PROGRAMME FOR HARMONISED AIR TRAFFIC MANAGEMENT RESEARCH IN EUROCONTROL

PHARE

EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION EUROCONTROL

DOC 97-70-13

Volume 2 of 2

PD/2 FINAL REPORT

Annex A

Experimental Design And Methods

EUROCONTROL

Rue de la Fusée 96

B - 1130 Bruxelles

Prepared by: F Schick

S Tenoort

Date: June 98

Version: Version 1.0

The information contained in this report is the property of the PHARE Participants*.
The report or parts thereof may be published and or reproduced on the condition that due acknowledgement of authorship is made by quoting the copyright statement below. The copyright and the foregoing condition on publication and reproduction shall extend to all media in which the information may be embodied.
The information contained in this document is provided on an "as-is" basis and the PHARE Participants shall provide no express or implied warranty of any kind and shall accept no liability whatsoever for or in connection with the use of the information contained in the document.

* The PHARE Participants are:

- the EUROCONTROL Agency;

- the CENA (Centre d'études de la navigation aérienne);

- the STNA (Service technique de la navigation aérienne);

- the NLR (Nationaal Lucht- en Ruimtevaartlaboratorium);

- the RLD (Rijksluchtvaartdienst);

- the LVB (Luchtverkeersbeveiliging);

- the DLR (Deutsches Zentrum für Luft- und Raumfahrt e.V.);

- the DFS (Deutsche Flugsicherung GmbH);

- the UK CAA (Civil Aviation Authority);

- the NATS (National Air Traffic Services);

- the DERA (Defence and Evaluation Research Agency)

Copyright statement:

The copyright in this report vests in the European Organisation for the Safety of Air Navigation (EUROCONTROL); the CENA (Centre d'études de la navigation aérienne); the STNA (Service technique de la navigation aérienne); the NLR (Nationaal Lucht- en Ruimtevaartlaboratorium); the RLD (Rijksluchtvaartdienst); the LVB (Luchtverkeersbeveiliging); the DLR (Deutsches Zentrum für Luft- und Raumfahrt); the DFS (Deutsche Flugsicherung GmbH); the UK CAA (Civil Aviation Authority); the NATS (National Air Traffic Services) and the DERA (Defence and Evaluation Research Agency).

All rights reserved.

REVISION HISTORY

July 1997	Draft version 0
October 1997	Draft version 1, incorporating VAL and PCC review comments
June 1998	Version 1.0

	NAME	SIGNATURE	DATE
AUTHOR 1	F Schick		
AUTHOR 2	S Tenoort		
Editorial Reviewer	I A B Wilson		
PHARE PROGRAMME MANAGER	H Schröter		

Page intentionally blank

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction

Any valid experiment has to start with an explicit statement of the objectives of the experiment which rule, as the central issue the methods used. The tasks and test persons involved, as well as measurements and analysis techniques are selected to relate directly to the objectives.

The general objectives of PHARE Demonstrations, as stated early in the PHARE programme, are

- "To determine the effect on controller workload and traffic throughput by the introduction of computer assistance tools from the PHARE Advanced Tools (PATs) programme"
- "To determine the effect on controller workload and traffic throughput by the increasing proportion of 4-D FMS equipped aircraft with full duplex datalink"
- "To gain a degree of controller approval for the computer assistance tools introduced"

Note that those overall objectives apply throughout all PHARE Demonstrations, thereby referring to specific sets of tools for en-route (PD/1), TMA (PD/2), and combined multi-sector (PD/3) control.

Page intentionally blank

2 Experimental Design

Two independent variables were defined in PD/2: system organisation and traffic volume. Three different organisations (ORGs) were used:

- a baseline system (ORG 0), which corresponded to a typical strip-oriented ATC system with limited planning aids like those actively used today (e.g. COMPAS),
- an advanced system (ORG 1), in which the PHARE Advanced Tools and a new GHMI were implemented to assist controllers,
- ORG 2/ 30% and ORG 2/ 70% which had the same functionality as ORG 1, but additionally 30%, or 70% of 4-D FMS and datalink equipped aircraft were introduced.

Table 0.1 below summarises the differences and conformities of the different organisations, respectively ORGs, and shows how they were related to the objectives of PD/2: analysis of ORG 0 against ORG 1 data investigated differences due to effects of introducing computer assisted tools (PATs) and GHMI, whereas effects of increasing proportions of 4-D FMS/datalink aircraft were identified by comparing ORG 1 data against ORG 2/ 30%, and further against ORG 2/ 70% data.

