = ORG3	-	0.92

These results show that there was a significant increase in the number of times the ADFL tool was invoked between sector 10 and Hornsea with direct routes. The estimated power suggests that for sector 11 and Hornsea, the number of times the ADFL was invoked was the same for structured routes.

Number of times HIPS invoked

Role	Comparison	Conclusion	Power
Planning and Tactical	sector 10 vs Hornsea	ORG0 = ORG1	0.04
		ORG2 = ORG3	
	sector 11 vs Hornsea	ORG0 = ORG1	
		ORG2 = ORG3	

There was no significant difference in the number of times HIPS was invoked between any of the ORGs. However, the estimated power indicates that there is no evidence to suggest that the number of times the HIPS tool was invoked was the same.

Questionnaires

The following results have been taken from the questionnaires issued at the end of each ORG and relate to specific questions asked about differences in tool use between sectors 10 and 11 and Hornsea.

Was the HIPS/CRD more suitable for Hornsea than for sectors 10 and 11 ?

	Sector 10/11	Hornsea	No difference
HIPS	0	5	3
CRD	0	5	3

ORG1	Tactical	*"Generally the time taken to use HIPS was more suitable to larger sectors".* *"The less boundaries there are the easier it becomes* [with HIPS]*".*

E2.2. For each measured sector, examine whether alternative airspace structures ie structured routes versus direct routes, had a positive impact on tool usage, given the same sectorisation, but different operating practices.

Number of times ADFL invoked

Role	Sector	Conclusion	% difference in median	Power
Planning	sector 10	ORG0 = ORG2	-	**0.99**
and	sector 11	ORG0 = ORG2	-	0.84
Tactical	Hornsea	ORG1 < ORG3	60 %	-

Number of times HIPS invoked:

Role	Sector	Conclusion	Power
Planning	sector 10	ORG0 = ORG2	0.04
and	sector 11	ORG0 = ORG2	
Tactical	Hornsea	ORG1 = ORG3	

These results show that when comparing direct routes with structured routes there was a significant increase in the number of times the ADFL tool was invoked for Hornsea sector. The estimated power suggests that for sector 10 the number of times the ADFL tool was invoked was the same.

There was no significant difference in the number of times HIPS was invoked. However, the estimated power indicates that there is no evidence to suggest that the number of times the HIPS tool was modified was the same.

Questionnaires

The following results have been taken from the questionnaires issued at the end of each ORG and relate to specific questions asked about differences in tool use between structured routes and direct routes.

Was the HIPS/CRD more suitable for direct routes than for structured routes?

	Structured routes	Direct routes	No difference
HIPS	0	4	4
CRD	2	3	3

ORG2	Tactical	*"HIPS…is useful in both".* *"On structured routes there was more likelihood of conflict and the CRD was useful in finding them"*

Did you find yourself relying more on the tools when using direct routes?

More	No change	Less
4	4	0

ORG2	Planning	*"For conflict detection ADFL and HIPS initially, then CRD".*

The following comment was made by one controller on a comment sheet:

- *"The tools worked the same whether you were en route [structured] or off route [direct]. It's just possible that off route is easier in terms of planning, I think".*

PUMA analysis

The following section details the results of the PUMA analysis carried out to investigate tool usage, controller roles, operating practices and the usability within both a structured route system and direct route system (ORG1 versus ORG3).

The exercises selected for PUMA analysis are detailed in Appendix B. The same fifteen minute time interval was selected from each exercise for analysis, in which the controllers were actively using the tools.

PUMA analysis time-lines

The initial results of the PUMA analysis are presented in the form of time-lines showing the tasks observed and their duration.

