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PHARE:
LESSONS LEARNED FROM THE ORGANISATION OF MULTI-NATIONAL R&D ON AIR TRAFFIC MANAGEMENT[1]

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Abstract
The Programme for Harmonised ATM Research in EUROCONTROL (PHARE) is a collaborative research programme within Europe directed to Air Traffic Management of the future. The objective of PHARE is to organise, co-ordinate and conduct studies and experiments aimed at proving and demonstrating the feasibility and merits of a future air-ground integrated ATM system in all phases of flight. The programme was started in 1989 and will finish in the beginning of 1999. The cost over 10 years has been approximately 80 MECU of which about 50% was funded from the research budget of the EUROCONTROL Agency.

This paper will not discuss the results obtained by the programme in detail, but will concentrate on an overview of the lessons learned from running a large R&D programme in a multi-national environment. Although at first sight, some of the items mentioned would seem to be typically European, it is considered that the lessons learned are equally applicable to the USA. Of course the US does not suffer from the problem of having to cope with different languages, however, differences in the cultures between company or institution or even differences in mentality between different branches of the same organisation can lead to similar difficulties as experienced in PHARE.

Items covered are:
1. The agreements for collaborative projects;
2. Cultural differences;
3. Communication amongst the partners;
4. Organisation of the main funding of projects;
5. Organisation of the funding of mission costs;
6. Tracking of the progress;
7. PHARE Demonstrations;
8. Common approach and deliverables;
9. Lessons learned (do's and don'ts).

[1] The views expressed are those of the authors and not necessarily those of the EUROCONTROL Agency and the other PHARE partners

It is concluded that PHARE has paved the way for co-operation of ATM R&D in Europe and has created a forum from which the present and future European/US collaborative effort has developed.

1. The basic PHARE Agreement

In the planning and execution of PHARE, a number of European research establishments, assisted by the authorities concerned, decided to combine their ATC and aeronautics experience and resources to enable a comprehensive and co-ordinated research effort to be mounted, building on existing in-house research programmes.

When PHARE was set-up, air-ground integration for ATM looked like a futuristic idea of researchers in various ATM research establishments. The very early meetings were held at the level of Heads of those establishments with the objective to exchange ideas, to get more knowledge of the other partner's work and to compare results. From these meetings the idea emerged to "pool" resources in order to get a programme of research started that could not be accomplished by any partner alone due to resource limitations.

It was felt that forming a "gentleman's club" to perform jointly defined research was the way to proceed and having an officially signed agreement stating this intention would be the way to give the "club" a legal perspective.
The basic PHARE agreement stated the programme's aim, defined the management structure and established the rules of participation. Following endorsement by the EUROCONTROL Committee of Management, the agreement was signed for an initial seven years period in 1989 between the Director General of the EUROCONTROL Agency and the participating partners. The Agreement was later extended until January 2000.

The participants in PHARE are:

- CAA/NATS, UK;
- STNA and CENA, France;
- DFS and DLR, Germany;
- RLD/LVB and NLR, The Netherlands;
- EUROCONTROL Agency HQ, Brussels and EUROCONTROL Experimental Centre (EEC) Brétigny, France.
- The Commission of the European Communities (DG VII) participates in and supports PHARE.
- FAA and NAV Canada are co-operating within the frame of relevant agreements.
- ENAV/SICTA (Italy) with observer status
- AENA (Spain) with observer status.