	ORG 0	ORG 1	ORG 2/ 30%	ORG 2/ 70%
PATS	conventional planning	PATS trajectory based planning	PATS trajectory based planning	PATS trajectory based planning
GHMI	Reference system with paper strips	Advanced, no paper strips	Advanced, no paper strips	Advanced, no paper strips
4D FMS datalink	none	none	30 % of a/c in traffic sample	70 % of a/c in traffic sample

ORG 0 vs. ORG 1: Effect of PATS and GHMI introduction

ORG 1 vs. ORG 2: Effect of increasing proportion of 4-D FMS and datalink equipped a/c

Table 0.1 Summary of organisations

Two traffic samples were developed,

a ‘medium traffic‘ sample in which traffic volume, mix of aircraft weight categories, and distribution over the arrival routes were tuned to represent a typical today’s situation of Approach controller workload in peak traffic periods,

a ‘high traffic’ sample with an increase of more than one third of this traffic; actually the sample had 37% more aircraft, with linear increases of both, the number of aircraft per weight category, and the number of aircraft on different arrival routes.

By using those two traffic samples in each ORG two different volumes of inbound traffic were employed:

- 'medium', corresponding to a traffic demand of 48 inbound aircraft per hour, and
- 'high', corresponding to an increased demand of 66 inbound aircraft per hour.

These figures were not further varied because the aim of PD/2 was not to increase runway capacity but to determine the effect of introducing computer assistance tools and 4-D FMS/datalink. The experiment was based on repeated measurements of eight teams with four controllers in each team. All teams performed the same experimental programme. Four different tasks, named ORGs, each performed under high and medium traffic load, resulted in eight measured runs per team.

2.1 Sequencing of Simulation Runs

In order to avoid undesired effects from keeping the sequence of simulation runs the same for all teams the following factors were varied systematically, and thus balanced over the eight trials weeks:

- the order of the ORGs,
- the order of medium/high traffic runs within the ORGs, and
- the order of 30%/70% class A aircraft runs within ORG 2

2.1.1 Order of ORGs

The simulation runs of the three ORGs were conducted in three blocks: a block of three runs for ORG 0, another block of three runs for ORG 1, and a block of six runs for ORG 2.

Every block started with a warm-up run, followed by two measured runs in case of ORG 0 and ORG 1, in case of ORG 2 followed by four measured runs. The ATTAS/Experimental Cockpit Demonstration run was always the sixth and final run of the ORG 2 block.

The order of the ORGs blocks was balanced over the eight trials weeks according to the scheme below. Note that the ORG 0 block was either at the beginning or at the end of a week, and that the order of ORG 1 and ORG 2 was alternating from week to week.

weeks 1 and 5	ORG 0	ORG 1	ORG 2
weeks 2 and 6	ORG 0	ORG 2	ORG 1
weeks 3 and 7	ORG 1	ORG 2	ORG 0
weeks 4 and 8	ORG 2	ORG 1	ORG 0

Table 0.2 Order of ORGs

2.1.2 Order of Measured Runs within ORGs Blocks

The eight measured runs of a week, as indicated by the letters A to H below, were:

ORG 0/ORG 1

four measured runs

(A, B, C, D)

ORG 0 Medium Traffic A	ORG 0 high traffic B
ORG 1 Medium traffic C	ORG 1 high traffic D

Table 0.3 Classification of measured runs

ORG 2

four measured runs

(E, F, G, H)

30% class A medium traffic E	30% class A high traffic F
70% class A medium traffic G	70% class A high traffic H

A combination of the two matrices was applied which

- alternated medium/high traffic scenarios from run to run,
- balanced the starting order of medium/high traffic runs, and
- balanced the order in which 30%/70% class A scenarios were treated within ORG 2 :

week 1	week 2	week 3	week 4
ABCD	ABCD	DCBA	DCBA
EFGH	EFGH	FEHG	FEHG
week 5	week 6	week 7	week 8
ABCD	ABCD	DCBA	DCBA
GHEF	GHEF	HGFE	HGFE

Table 0.4 Order of measured runs

Note that the internal sequences were medium-high-medium-high traffic in weeks 1, 2, 5, and 6, whereas reserved sequences of high-medium-high-medium traffic were applied in weeks 3, 4, 7, and 8.