Planning controller OTA **Tactical controller OTA**

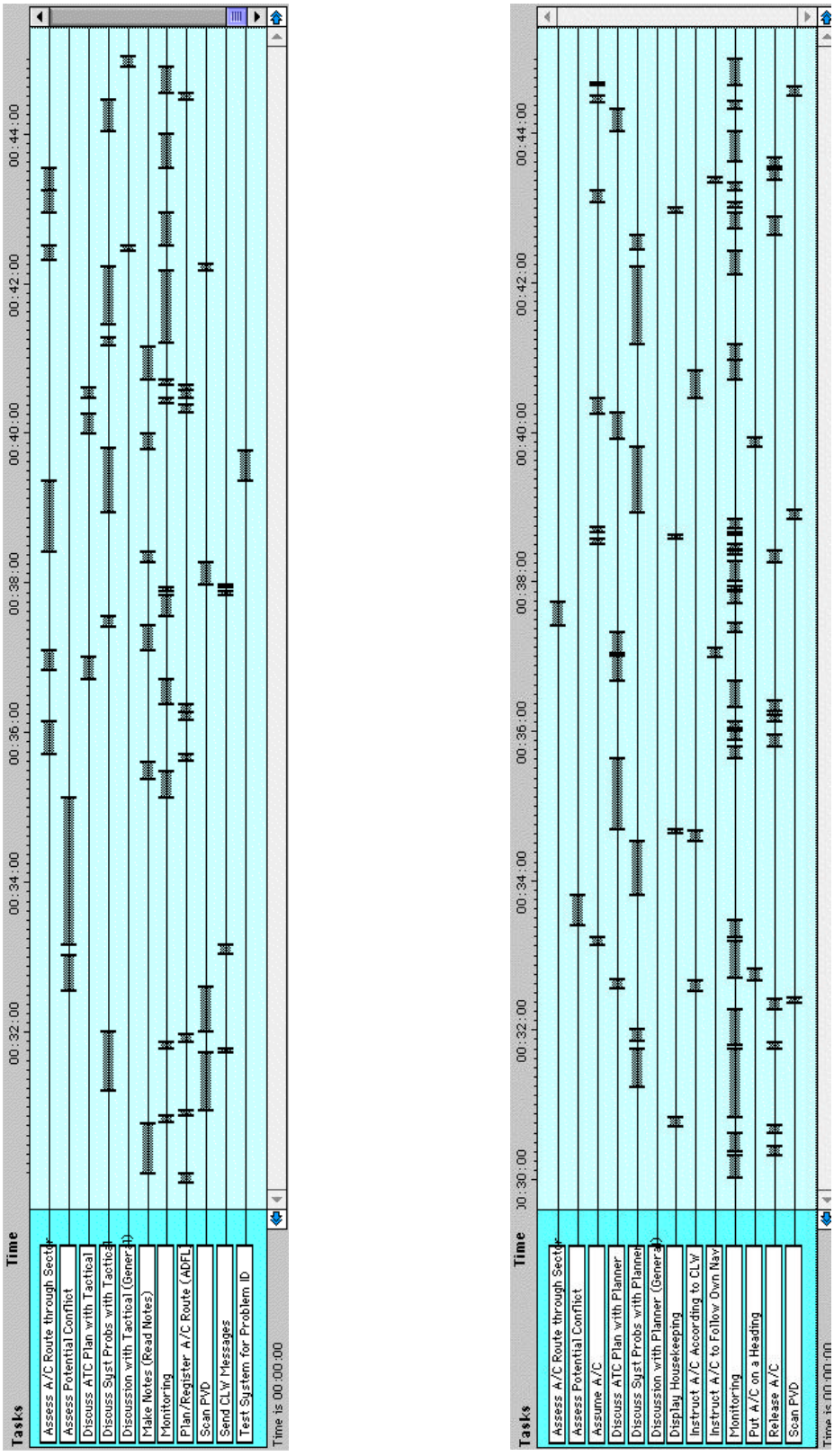
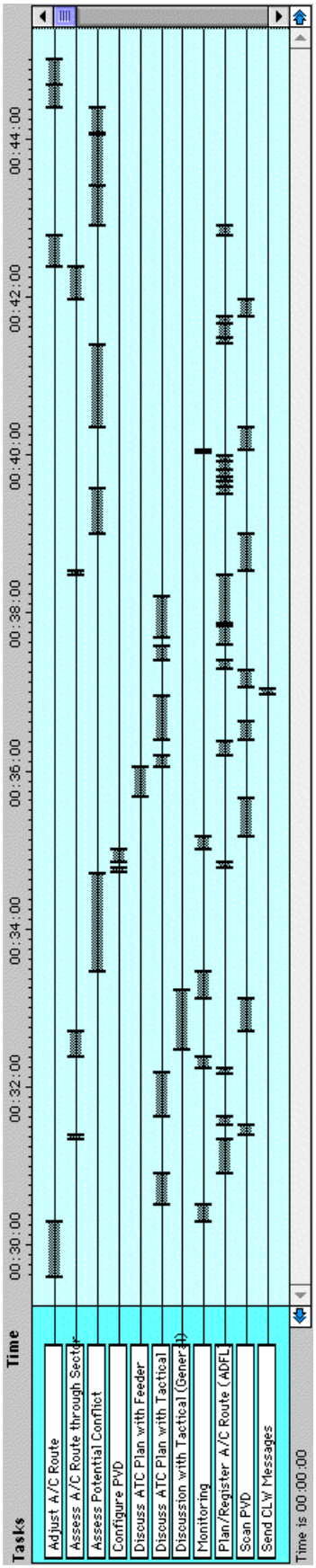