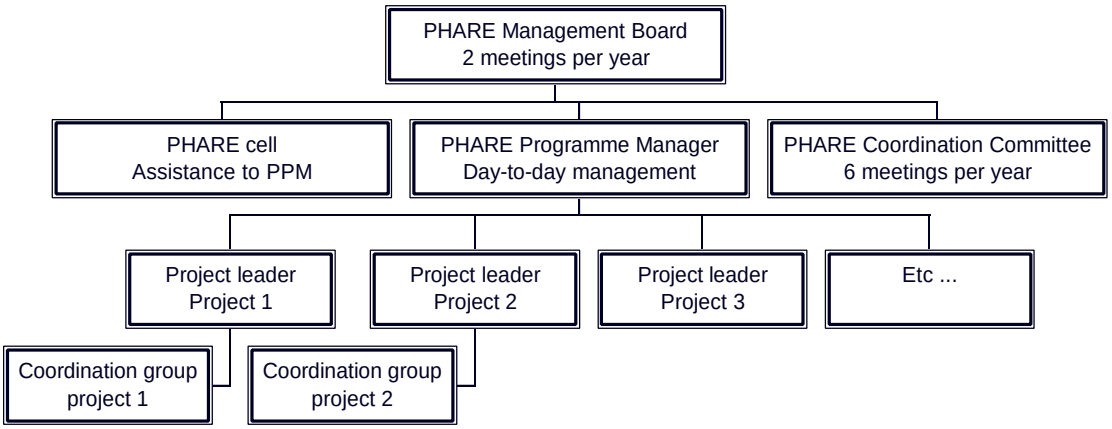
The preliminary description of the PHARE programme attached to the agreement was already quite detailed and surprisingly similar to what has become the PHARE Programme over the years.

One of the first results of the combined PHARE research effort was the elaboration of the PHARE Medium-Term Scenario, a conceptual model for a future ATM system making full use of the assumed capability of aircraft to fly precise 4-dimensional trajectories in an air/ground datalink environment.
It was decided early in the Programme life, that all experimental work would be directed towards performing a coherent series of large scale real time simulation trials (called "PHARE demonstrations" or PDs) showing the merits of this concept.
These demonstrations were set-up as large scale validation activities integrating ground systems, air systems and air-ground datalink facilities as one ATM System. The demonstrations exercised advanced controller assistance software tools in the ground ATC simulators and provided advanced flight management functions to real and simulated aircraft, allowing these systems to exchange information over datalink.

Significant development of the PHARE partners' simulation facilities was required to support the computer assistance tools, the advanced human machine interface and the operating procedures that combined to make the PHARE Operational Concept.

1.1 Management of the Programme

The PHARE programme is managed at three levels:



At the highest level the PHARE Management Board (PMB) manages the political and resource aspects of the programme. Representation on this board is generally at the level of Heads of Research Centres or Institutes of the partners plus the PHARE Programme Manager. It is at this level that major decisions affecting individual projects within the overall PHARE programme have been made.
PMB meetings were generally held twice a year and were also attended by the associate partners of PHARE (FAA, NAV Canada, ENAV/SICTA and AENA from Spain)