Moreover, ORG 2 started with the runs of 30% class A aircraft in weeks 1 to 4, with the runs of 70% class A aircraft in weeks 5 to 8.

2.2 Rotation of Approach Controllers

Within a team's trials, the APPROACH Pickup and Feeder controller rotated their positions, whereas the APPROACH Planner and the ACC West controller always kept their positions, thus resulting in the following scheme of "constraint rotation":

in the four measured runs with the **medium traffic** scenario

APP controller 1 was in Pickup position,

APP controller 2 was in Feeder position,

APP controller 3 was in Planner position,

the ACC controller was in ACC West position,

in the four measured runs with the **high traffic** scenario

APP controller 2 was in Pickup position,

APP controller 1 was in Feeder position,

APP controller 3 remained in Planner position,

the ACC controller remained in ACC West position.

This allowed the data of each week to be analysed in two separate strings of analysis, one string based on the medium traffic scenarios, and another string based on the high traffic scenarios. Note that, as the controllers kept their fixed position within a string, a comparison between ORGs and percentages of class A aircraft could be made by utilising matched pairs of observations.

3 Measurements

Early in the PHARE programme, a guideline entitled "Template of Measurements to be used in PHARE Demonstrations" identified the overall objectives of PHARE Demonstrations as being related to the criteria of performance, workload, and acceptance. It defined a set of measurements and recordings which were agreed to be mandatory throughout the PHARE Demonstrations. The table below gives an overview.

Criteria	Measurements and Recording
System Performance	• Planned Traffic Data • Actual Traffic Data
Controller Workload	• ATC instructions issued • Subjective Workload Measures
Controller Acceptance	• Questionnaires • Debriefings

Table 0.5 PD/2 Evaluation Criteria, Measurements and Recording

The data listed in the table were recorded directly from the simulation system and from controller responses. They were completed by video-/audio-recordings of controller activities taken simultaneously from the four working positions during all the simulation runs, and by observer's notes logged by two PD/2 staff observers on each run. In this way objective and subjective data were collected.

3.1 System Performance

The key measurements of system performance which were produced from the recorded data were the following:

- Number of Landings
- Flight Time
- Inbound Delays
- Precision of Delivery
- Separation

The performance domain refers to measurements of traffic throughput as well as quality of service because of the close relationship between the quantity of traffic throughput and the quality of service provided to airspace users. For instance, for the constant traffic sample that was applied in all ORGs of PD/2, the number of aircraft served per time unit (in PD/2 the **number of landings** per hour) which is often used as the most straightforward indicator of throughput, correlates with the average flight time in the TMA which further is immediately relevant for an airline's perception of quality of service, since it affects delays, fuel consumption, etc.

Inbound delay was calculated in PD/2 as the difference between the actual time of Gate overflight and the estimated time of an aircraft's Gate overflight. The estimated, or preferred, time was computed at the early state of an aircraft's entry into simulation and refers to its time over the Approach Gate if there were no other inbound aircraft and it could therefore follow its preferred trajectory. This preferred trajectory corresponds to the initial trajectory an aircraft sends down to the

ATC and takes into consideration an environmental flightpath, respectively the airlines operational procedures.

Precision of delivery was calculated from the difference between actual time over Gate and planned time over Gate. Note that the planned time over gate may already include an inbound delay because the planning algorithm has to account for the overall traffic situation either by using merely arrival time estimates in ORG 0, or by using conflict-free trajectories in ORG 1 and ORG 2. Precision of delivery was considered to be a useful indicator of how precisely the tools-generated plans were actually implemented.

Finally, **separation** over gate was chosen as an indicator to check whether potential benefits (in terms of flight time, delays, etc.) were achieved at the expense of reduced minimum separations.

3.2 Controller Workload

Workload was stated as one of the crucial elements of the PHARE demonstrations. To measure the effect of the PHARE operational concept on controller workload objective and subjective sources of data were analysed in PD/2:

Objective Workload Indicators

- Number of ATC instructions issued
- Frequency of R/T calls
- Percentage of simulation time spent for R/T communication

Three different parameters of workload indicating the activity of the tactical controllers while giving ATC instructions, respectively how much radio/telephony (R/T) communication is necessary for this, were calculated. These operational measures are often referred to as objective workload indicators.

Subjective Workload Estimates

- SWAT (Subjective Workload Assessment Technique)
- NASA-TLX (Task Load Index)

Subjective workload estimates were collected during the course of simulation runs using SWAT, and by using the NASA-TLX method after completion of each run.