Figure E1 - Observational task analyses (OTA) for ORG1

Planning controller OTA



Tactical controller OTA

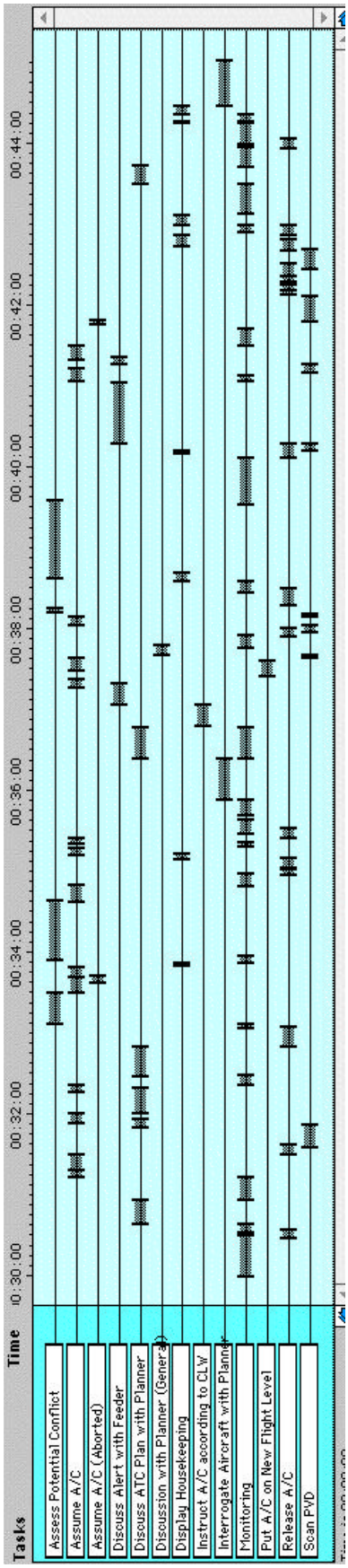


Figure E2 - Observational task analyses for ORG3

PUMA Static analysis results for the planning and tactical controller tasks

Task name	Number of occurrences during given period	Total time spent on task (sec) during given period	Average duration of task (sec)	Percentage of time spent on task during given period
Adjust aircraft route	0	-	-	-
Assess aircraft route through sector	6	147.2	24.5	16.4%
Assess potential conflict	2	146.5	73.3	16.3%
Configure PVD	0	-	-	-
Discuss ATC plan with feeder	0	-	-	-
Discuss ATC plan with TC	3	41.9	14.0	4.7%
Discuss system problems with TC	6	187.9	31.3	20.9%
Discussion with TC (general)	2	11.9	5.9	1.3%
Make notes or read notes	6	122.1	20.4	13.6%
Monitoring	12	210.4	17.5	23.4%
Plan/register aircraft route (ADFL)	10	57.5	5.8	6.4%
Scan PVD	4	105.6	26.4	11.7%
Send CLW messages	4	16.1	4.0	1.8%
Test system for problem identification	1	24.1	24.1	2.7%
Total	56	1071.4	-	119.0%[1]

Table E1 - Static analysis data for the planning controller in ORG1

Table E1 shows that the planning controller spent 16.3% of the 15 minute time interval examined during the PUMA analysis investigating a potential conflict. There were two occurrences of this taking an average of 73.3 seconds each. Both occurrences involved a discussion of the conflict with the tactical controller and highlighting the relevant TDBs on the PVD.

[1] The static analysis does not take into account that tasks can be carried out at the same time.

Task name	Number of occurrences during given period	Total time spent on task (sec) during given period	Average duration of task (sec)	Percentage of time spent on task during given period
Adjust aircraft route	4	102.5	25.6	11.4%
Assess aircraft route through sector	4	51.0	12.8	5.7%
Assess potential conflict	6	260.6	43.4	29.0%
Configure PVD	2	14.7	7.4	1.6%
Discuss ATC plan with feeder	1	23.4	23.4	2.6%
Discuss ATC plan with TC	6	141.7	23.6	15.7%
Discuss system problems with TC	0	-	-	-
Discussion with TC (general)	1	45.4	45.4	5.0%
Make notes or read notes	0	-	-	-
Monitoring	5	55.4	11.1	6.2%
Plan/register aircraft route (ADFL)	18	168.4	9.4	18.7%
Scan PVD	8	146.8	18.3	16.3%
Send CLW messages	1	5.1	5.1	0.6%
Test system for problem identification	0	-	-	-
Total	56	1014.9	-	112.8%[2]

Table E2 - Static analysis data for the planning controller in ORG3

Table E2 shows that the planning controller spent 29% of the 15 minute time interval examined during the PUMA analysis planning and registering aircraft using the ADFL. There were eighteen occurrences of this taking an average of 9.4 seconds each.

[2] The static analysis does not take into account that tasks can be carried out at the same time.

Task name	Number of occurrences during given period	Total time spent on task (sec) during given period	Average duration of task (sec)	Percentage of time spent on task during given period
Assess aircraft route through sector	1	19.3	19.3	2.1%
Assess potential conflict	1	23.8	23.8	2.6%
Assume aircraft	7	42.8	6.1	4.8%
Assume aircraft (aborted)	0	-	-	-
Discuss alert with feeder	0	-	-	-
Discuss ATC plan with PC	6	140.4	23.4	15.6%
Discuss system problems with PC	6	211.0	35.2	23.4%
Discussion with PC (general)	1	7.4	7.4	0.8%
Display housekeeping	0	-	-	-
Instruct aircraft according to CLW	3	39.2	13.1	4.4%
Instruct aircraft to follow own nav.	2	11.1	5.6	1.2%
Interrogate aircraft with PC	0	-	-	-
Monitoring	27	378.5	14.0	42.1%
Put aircraft on a heading	2	15.7	7.8	1.7%
Put aircraft on new flight level	-	-	-	-
Release aircraft	11	95.4	8.7	10.6%
Scan PVD	3	20.4	6.8	2.3%
Total	73	1014.0	-	112.7%[3]

Table E3 - Static analysis data for tactical controller in ORG1

Table E3 shows that the tactical controller spent 42.1% of the 15 minute time interval examined during the PUMA analysis monitoring aircraft progress.