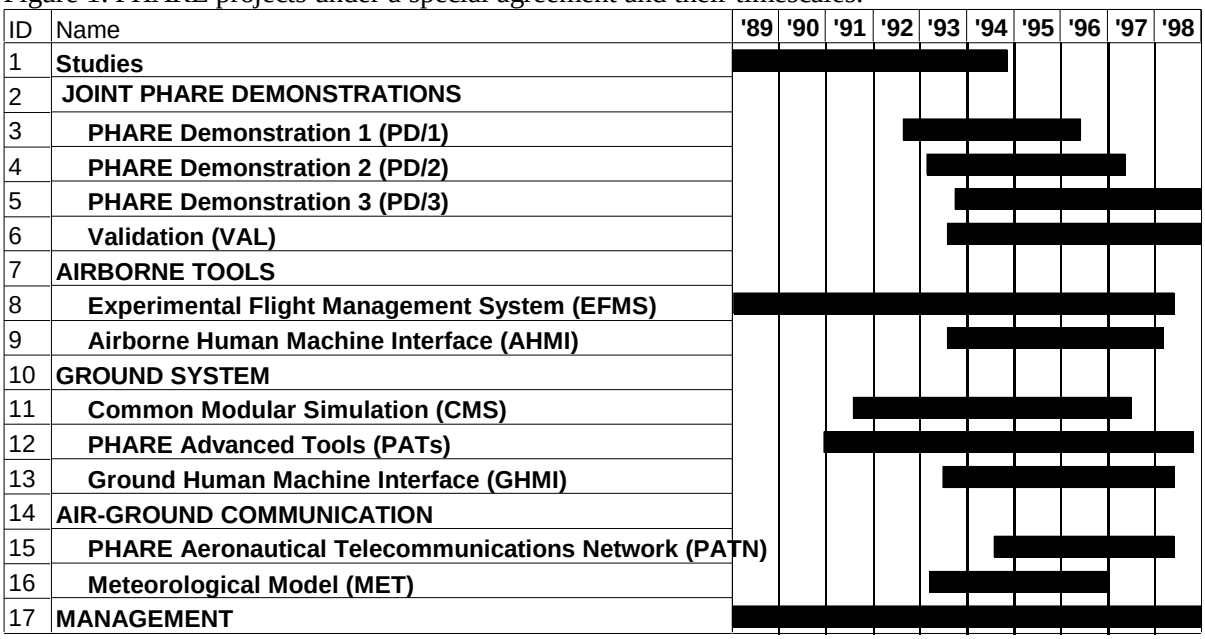
At the second level the day to day management is performed by the PHARE cell, headed by the PHARE Programme Manager at EUROCONTROL Headquarters, in co-operation with the PHARE Co-ordination Committee (PCC) with representatives of all active partners. Project progress is monitored in meetings of the PCC on a two-monthly basis where decisions on priorities are taken or brought up to PMB level if they are of a political nature.

At the third level project leaders have been appointed for each specific project, some supported by additional co-ordination groups to allow cross-co-ordination with other closely interrelated tasks.

1.2 The PHARE Agreements on specific projects

The basic PHARE agreement has served as the framework for a series of separate agreements on specific projects that needed common financing, like all tool and function development programmes and the PHARE demonstrations mentioned earlier. The prior official approval of the EUROCONTROL Committee of Management for these special agreements made it possible to plan for corresponding budgetary credits for commonly financed activities and to place contracts with the partners without the need to go through a time and effort consuming call for tender process. In practice, common financing meant that PHARE partners were providing about 50% of the required funding themselves and the Agency provided the rest.
Figure 1 gives an overview of all projects carried out under the PHARE umbrella with their timescales:

Figure 1: PHARE projects under a special agreement and their timescales.



1.3 Definition and execution of shared and commonly financed projects

Before a specific project was started and a corresponding agreement could be signed, a detailed project plan with the allocation of the work to the different partners over the years of collaboration had to be developed. This was done by common negotiation and by the partners' declaration of their interests and competence, as well as the availability of current or planned simulation facilities. In most cases the partners were eager to participate in all specific projects so as not to miss the knowledge and funding.
This resulted in a widely distributed approach based on the good intentions of the participants over an extended period of time. Following the progress of the work and the EUROCONTROL procedures for its annual financial commitments, about 40 contracts had to be placed with the different partners each year. The co-operation of the EUROCONTROL Experimental Centre was a particular case, as no official contracts were placed internally with this unit of the EUROCONTROL Agency.

The distribution of projects and funding was kept completely transparent to all concerned by distributing tables giving overviews per project and partner for each year. As an example the table for 1996 is shown in figure 2.

Figure 2: Example of budget tables maintained per project and partner:
Overview of credits of EUROCONTROL Budget committed for PHARE projects in 1996 (KECU)

Projects	CAA	CENA	DLR	EEC	NLR	EHQ contract	Ext. Contracts	SUM
PD1	84							84
PD2		14	524		14			552
PD2 Flying			100					100
PD3	114	647	24	568	646			1999
EFMS	80	18	44		71		423	636
EFMS Flying	100		40		100			240
AHMI	59		59		63			181
PAT	171	326	268	205	185			1155
CMS	36	87	12	94	61			290
GHMI	77	150	47	105	182			561
VAL	92	32	96		33			253
PATN	38	83	48		73		110	352
MET	58	64						122
Management						391		391
SUM	909	1421	1262	972	1428	391	533	6916

1.4 Collaboration

In the course of the ten years, the atmosphere in the world of PHARE has changed significantly for a number of reasons. What started as a "gentlemen's club" with very good intentions had to change into a more business-oriented approach. All research establishments had to adopt a more business-like structure and some formed their own Consortia outside of PHARE to conduct work under the European Commission's 3rd and 4th Framework Programmes that were running during this period.