SWAT is a three-dimensional approach to workload measurement. The dimensions, or factors of workload in SWAT are Time load, Mental effort load, and Psychological Stress load.

Every two minutes during the simulations controllers were requested to give their estimates of workload by entering a number (1,2 or 3) for each factor. SWAT combines the entries into an overall workload score on a scale ranging from 0 to 100, thereby accounting for individually different importance weightings of the factors. The weightings have to be assessed once beforehand from an introductory session to SWAT. So, SWAT provides a quasi-continuous record of workload during an exercise or simulation run.

NASA-TLX provided an off-line summary workload estimate immediately after the simulation runs from each controller. TLX identifies six factors contributing to workload: Mental demand, Physical demand, Time pressure, Effort expended, Own performance and Frustration experienced.

At the end of a run the TLX input dialogue popped up on each of the controller screens, asking them first to determine the relative importance of the six factors for this run by pairwise comparison of the factors, and then to rate their workload for each factor on a 20-point scale from ”low” to

”high”. From combination of weights and ratings an overall score was calculated to estimate the controllers workload.

All tactical controllers rated their perceived workload themselves, whereas a different method was used for the planning controller. As became apparent during the pilot phases of PD/2 the introduction of the PATS and furthermore the increasing proportions 4-D FMS/datalink equipped aircraft had a tremendous impact on the role of the planning controller in such a way that tasks were re-distributed to the pickup and feeder controllers and there was little left for the Planner to do. Therefore in all trials of all ORGs the planner controllers were asked not to assess their own workload but that of the pickup and feeder controllers who constituted the approach team.

3.3 Controller Acceptance

Acceptance is naturally a highly subjective matter, nevertheless it is of great importance. It is based on subjective responses from controllers, but can be assessed objectively using questionnaires and a consesus of opinion of observers and from debriefing sessions. Therefore controllers participating in PD/2 were intensively asked for their opinions, comments, and criticisms they had regarding the experiment, i.e. the simulation environment and training, as well as regarding the PD/2 concept in terms of the human/machine interface, operational procedures, and individual tools and functions.

This was done in two different ways. First, a debriefing session was held after each run. This was a group interview which was audio-taped. PD/2 staff made use of a structured interview guideline, observer logs, and simulation data immediately available after each run (e.g. radar plots of horizontal flight paths).

Additionally, questionnaires were applied: three questionnaires to collect the controller judgements for the three ORGs individually, and additionally a final questionnaire to collect the overall, non ORGs-specific issues. The following areas were addressed in the questionnaires:

- Simulation environment and training
- Human-Machine Interface (HMI)
- Operational procedures
- Tools and functions

All questionnaire items were presented to the controllers as positively or negatively worded statements, with controllers to check the appropriate level on the six-point rating scale below:

strongly disagree	disagree	slightly disagree	slightly agree	Agree	strongly agree

Table 0.6 Rating scale for questionnaires

List intentionally blank

4 Analysis Methodology

4.1 System Performance Investigation

The following null hypotheses (H_0) were stated to statistically test the performance data. H_1 refers to the alternative hypothesis which is accepted if the H_0 is rejected. As it was implicitly expected that the effect of introducing PATs and datalink would be a positive effect, one-tailed statistical tests of significance were appropriate for the quantitative analysis of traffic throughput/quality of service parameters.

The hypotheses tested for analysing ORG 0 against ORG 1 data were

H_0: There is no difference in traffic throughput/quality of service between ORG 0 and ORG 1 due to PATs and GHMI introduction,

H_1: Traffic throughput/quality of service is higher/better in ORG 1 than in ORG 0 due to PATs and GHMI introduction.

The hypotheses tested for comparing ORG 1, ORG 2/ 30 %, and ORG 2/ 70 % data were

H_0: There is no difference in traffic throughput/quality of service between ORG 1, ORG 2/ 30 % and ORG 2/ 70 % due to different proportions of 4D FMS/datalink aircraft,

H_1: Traffic throughput/quality of service is higher/better with introducing proportions of 30 % to 70 % 4D FMS/datalink aircraft in ORG 2.

The statistical tests were applied in the same way on both the high and the medium traffic load for each of the performance measurements described in section 0. However, high and medium traffic data were submitted to two separate strings of analysis independently, because due to controller rotation of pickup and feeder position between traffic volumes no repeated measurement data are available for a pooled analysis. Furthermore separate analyses were conducted for the different arrival routes of the simulated airspace in PD/2 where appropriate (i.e. for inbound delay and precision of delivery).