[3] The static analysis does not take into account that tasks can be carried out at the same time.

Task name	Number of occurrences during given period	Total time spent on task (sec) during given period	Average duration of task (sec)	Percentage of time spent on task during given period
Assess aircraft route through sector	0	-	-	-
Assess potential conflict	4	127.9	32.0	14.2%
Assume aircraft	14	109.5	7.8	12.2%
Assume aircraft (aborted)	2	9.0	4.5	1.0%
Discuss alert with feeder	3	67.0	22.3	7.4%
Discuss ATC plan with PC	6	101.9	17.0	11.3%
Discuss system problems with PC	-	-	-	-
Discussion with PC (general)	1	7.4	7.4	0.8%
Display housekeeping	8	39.5	4.9	4.4%
Instruct aircraft according to CLW	1	16.0	16.0	1.8%
Interrogate aircraft with PC	2	63.8	31.9	7.1%
Monitoring	21	258.9	12.3	28.8%
Put aircraft on a heading	0	-	-	-
Put aircraft on new flight level	1	11.1	11.1	1.2%
Release aircraft	15	127.0	8.5	14.1%
Scan PVD	8	71.9	9.0	8.0%
Total	86	1010.9	-	112.3%[4]

Table E4 - Static analysis data for tactical controller in ORG3

Table E4 shows that the tactical controller spent 26.3 % of the 15 minute time interval examined during the PUMA analysis either assuming or releasing aircraft. 28.8% of the time was spent monitoring. Although the same traffic sample was used in ORG1 and ORG3, during the 15 minute time period examined, the number of aircraft dealt with was greater in ORG3 than in ORG1.

[4] The static analysis does not take into account that tasks can be carried out at the same time.

ORG1		ORG3	
Planning	Tactical	Planning	Tactical
24(15)	22(20)	52(23)	31(24)

Table E5 - Number of interactions with controller interface (number of different aircraft)

Table E5 shows the number of interactions made during the given period, and the number of different aircraft involved. Interactions include the tasks: assume aircraft, release aircraft, invoke ADFL, and invoke HIPS. The planning controller made 24 interactions involving 15 different aircraft during ORG1.

E2.3. For each controller role, examine the usability of the PD/1++ tools and interface

This section initially details the results of the SUMI questionnaire, moving on to consider the usability of the PD/1++ tools and interface in general terms. Detailed results are then presented for each component before finally detailing the usability results relating to the ATC aspects of the trial and the overall concept. The results presented are taken from the observations made by a specialist observer, questionnaires, debriefs and controller comments.

The following comment made by one controller should be born in mind when considering all of the following results:

- *"I think, to be fair, and it's a compliment, this simulation is running so much better in terms of its stability and functionality. I mean I was involved with PD/1+, including being a participant on one of the four weeks. We never at the end of PD/1+ got as close to being able to assess the real air traffic control issues as we have done in the first three or four days on PD/1++. It's that much better. I mean it's a compliment in some respects that this all coming out now, that we're actually, we've got a simulation which is good enough that we can spot the trees instead of the wood".*

E2.3.1 Software Usability Measurement Inventory (SUMI) questionnaires

The SUMI questionnaires quantitatively measured the controllers' subjective opinions of the PD/1++ user interface during the trial period.

The Controllers were instructed to complete the SUMI questionnaires based on their experience of the PD/1++ system during the course of the trial. The results of the questionnaires were then processed by the SUMISCO analysis software, giving a global score and ratings on five aspects of the software:

- efficiency
- likeability (affect)
- helpfulness
- control
- learnability.

The SUMI scales are arranged so that the standard for average commercial software is 50. Software rated above this is better than average for quality of use, and software rated below 50 is poorer. Most 'state of the art' or 'good' software will rate above 60 in most sub-scales, and any ratings below 40 usually indicate the need for improving the user interface.