Initially the relations between the PHARE partners were very positive and the reasons for starting the co-operation were shown to be valid, in that the sum of the parts was larger than the parts individually. The synergy resulting from meeting people working in the same field led to increased enthusiasm. In the course of the years this advantage diminished with the increased knowledge of each other. Gaining agreement on work distribution and funding allocation became more difficult. Additionally, the amount of effort for conducting specific tasks had often been underestimated and thus the pressure on resources increased, while at the same time the partners' R&D budgets - needed for their 50% of the funding - were capped or even reduced.

Nevertheless, on the higher management level there has always been a strong tendency to stick together and to reach agreement on controversial matters.
However it has required a considerable amount of managerial effort to keep the partners together on the working level. This became particularly evident during the final preparation for the PHARE demonstrations. At these major milestones, the different project deliverables had to come together for integration and the dependencies of the projects became critical for the overall success. In such a situation the gentleman's approach failed. It could not provide the individual project leader of a particular PHARE demonstration the required authority over another partner's priorities and resource allocation.

2. Cultural differences

2.1 National peculiarities

In a multinational R&D Programme such as PHARE, the national peculiarities of people, the culture of the particular R&D establishments and the differences in the relationships between the ATM R&D researchers and the air traffic

controllers in different countries are non-negligible issues.

The EUROCONTROL Agency is a good place to study national idiosyncrasies as here nationalities have merged during many years and although many of the typical national traces are disappearing, some very resistant particularities do not really die.

It would be much too simplistic to generalise on national traits, however, one could surmise that:

-The French are not very well organised, but they are creative and get things done;
-The Germans are expected to work very thoroughly, but as they work short days and take long holidays their work takes a considerable time;
-The British are well organised and straightforward, but very bureaucratic. It takes time but they will get there;
-The Dutch are very much like the British, working in a structured fashion, but rather inflexible and tend to be expensive as they include large overhead costs.

However, traces of such behaviour became visible in PHARE. How to tackle a problem or relate to colleagues and collaborators from other research institutions is certainly influenced by traditions and by the education in the different European countries. Additionally the traditional approach in research establishments was often "research for the beauty of the research results". The rapid evolution of some of the partners to more business-oriented enterprises was not always matched by the speed of the change in the attitude of the staff.

Significant differences were also found in the attitude of the air traffic controllers of different nationalities and background who participated in the real-time simulation trials that made up the PHARE demonstrations. Controller acceptance depended on their degree of involvement in national ATC improvement programmes or national ATM R&D, and on their experiences with advanced tools and related simulation environments. Although most accepted the PHARE concept others were reluctant to accept their role in the simulated environment - trying to maintain their present day procedures in a completely changed context. Luckily there were only few of this last category, but the "surprising" fact is that they all were of the same nationality or had the same background in one organisation.

2.2 Language

Apart from the fact that national peculiarities may influence co-operation, the situation is made even more difficult when those involved do not share a common native language. All those involved in PHARE have a reasonable knowledge of English; nevertheless, it cannot be denied that some people for whom English is not the mother tongue, did not understand all the nuances in discussions or written material.

Therefore there are two barriers in understanding each other, first the language and second the cultural background with which expressions are translated. This has certainly led to a number of misunderstandings and lengthy debate with sometimes violent arguments, which actually turned out to be agreements.