4.2 Controller Workload Investigation

In order to examine controller workload subjective and objective measurements were conducted in the PD/2 trials. The following null hypotheses (H_0) were stated to statistically test the data. H_1 refers to the alternative hypothesis which would be accepted if the H_0 was rejected. Note that the statistical tests conducted are two-tailed, i.e. hypotheses were specified that differences are in either direction.

ORG 0 vs. ORG 1

H_0: There is no difference of workload between ORG 0 and ORG 1

H_1: Workload is different as an effect of introducing PATs and GHMI

ORG 1 vs. ORG 2/ 30% vs. ORG 2/ 70%

H_0: There is no difference of workload between different proportions of 4-D FMS/datalink equipped aircraft

H_1: Workload is dependent on the percentage of 4-D FMS equipped aircraft

The statistical tests were applied again separately for high and medium traffic load for each of the workload measurements described in section 0. However, high and medium traffic data were submitted to two separate strings of analysis independently, because due to controller rotation of pickup and feeder position between traffic volumes no repeated measurement data were available for a pooled analysis. Furthermore, separate analyses were conducted for each controller working position.

4.3 Controller Acceptance Investigation

The hypotheses of acceptance apply to the distributions of controller responses to the individual questionnaire items. For each item the following hypothesis was tested:

H_0: There is no difference in the frequency of positive and negative controller responses

H_1: There is a difference in the frequency of positive and negative controller responses

The responses obtained in the questionnaires were analysed separately for each item. As a first step, the frequency distribution of the responses in the six categories was compiled and plotted as a histogram. Secondly, a statistical test was applied as an objective means to identify whether a significant trend of responses, to agree or to disagree, existed. The statistical tests were applied to the pooled responses of all controllers, as well as for each controller working position separately.

4.4 Statistical Test Used

4.4.1 Performance And Workload

The effect of introducing the PATs and the operational procedures they supported was examined by comparing ORG 1 with the baseline ORG 0. The statistical test used was the Wilcoxon Matched-Pairs Signed-Ranks. The effect of different proportions of 4-D FMS equipped aircraft was examined by comparing ORG 1 vs. ORG 2/ 30% vs. ORG 2/ 70%. The test used was the Friedmann Two-Way Analysis of Variance (Anova).

Both tests were standard statistical tests and used

a) for experimental designs with repeated measurements (matched pairs of observations) and

b) for non-parametric data (i.e. without assumptions about the distribution of data).

The significance criterion of all performed test was set at $p \leq 5\%$.

4.4.2 Acceptance

To analyse the questionnaire responses the Binomial Test was used to test two-class frequency distributions (binomial distributions). In the PD/2 case, the two classes were formed by combining all responses on the left-hand ("disagree") part of the scale against all combined responses on the right-hand ("agree") part of the scale. The Binomial Test gave the probability of an observed proportion of the two frequencies, under the hypothesis that there was no true difference between the two. This hypothesis is equivalent with saying that there is no significant cumulation of responses on either side of the scale, and thus observed differences are caused by chance alone. The more different the two observed frequencies are, the smaller becomes this probability, and in case of a low probability of less than five percent ($p \leq 0.05$) a significant trend, either to agree or to disagree, would be stated.

5 Controllers

The PD/2 trials were generously supported by many national organisations who supplied their controllers. There were 32 controllers participating, coming from 7 European countries. They represented all kinds of backgrounds in military and civil ATC, and also a wide range of computer experience. There were teams that used to work together in their home unit over years as well as teams whose members never met before PD/2. A mixed military/civil controller team was also involved. The table below gives an overview of the participants.

PD/2 Pilot Phase	
one team of 4 military controllers from UK	
PD/2 Main Phase	
32 controllers (eight teams) from	
• France (ADP)	• Romania (ROMATSA)
• Germany (DFS)	• Sweden (LFV)
• Italy (SICTA)	• United Kingdom (NATS)
• Netherlands (MilATCC)	

Table 0.7 Supporting organisations for controllers in PD/2

The controllers' ages ranged from 26 to 54 years, resulting in a mean age of 39.97 years. The majority of controllers were between 40 and 49, and between 30 and 39 years old (Figure 0.1). Only four participating controllers were in their twenties.