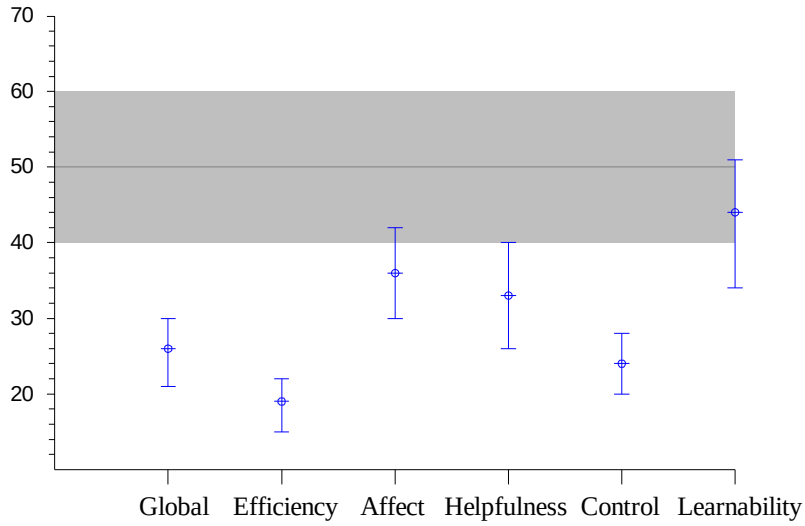


Figure E3 - SUMI Scores

Global

The global scale provides an accurate temperature gauge of a user's view of the software usability. The median score for the PD/1++ software was very low, when compared with an expected score of about 50 for commercial software; the upper confidence limit does not fall within the 'is less than 40' limit for commercial software. However the results must be viewed in the context that the software was a prototype and not pre-operational.

Efficiency

The efficiency score provides a guide to whether the controllers felt that the software provided a quick and effective means for the controller to carry out tasks. The score with the PD/1++ software was even lower than that for the global score, indicating that the controllers' perception was that the software was getting in the way of performance. The following comment was made during a debrief:

- *"From the point of view of the tactical, once we've take an aircraft off planned route, whether it's 3D or 4D, we really want two functions: one is to very quickly be able to put in whatever tactical data entry we've made and have it displayed; and at some other stage, when we are ready to be able to take that aeroplane and re-connect it to where it used to be going and then it would reconnect".*

Affect

The affect score provides a guide to a user's feeling about the software; its 'likeability', and can be treated independently of the operational scoring. In this case the score was reasonably good (for a prototype), showing that the controllers generally liked the user interface.

Helpfulness

The helpfulness score indicates whether the controllers thought that the software helped to resolve operational problems. Again in the case of the PD/1++ software this score was reasonably good, showing that the controllers found the messages and warnings provided by the software to be generally useful. The following comments were made during a debrief:

- *"You spend a lot of time trying to get the system to do something but it would be far better if it just came up and said 'Can't do that, try something*

else', or whatever. I mean you get the occasional message saying that, you know, 'It's too late to do this for this particular aircraft' but all we really need is a 'why' as well and certainly more messages, because time after time I do something, press validate and go off and then it'll come back so I click it again, and all that time I was concentrating on that little window to the detriment of everything else that was going on around";

- *"It's the other side of the work station as far as I'm concerned ...there's an arrow comes up, if there's something wrong that it can't do in HIPS, HIPS should give you the error. If something comes up on the PVD, the PVD should give you the error, it shouldn't be happening in some other obscure window down the bottom where you've got better things to be doing";*

Control

This score indicates whether the software responded as it should to the controllers inputs, and in a consistent way. Observations highlighted that this was not always the case during the trial, and this was reflected in the control results which are very low. The following comments were made during a debrief:

- *"...I got very frustrated because it [HIPS]didn't seem to respond, I put up the new route for example, go orange, I would register it and it would suddenly come up green on the original route so all of my effort had been wasted";*
- *"On several occasions I just couldn't get into it because the HIPS vertical scales kept leaping up and down around the 47 mark and I was trying to move it and I was doing it as subtly as possible, just lifting it gently, and bang away it goes".*

Learnability

This score indicates the controllers feelings as to how straightforward the software was to come to grips with, ie become familiar with the way it works; and how effective was the training associated with the software. This score for the PD/1++ software falls well within the standards expected for commercial software. This result underlines the usefulness of the on-line tutorials, and the general intuitiveness of the software.

E2.3.2 General results relating to the usability of the PD/1++ tools and interface

There was a general feeling that at times the scenarios did not push the controllers sufficiently enough for them to make full use of the tools, however during those times when there were high traffic levels, the tools would start to fail, increasing the levels of frustration.

Many of the controllers did not make full use of the glass space available on the Sony 28" monitors. When asked why this was many controllers felt that the bottom 3/4 of the screen was easier to view, and the top 1/4 was out of their view.

Controllers generally liked the ability to set up their own individual layout, and it was felt that the preferences tool worked well. The only comment about the usability of this tool was that the load and save buttons were too alike and close together.

Due to the way in which the Plan View Display was presented window message pop-ups could become hidden behind it, without the controller knowing they were there.

Questionnaires

The following results have been taken from the questionnaires issued at the end of each ORG.

Were the tools reliable?

ORG0	Planning	*"The tools behaved well, in terms of conflict detection and presentation. They were unreliable due to lack of consistency…on occasion the tools failed"* *"ADFL reliable. HIPS often unreliable. CRD sometimes showed spurious conflicts"*.
ORG1	Planning	*"There were many instances where the CRD showed a potential loss of separation while the HIPS showed no red".* *"Difficult interaction with HIPS at times and disagreement between tools".* '…*when it* (the system) *was bad it was horrid".*

Were the tools easy to use?

ORG1	Tactical	*"Easy to use yet difficult to interpret"*.
	Planning	*"HIPS often difficult, particularly on height changes, when the scale leapt about".* *"…normally more than one input required".*

Which tasks were you unable to perform?