We think that PHARE has contributed considerably to overcome cultural differences. However it cannot be denied that in times of high tension some people became nearly paranoid and accused others of working to a "hidden agenda" in the interest of their own, purely national objectives.

3. Communication amongst the partners

3.1 Meetings

Many of the problems experienced in PHARE were caused by difficulties in communication between people. As explained earlier, language and cultural differences played a significant role in such misunderstandings.
With more than 100 people working on PHARE in five research establishments spread over

different countries, communication is not a simple matter. Regular working meetings were held for all projects. Fortunately, the mission costs amounting to 200-300 KECU per year were covered by a special EUROCONTROL PHARE mission budget.

From the management side serious attempts were made to make the programme as transparent as possible. All updated project plans, all project progress reports, all management decisions, updated budget distribution over partners and projects per year were distributed every two months to all partners present in the PHARE Co-ordination Committee and to all project leaders. A high level overview of this information was presented to the PHARE Management Board twice a year.

At the beginning of the larger projects, such as PD/3, there was a tendency to set-up a large number of task forces and working groups. These would meet regularly to concentrate on specific items with the aim of keeping the project manageable for the project leader. However, such task forces and working groups have a tendency to develop their own strategies and objectives, blurring the overall project aim. It has to be concluded that this type of work distribution only works well if controlled very tightly by the project leader. Such tight control would require such an amount of additional effort from the project leader that the overall benefit tends to be marginal.

3.2 Email

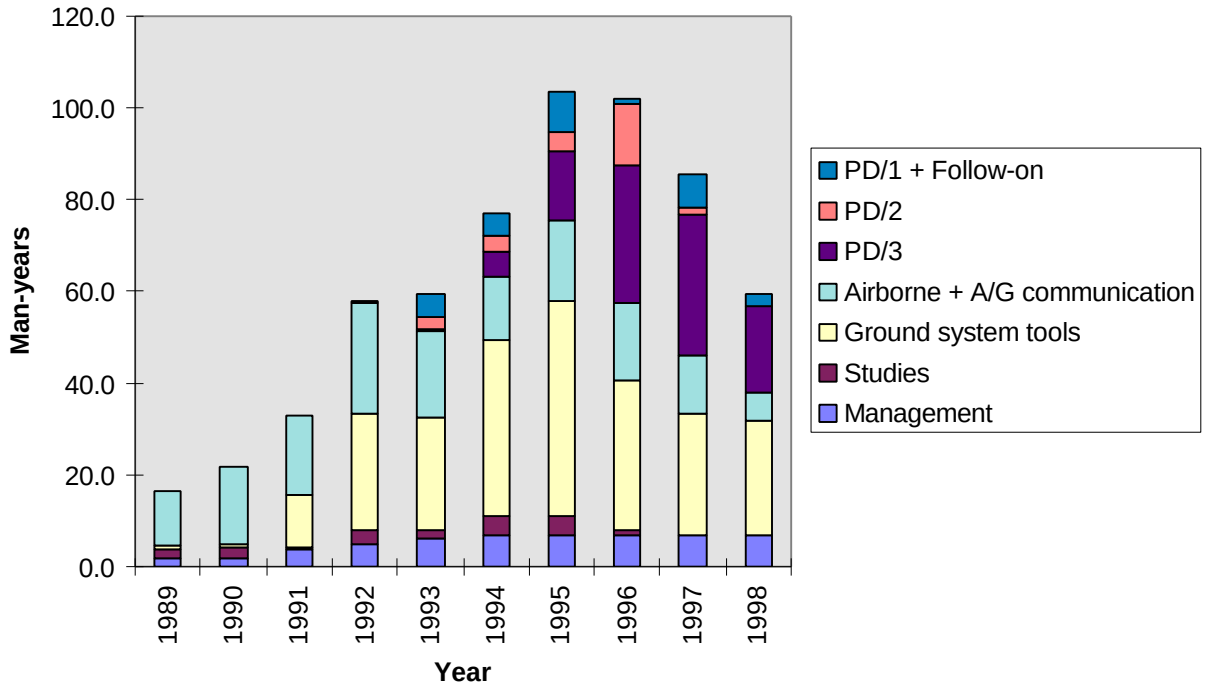
Fax and email are an important means of communication within PHARE. When PHARE began in 1989, the use of email was very uncommon; the European Commission's Eurokom conferencing system was the first acquaintance of many people with electronic mail. After the usual difficulties that everyone had to go through with email, PHARE has now reached a state that, with the exception of some of the high level managers everyone is using email actively. Several externally available email address groups were created to reach the various management bodies and working teams in PHARE, without everyone having to create their own, individual distribution lists.