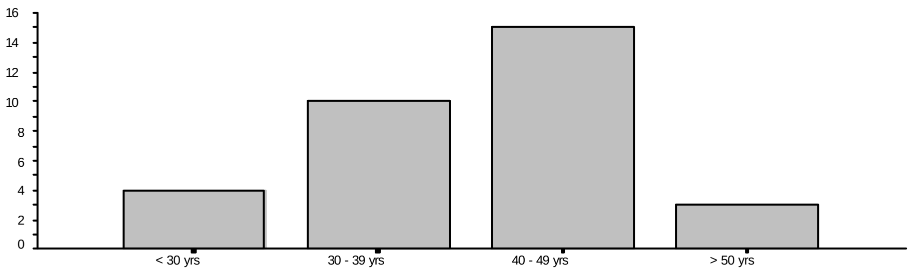

Figure 0.1 Controllers' age

Their experience as an airtraffic controller ranged from 3 years up to 36 years, which averaged to 17.93 years. Most of them had more than 20 years of experience working as a controller (Figure 0.2), so we can conclude that a high degree of expertise graced the halls of PD/2.

When asked about their experience in their present function a different picture emerged. Most of the controllers had less than 5 years of experience in their present function and few have stayed for more than 20 years in one position, an overall average of 8.55 years (Figure 0.3).

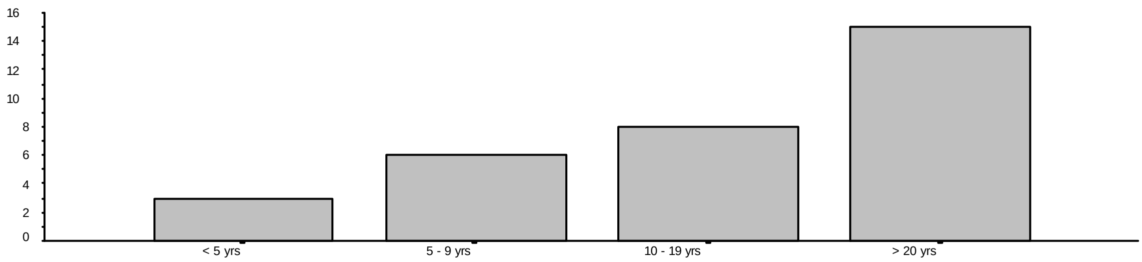

Figure 0.2 Experience as an air traffic controller

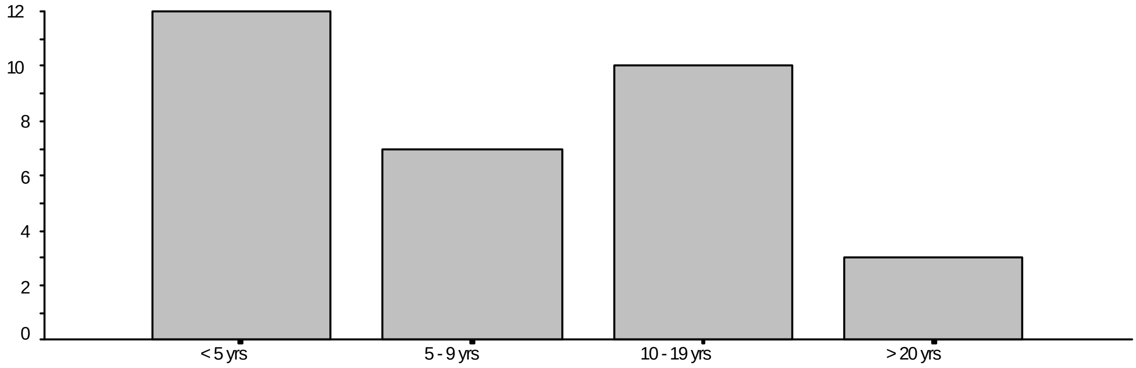

Figure 0.3 Experience in present function

The computer experience of the controllers was of great interest. It could be expected that a transfer from former experience with computers and especially graphical user interfaces (GUI) is essential for immediate use of the new computer based HMI provided in PD/2, in which mouse interaction was fundamental.

When asked to self-assess their experience with computers, programs and applications, most of the controllers rated it as quite high, being regular or occasional users. Only 5 controllers admitted they have no or only rudimentary experience with computers (Figure 0.4). A similar picture emerged when asked about their experience with graphical user interfaces (Figure 0.5) and with using a mouse (Figure 0.7). Again the majority of controllers rated their experiences as being regular users. Obviously those controllers who work with computers, preferred using a GUI, mostly Windows 3.x or 95. As a GUI is of limited usability without the required mouse interaction, equivalent results were obtained for experience with such pointing device.