ORG0	Tactical	*"Climbs, descents and turns into other sectors".*
	Planning	*"Effective ATC across boundaries".* *"Changes to exit points offered to aircraft outside ones own sector".*
ORG1	Tactical	*'Altering heading and returning to course/track/own navigation".*

What would you change about the tools?

ORG0	Tactical	*"Short Term Conflict Alert (STCA), HIPS and CRD need to talk to each other and not present different or conflicting information".*
	Planning	*"Make the facility to change the trajectory in the HIPS PVD available on the main display. The HIPS PVD is too small for accurate changes'.* *"HIPS - easier correlation of waypoints to ADFL trajectories".*
ORG1	Planning	*"ADFL -the ability to show two trajectories simultaneously*".

E2.3.3 Results Relating to the use of Individual Tools

Highly Interactive Problem Solver HIPS

Which of the tools did you use?

HIPS		ORG0	ORG1	ORG2	ORG3
Planning	Frequently	3	3	3	4
	Regularly	1	1	1	0
Tactical	Regularly	2	3	3	2
	Rarely	2	1	1	2

The following comments were made by the controllers with respect to the HIPS tool:

- *"Unable to stop line at required level on level element of HIPS" (ORG2, planning);*
- *"You have to resolve the problems with HIPS, then [the workload] becomes quite high because of the interaction, the time spent interacting with HIPS is a lot longer than would be ideal".*

A common complaint was that the HIPS tools would not allow the planning of route changes beyond the boundaries of the sector, which proved inefficient when problem solving, and caused frustration.

- *"You need to be able to manipulate HIPS across sector boundaries to do effective ATC".*
- *"Most of the time it is fine, but once you start to get involved with working near sector boundaries or you want to make a change when the aircraft is still pink or it is not been assumed, then there seem to be all kind of rules come in to fly. But get in the way of you using HIPS to resolve air traffic control problems".*

The HIPS performance was sometimes very slow. This lead to a high level of controller frustration which was reflected in the observations, debriefs, and SUMI results.

Some planning controllers felt that the HIPS tools should update automatically upon selection of the ADFL, so that there could not be any confusion as to what was being presented to the controller. The act of having to purposely select the

presentation of a flight on the HIPS tools was inefficient from the controllers perspective.

The waiting time for a route proposal to be accepted significantly held up the planning controller, which caused a build up of tasks in times of high workload.

HIPS Horizontal Planning Tool (HPT)

This component could be frustrating for the controllers to use due to the lack of facilities available to modify the range and scale in each window to encompass the area of interest. Re-sizing the window caused the range and scale to change rather than exposing more information, which would have been preferable to some controllers.

There was not the facility provided to be able to zoom in on an area within the HPT, which was annoying for the controllers in situations where there was cluttered information, obscuring the conflict details.

- *"What I would like to be able to do is to go onto the bit of HIPS and change the window of the HIPS, expand the bit that I want to look at but I can't do that";*
- *"If I can expand that bit I am looking at, effectively into the whole of the HIPS picture…I personally find it much easier to figure what it is I am trying to do in the first place".*

The route editing within the HPT was sometimes frustrating as the controller could not always easily select the route constraint points they wished to edit. The controllers did not always appear to understand the difference between a profile constraint point and a route constraint point when editing the trajectories.

The planning controllers' task of proposing and registering a route profile amendment was very time consuming. This should be looked at with a regard to reducing the amount of interaction required to achieve this. This became especially important when the controller was faced with a high workload situation.

HIPS Vertical Problem Tool (VPT)

There would appear to be a problem perceived between the HPT and the VPT

- *"I was having a problem with the HMI. The way you interact with the vertical window is different to how you interact with the horizontal window. In one you dragged the hatched white line and in the other you actually pull out the green trajectory".*

The tool occasionally presented a different accepted route profile to that requested by the controller, which meant the controllers lost trust in the tool. There were occasions where the tool refused to accept controller inputs, which cost the controller time and concentration.

The HIPS vertical profiles presented were sometimes unrealistic when compared to that which was considered by the controller to be achievable for the particular flight. This was a system problem which unfortunately reflected badly on the tools.

Modification of vertical flight profiles was often hampered by the fast scrolling of the vertical flight levels, such that small changes could not be entered. The vertical scale would often flash past in a matter of milliseconds until the level limits were met.

- *"Sometimes I find the flight levels are jammed together, you know one, two, three, right above each other, you can hardly see them. Other times they are spread out, I have no idea why, but I have got no control over that".*

The waypoints indicated within the HIPS VPT and those on the ADFL did not always correspond. The outcome was that the controller had to count how many points along the profile a particular point was, which was very inefficient and unnecessary.

HIPS Speed Problem Solver

Controllers were not using the HIPS speed window to separate aircraft. The controllers were not visualising this dimension of control despite the provision of advanced tools for this purpose.

The HIPS speed window was generally not understood by the controllers and as such remained largely unused. When a controller did use the tool it worked well.

Augmented Dynamic Flight Leg (ADFL)

Which of the tools did you use ?