In some cases people used nothing else than email for communication, even when a personal word would have cleared the situation much quicker. There have been numerous email "flame wars" with copies circulating to increasingly large numbers of increasingly senior addressees that have, at least temporarily, seriously worsened relations.
Many people are not aware of the impact of an offensive email on a receiver; immediate reactions are not the best way to solve sensitive issue. This is also not helped by some national differences in the definition of what constitutes an "offensive" email. People have apparently forgotten the telephone, which is a much better means to express emotion and to solve an issue. A lesson learned is that email is an efficient tool of communication but it should not totally replace personal contacts.

4. Organisation of the main funding of projects

The procedure of defining a framework within PHARE for funding over several years has eased the annual contracts placements. For each specific "project agreement" a complete work breakdown and project planning was defined, resulting in a multi-year overview of work and funding distribution per partner and project. This overview was constantly maintained and adapted to the changing requirements throughout the years. This created the long-term funding stability needed by the R&D establishments' and allowed the senior management the confidence to build-up a considerable ATM R&D workforce. A positive added by-product of this specific funding procedure was that more effort could be spent on technical work rather than on the potentially nugatory effort to acquire contracts annually.
On the other hand there are also indications that this relatively easy project continuation created some complacency.
An overview of the total number of man-years spent on PHARE is provided in figure 3.

Figure 3: Manyears spent on PHARE work per year



The fact that the work generally was 50% funded by the EUROCONTROL Agency's budget had advantages and disadvantages. An obvious advantage in the interest of EUROCONTROL is that more resources could be gained for a specific project within a given amount of funding budget. Moreover, the fact that 50% comes from the partners ensures that they will have their own interest in the project and are bringing in their own ideas and vision. This had the effect of avoiding the possible pitfall of partners purely playing a contractor role to get the money, regardless of the subject.

A serious disadvantage, however, is that project control is very difficult. There is no visibility of which items the partners are funding from their own budget and there is no real EUROCONTROL authority over the allocation of the resources. In some cases partners changed priorities (as a result of conflicts of interest with other projects) which affected PHARE in a negative way. The EUROCONTROL programme managers had limited means to exert contractual pressure.

The shared funding also resulted in a complicated and sometimes difficult situation with respect to ownership of Intellectual Property Rights. All products are supposed to be commonly owned by all partners. Distribution of the R&D results, granting of related licences and collection of royalties becomes difficult due to the individual interests and different commercial considerations of some of the partners. There could also be conflicts with the legal framework and requirements for handling Intellectual Property Rights embodied in each partner's establishment.

The experience has led the EUROCONTROL Agency to reconsider joint funding of future ATM R&D projects on a case to case basis. However, a formal EUROCONTROL Agency policy has still to be developed in this field.

5. Organisation of the funding of mission costs

From the beginning the possibility to travel for meeting the other partners, for working temporarily in combined teams and attending workshops, for participating in the experimental trials and for getting Air Traffic Controllers for the real-time simulations, was considered an important element of such Europe-wide collaboration.
As is generally known, the mission budgets of the different R&D partners, if they existed, were particularly limited. International missions were seen as exceptional and were subject to cumbersome in-house procedures for approval; in some cases four weeks in advance signature by a Director on the basis of a detailed justification. It was clear that PHARE could not be achieved with such constraints.