Graphical user interfaces became popular only few years ago. Thus it was expected that most of the controllers reported that they had less than 5 years of experience with GUIs (Figure 0.6), some had 5 years or more, and 5 controllers were still novices with less than one year of experience. On average that made up 3.9 years of GUI experience.

Figure 0.4 Self rating of experience with computers

Figure 0.5 Self rating of experience with graphical user interfaces (GUI)

Figure 0.6 Years of experience with GUI

Figure 0.7 Self rating of experience with mouse or other pointing devices

When asked to report their experience with computers at home (Figure 0.8) 11 controllers indicated that they did not own a PC. Most of those controllers who used a computer at home had done so for less than 5 years or for less than 10 years.

Those controllers who did own a computer used it regularly, most of them even daily as depicted in Figure 0.9, and the applications they use are mainly text systems and spreadsheets.

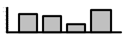

Figure 0.8 Years of experience with computers at home

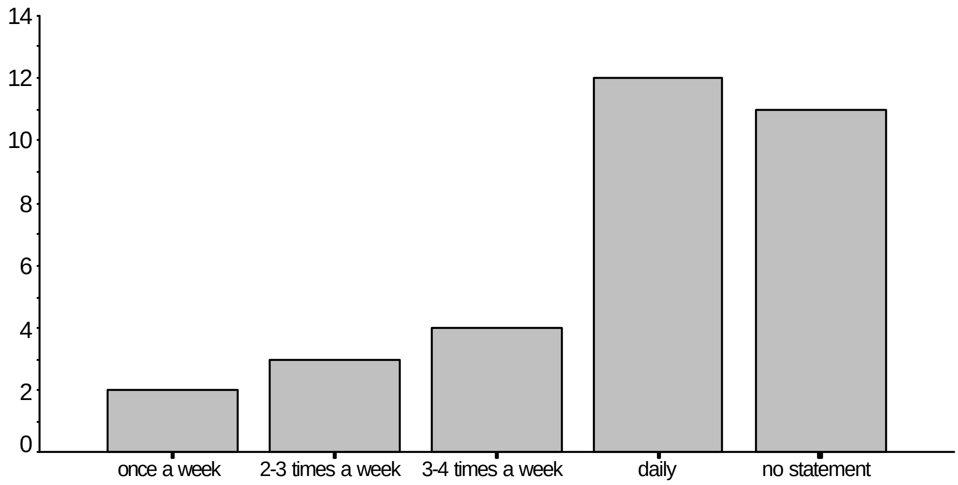

Figure 0.9 Computer usage at home

The use of computers at work seemed to be less wide-spread than at home. Six controllers indicated that they didn't use computers at work at all. However, the majority of controllers used computers at work for only 4 years or less (Figure 0.10). Most of those who had computers at work used them daily. Only five controllers reported an infrequent or irregular usage.

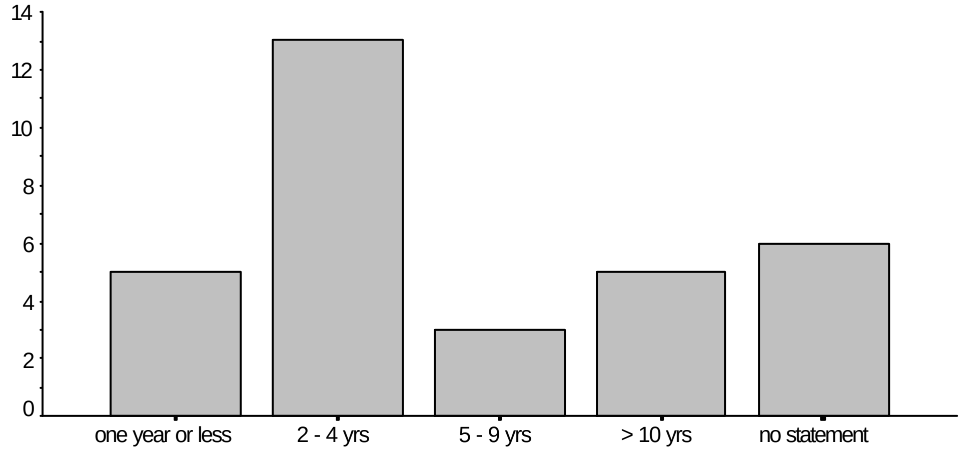

Figure 0.10 Years of experience with computers at work

6 Running the Experiment

After two pilot phase weeks in October and November 1996 the PD/2 main experiment took place from Dec. 2, 1996 to Feb. 21,1997. All controller teams were available for a two-weeks period, one week of training and familiarisation with the PD/2 concept and the environment, the following week for their measured trials. As indicated in the timescale (Table 0.8) training of one team and trials of another team were mostly done in parallel. This was enabled by having a stand-alone training system that allowed training to take place without interference with the operational trials.