ADFL		ORG0	ORG1	ORG2	ORG3
Planning	Frequently	4	4	4	4
Tactical	Frequently	2	1	1	1
	Regularly	1	2	2	2
	Rarely	1	1	1	1

With respect to resolving conflicts, it would be useful if the controllers were able to display the route trajectories on the situation display for more than one flight, involved in a conflict,

- *"But it would be useful when you've got the first one, if it is giving you a situation, that is giving a conflict, that some data on the other aircraft is also presented so that you can make a sensible decision".*

Aircraft Label

With respect to the aircraft label movement, the manual manipulation appears to have been more useful than the automatic positioning facility.

- *"I'm putting the west bounds on the north side and the east bounds on the south side with alternately long and short labels, to try to keep sorting out".*
- *"If you go on to auto label conflict you don't know what the hell's going on, especially when you're en-route, when you're off route, the labels are a double-edged sword – they can be helpful, they can be exceedingly unhelpful".*

Some controllers found the track symbols used to identify 4D aircraft and deviation alerts confusing.

The Cleared Flight Level field was incorrect on some flights, presenting values of FL101 for example.

The leader lines for the aircraft labels were not obvious enough and sometimes caused confusion when labels were close together.

When a STCA occurred you could not see which sector was working the traffic ie was it a pink/white/grey aircraft label?

The presentation of an assigned speed should be as a Mach number for flights above FL250, and only TAS below.

Extended Label Window (ELW)

The extended track label information appeared cluttered. The actual information the controller wanted to see was the callsign, aircraft type, and RFL. These could possibly be made available to the aircraft label in a more efficient manner than having the overhead of the expanded ELW.

Menus

Which of the tools did you use ?

TST		ORG0	ORG1	ORG2	ORG3
Planning	Frequently	4	3	3	3
	Regularly	0	1	1	0
	Rarely	0	0	0	1
Tactical	Frequently	2	0	0	0
	Regularly	0	2	2	2
	Rarely	1	1	0	1
	Never	1	1	2	1

The full callsign could not always be read from the Trajectory Support Tool (TST) menu as it was obscured by the close button.

Within the callsign menu there was not an option to 'force assume' a flight when it hasn't been released to the controller. The 'release' option in the callsign menu should be the default when the flight is already in an assumed state.

Sector Inbound Lists (SIL)

There was no way a controller knew if a flight was 3D or 4D, when the track position indicator was off-screen. SILs provided no indication. Perhaps this information should be added to the SIL.

Flight entries within the SILs would suddenly drop out, causing some selections to be applied to the wrong flight. A row containing a flight should be locked when the controller has the pointer focused on it.

A single SIL would possibly be better for the planning controller as a means of prioritising the flights that require planning, the SIL made it difficult to select the next most important flight to be handled, especially under high controller workload conditions.

When a range expansion has been performed on the situation display, the SILs did not re-establish their original geographical positions on the situation display upon resumption of the original range expansion. This occurred when the SILs hit the edge of the situation display, and then remained at those relative positions upon expansion.

The controllers were constantly re-arranging the positioning of the SILs, so they did not obscure portions of the display where flights were coming in. This plus the previous comment would indicate that the SILs should be independent of the

main situation display, so they can be position around the display, and not be affected by range and scale.

One controller made the request: "*Could a selected aircraft label be made to overlay the SILs such that it can be seen by the controller?"*.

Conflict Risk Display

Which of the tools did you use ?

CRD		ORG0	ORG1	ORG2	ORG3
Planning	Frequently	3	3	3	3
	Regularly	1	1	1	1
Tactical	Frequently	1	1	1	1
	Rarely	3	3	3	3

The CRD would appear to be a tool of high reliability, and utilisation. The following comments speak for themselves...

- *"…of all the tools that I could pay least attention to before this simulation, and the one that I came to trust most during the simulation, was the Conflict Risk display. It actually didn't let me down when everything else did, most of the time".*
- *"It's the only thing you've got to remind you of outstanding problems you haven't solved. If you're a planner, if you didn't have the CRD, you would really have to resolve everything at the time that it was offered to you because otherwise you've got no way of remembering what your outstanding tasks are".*
- *'I found myself looking at it (CRD) quite a lot to see what was going on";*
- *"The nice thing about the CRD is you can set it to 25 minutes or 15 minutes or whatever you want. You can do your essential entry tasks to make sure the aeroplane comes in safely and you know that sooner or later that little red sign is going to come rolling in on the right to remind you, if you have forgotten it, that there's still a separation task you've got to resolve. It's excellent for that, it's the only aide memoir that you've actually got on the whole system. Everything else is 'do it' 'done it' – that's the one thing that reminds you of outstanding tasks, and it also tends to be very reliable and accurate".*

There were occasional false alerts presented within the CRD, but this was not a user interface problem.

The CRD presented some conflicts which were not presented within the HIPS tools. There seemed to be several occasions when the HIPS and CRD tools were not in agreement. Generally though the controllers felt the CRD was the more accurate tool for determining conflicts.