Therefore the EUROCONTROL Agency provided a special, and not inconsiderable, mission budget for funding the travel costs of non-EUROCONTROL staff within the PHARE programme. Reimbursement of the transport costs and payment of a daily allowance followed the rules and rates for EUROCONTROL officials.
Strict, but efficient and rapid procedures, were set-up and consistently applied. The authority for mission approval and the final acceptance of the reimbursement claims remained with the PHARE Programme Manager.
In the most active years 1996 and 1997 the PHARE cell in EUROCONTROL Headquarters administered up to 800 mission requests and reimbursements with the assistance from the in-house mission office and the financial services of the Agency.
It is absolutely clear that the PHARE programme could not have been performed without this additional funding and centralised assistance.
Strict control and follow-up was applied to avoid abuse and nugatory expenditure. This type of procedure worked well in PHARE but took up a significant amount of organisation and tracking effort.

6. Tracking of the progress

In order to track progress in this multi-project, multi-national programme a sophisticated multi-project planning mechanism was set-up and maintained throughout the programme.
Complete detailed project plans for each project were interlinked by showing deliverables of one programme as milestones in another project (Microsoft Project was used for this).
The tracking of the progress was achieved by looking at the percentage of tasks completion for all tasks in each project with milestones indicating the availability of deliverables of the task .

All project leaders were asked to provide regular progress reports to the PHARE Co-ordination Committee at two-monthly intervals updating the percent completed and actual and estimated delivery times of all ongoing tasks in their project. The linking mechanism then showed what the influence of shifting a deliverable milestone in one project was on the other projects using the deliverable.
It must be admitted that the process was quite tedious, but it highlighted which tasks were slipping and the potential impact of the slip. For many projects it became evident that with time the cumulative delays were slowly absorbing all slack.
In both the first and the second PHARE demonstrations this led to postponement of the demonstration of one year each. In the case of PD/2 to it also led to a reduction in scope. In the third PHARE demonstration the fixed end date was announced very early and reductions in scope and functionality were decided at various (and repeated) instances when it was clear from the planning that no more slack was available.

This tracking created a transparent environment in which decisions to postpone tasks or reduce functionality (in order to satisfy time scales) could be taken with all management levels informed of the consequences at an early stage. It must be admitted that it took quite some effort of the PHARE cell to convince the project managers to adhere to the two-monthly updating procedure.

Project Leaders have a natural resistance to give insight to the details of their project progress to higher level management because under high time pressure they consider it as unwelcome extra workload and a nuisance. Moreover, they do not trust that the right 'informed' decisions will be taken on the basis of the information. Also the classical problems of a matrix organisation appeared when a partner's representative in the PHARE Co-ordination Committee or PHARE Management Board was not the line manager of a PHARE project leader in his establishment.

7. PHARE Demonstrations

7.1 PHARE demonstration 1 (PD/1) and related trials

PHARE demonstration 1 (PD/1), an en-route ATM exercise lead by the UK National Air Traffic Services NATS, was organised with a small, very efficient, full-time integration team working on site at their main contracting site at the Defence Research Agency DRA (now DERA) in Malvern. The team did everything needed to get the simulation to work by adapting the tools software delivered to them and testing it until the required functionality was achieved. The PD/1 trials worked well and it was in particular a DRA/NATS success to achieve overall integration of the PHARE tools. The time from establishing initial requirements (August 1992) to actually running the trial (December 1995) was 3.5 years and the publication of the full final PD/1 final report took a further 2 months. The results and demonstrations of the PD/1 system were presented in a PD/1 Forum held in Bournemouth in May 1996.

The PD/1 trials involved 32 controllers from 7 countries and included real flights of the NATS/DERA BAC 1-11 research aircraft. It evaluated an experimental system in which advanced computer assistance tools were connected to both simulated and real 4-D flight management systems through an air-ground datalink. The aim was to explore the effectiveness of the negotiation of conflict-free trajectories; to see if they reduced the workload of primarily the tactical controller, but also the planning controller thus increasing airspace capacity. The results showed that controllers generally approved the PD/1 trials environment with the assistance in trajectory planning and conflict resolution given by the system. However, the effect of the tools on planner and tactical controller workload and airspace capacity was not completely clear-cut and many controllers complained that it was difficult to "maintain the picture".