	Dec 2-6 1996	Dec 9-13 1996	Dec 16-20 1996	Jan 6-10 1997	Jan 13-17 1997	Jan 20-24 1997	Jan 27-31 1997	Feb 3-7 1997	Feb 10-14 1997	Feb 17-21 1997
Training	Team 1	Team 2	-	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	-
Trials	-	Team 1	Team 2	-	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8

Table 0.8 Timescale of PD/2 main phase

A team's training week started with a general introduction into PHARE, followed by an extensive introduction of the PD/2 concept, the tasks and roles the controllers, and the HMI. Thereafter, the stand-alone training system was used for tutorial lessons which allowed the participants to learn and practice the essential features of the PD/2 PATs and HMI (see Table 0.9) self-paced.

- Stand-alone training system
- Tutorial lessons
  - mouse and windows management
  - plan view display
  - airspace structure and traffic flows
  - classes of aircraft
  - aircraft label layout
  - label interaction
- Training runs: up to 16 runs
- Support from an expert controller and an expert from the simulation staff

Table 0.9 PD/2 Training

Starting from their second day, the teams carried out up to 16 training runs under ORG 0, ORG 1, and ORG 2. The traffic samples in training runs were different from those used in measured trials, to avoid learning effects. An expert controller and a simulation expert were available at all times.

The second week was a team's trials week. Eight measured runs (MR) of 90 minutes duration had to be performed, as shown in Table 0.10 below. The measured runs were performed in blocks of two runs for ORG 0 and ORG 1, respectively four runs four ORG 2. Each block was preceded by a warm-up run. After completion of the measured runs of ORG 2 a demonstration run was performed in which the live aircraft (ATTAS) was included in an additional ORG 2 traffic scenario. A total of 12 runs per week was planned. As an example of the trial week organisation a week plan is depicted in Table 0.11.

- Eight measured runs
  - ORG 0 high traffic
  - ORG 1 high traffic
  - ORG 2/ 30% high traffic
  - ORG 2/ 70% high traffic
  - ORG 0 medium traffic
  - ORG 1 medium traffic
  - ORG 2/ 30% medium traffic
  - ORG 2/ 70% medium traffic
- Three warm-up runs
  ORG 0 ORG 1 ORG 2 before measured runs
- One demonstration run
  including live aircraft in additional ORG 2 run
- Total of 12 runs per week

Table 0.10 PD/2 Trials

TIME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8.30 10.30	ATMOS Briefing	MR 2 ORG 2 Med. Traffic 30% Class A	Demo Run ORG 2 ATTAS/Exp.-Cockpit ORG 2 Quest.	MR 6 ORG 1 Med. Traffic ORG 1 Quest.	MR 8 ORG 0 Med. Traffic ORG 0 Quest.
10.30 12.30	Warm-up ORG 2	MR 3 ORG 2 High Traffic 70% Class A	Warm-up ORG 1	Warm-up ORG 0	Final Quest. Final Debriefing
12.30 14.00	Lunch	Lunch	Lunch	Lunch	Lunch
14.00 16.00	MR 1 ORG 2 High Traffic 30% Class A	MR 4 ORG 2 Med. Traffic 70% Class A	MR 5 ORG 1 High Traffic	MR 7 ORG 0 High Traffic	

Table 0.11 Example of Trials Week Organisation

The demonstrations of the on-board PD/2 display and control interface in the ATTAS Experimental Cockpit were carried out in a period between May 2 and June 15, 1997. Six pilots (one per day), with backgrounds as airline or test pilots, participated in the demonstration programme which consisted of a series of simulated flight tasks including FMS and datalink simulation. They evaluated the AHMI during five different flight tasks including on-board generation, negotiation, and implementation of 4-D trajectories. The method of evaluation was to use structured interviews in which the following areas were addressed: the operational philosophy, display modes and functions, the interaction device and edit functions.