- *"The cross-correlation between the 3 tools sometimes gives totally different pictures of the situation. That is intensely frustrating".*

The planning and tactical presentations of conflicts were sometimes completely different. The planning controller was getting presented with lots of conflicts, whereas the tactical controller saw none of these.

The CRD does not provide a highlighted area/division line to ease recognition of the standard separation minima.

Conflict Zoom Window (CZW)

Which of the tools did you use ?

CZW		ORG0	ORG1	ORG2	ORG3
Planning	Frequently	1	1	1	2
	Regularly	1	1	1	1
	Rarely	2	2	2	1
Tactical	Frequently	1	0	0	0
	Regularly	0	1	1	1
	Rarely	1	1	1	1
	Never	2	2	2	2

The only real criticism of the CZW was that it did not provide enough information as to its geographical location, for instance the waypoints presented were not labelled.

Communications List Window (CLW)

Which of the tools did you use ?

CLW		ORG0	ORG1	ORG2	ORG3
Planning	Frequently	1	1	1	1
	Regularly	2	2	2	1
	Rarely	1	0	0	2
	Never	0	1	1	0
Tactical	Frequently	2	1	0	1
	Regularly	0	1	2	1
	Rarely	2	2	2	2

The flight progress instructions presented within the CLW often appeared contrary to what a controller would do in similar circumstances.

- *"It doesn't give you the right information, in the right way, in the right place, at the right time and, quite frankly, I would seriously look at scrapping it".*

In some instances the CLW was providing nonsensical instructions on flights where the planning controller had not changed the flight profile.

The presentation of message instructions within the CLW was generally considered acceptable, but a better means of highlighting the messages closer to the time that they are required to be given is required. The flashing of a message was off-putting to some controllers, especially when there was still 3 minutes to go before the instruction was to be given.

- *"…trying to tick off in your mind how many more minutes it is before you have to follow the instruction there, and in the end in fact I took those instructions as being merely a hint of what to do".*

- *"...you're constantly watching the clock and trying to pair up the times to do the instruction".*

The CLW could be improved if the messages were presented about 1 minute prior to when they are needed to by read-out (this would allow a period to prioritise the messages if there was more than one), the message should highlight about 10 seconds prior to readout. Instructions were forgotten by the tactical controller as there was no obvious prompt that there were any messages waiting.

Once a message was acknowledged within the CLW, it disappeared. If the pilot asked for a repeat of the message, the information was no longer available for readout. An acknowledged message should be greyed out, and be deleted after a predefined time period.

Coordination

The use of co-ordination colours was found to be confusing, and also indicated that the controllers were not making much use of the Message-In/Message-Out windows.

- *"...the use of colour orange for co-ordination. Speaking myself as a tactical controller, I see one of the things show orange, I don't know if it's my planner co-ordinating out, or if its somebody else co-ordinating in. I think that's a deficiency".*

E2.3.4 Usability Results relating to the ATC aspects of the trial and the overall concept.

Tactical Interventions

The controllers raised the issue that should a situation require tactical intervention, the tools actually hindered the control of traffic. There were no facilities to aid the controller re-establishing a tactically controlled flight back to its planned trajectory, and the effort required in trying to do this within the constraints of the system, caused other tasks to build up.

- *"As soon as you do your first thing tactically, you created an extra workload that's not there in today's world. The system has created work which then goes exponential because then you have more things to do tactically, because everything's fallen behind".*
- *"There's too much HMI involved in tactical interventions. It appears to me that there's more HMI involved than with planning'.*
- *"One big thunderstorm in a sector like that, where 78% of the traffic is deviating around weather, and there's no way that two controllers would ever have a cat in hell's chance of ever getting them back!";*
- *"from the point of the tactical, once we've taken an aircraft off the planned role, whether it's 3D or 4D, we really want two functions; one is to very quickly be able to put in whatever tactical data entry we've made and have it displayed; and at some stage, when we are ready to be able to take that aeroplane and re-connect it to where it used to be going and then it would reconnect"*

Planning across a sector boundary

During the first debrief held with the trial controllers, one of the major issues which arose was the boundary limitations imposed by the HIPS tools.

The eligibility rules allowing a controller to amend the route profile beyond the sector boundary needs to be reviewed. Often the ideal solution cannot be proposed due to the inability to modify the route beyond the sector boundary. Consideration might be given to allowing the HIPS to intrude into the next sector airspace by one or two fixes. The facility could be provided to allow the planning of such routes, the acceptance of which could be achieved as a form of co-ordination between the adjacent controllers. The following comments were made by the planning controllers:

- *"You have also got the problem that you get a situation where you have got a potential conflict on the boundary and you think, well if I move mine, and the other controller moves theirs and we both move in the same direction, we still compound the problem";*
- *"Single functionality and let's bear in mind that that is an existing functionality in 3D flight management systems, let alone 4D ones. So the pilots can do it now on a button press on the systems. We're not asking for new functionality in the aeroplanes, we're asking just to have access to an existing system. That would make, I mean 90% of the problems we have at boundaries, I would guess, would be resolved just with that single functionality of being able to parallel aircraft off either in an opposite direction or same direction".*