Building on the results of the PD/1 trial, three further but smaller-scale trials were carried out on the UK NATS Research Facility to investigate some of these results.
An advantage was that these additional trials could be set-up at relatively low cost as the PD/1 platform was available and tested, rather than having to start development, integration and testing from scratch.
The first one, called the 'Planner Controller / Tactical Controller' experiment gave further insight on the changing role of planning and tactical controller in the PHARE concept. This was followed by the so-called PD/1+ trial in which some modifications to the tools, the human machine interface and the way to train controllers were tested. An important output from the trials was the highlighting of the disadvantage of applying the PHARE concept within the bounds of today's operations thinking: that is the use of a large number of relatively small sectors and the use of a fixed route structure. Therefore, it was decided to perform another trial on the same platform called PD/1++ which concentrated on the effects of sector size and introduction of direct routing for suitably equipped aircraft. The report is currently being finalised and the results show that benefits are to be obtained from airspace reorganisation and implementation of direct routes within the PHARE operational concept.

In summary it is concluded that PD/1 and its related trials formed a major, successful series of demonstrations of the air/ground integrated air traffic management concept in en-route airspace. The evidence suggests that considerable gains are achievable in controller workload, airspace capacity and quality of service to airlines.

However, it also appears to indicate that under the operational concept examined, the controllers do not need to maintain the same level of awareness of the ATC picture as in today's system.

7.2 PHARE demonstration 2 (PD/2)

In the case of PHARE demonstration 2 (PD/2), an arrival exercise in the extended terminal manoeuvring area of Frankfurt led by the Institute of Flight Guidance of the German Aerospace Centre DLR, the organisation was set-up in a different fashion by using extensive on-site support from many PHARE partners to the ATC simulator integration work of the DLR team. This also worked, albeit with less functionality than originally planned, but at the cost of very high inter-partner stress levels. In this case time from establishing initial requirements (March 1993) to actually running the trial (January 1997) was also almost 4 years and the full PD/2 final report was only published one and a half year later in June 1998. The results and demonstrations of the PD/2 system were presented in a PD/2 Forum held in Braunschweig in June 1997.
Unfortunately, after finishing PD/2, DLR had to change their priorities and dropped any further direct involvement in PHARE PD/3 activities.

The PD/2 system incorporating advanced controller assistance tools for arrival traffic was demonstrated for the ground part on DLR's real-time Air Traffic Management and Operations Simulator ATMOS, using 32 controllers from 7 European countries. The airborne part used the DLR Advanced Technologies Testing Aircraft System (ATTAS) Experimental Cockpit, both airborne and in ground simulation, with air-ground datalink and 4D experimental flight management systems (EFMS). Six pilots participated in an airborne demonstration programme, convincingly showing the ability to fly negotiated trajectories in a routine manner while operating on its inbound route down to the Approach Gate within continuous 4D tolerances.

The results showed that in general the PD/2 concept with controller assistance tools, using a mouse for interaction with aircraft labels and pop-up menus instead of working with paper strips was appreciated and areas for improvement in conflict detection and resolution were identified. Under high traffic load overall benefits were achieved for the number of landings per time unit, average flight times of the aircraft in the sector, inbound delays and time precision of delivery. In PD/2 no controllers complained about not being able to maintain the picture, which is understandable as standard arrival routes were used. However, some had concerns about automation leaving them in a monitoring role with the risk of losing their skills.
In summary, PD/2 was a major, successful demonstration of the integration of advanced tools, 4D FMS and datalink into an air-ground air traffic management system in an extended terminal area airspace. Experimental evidence suggests that the PHARE concept of trajectory-based traffic guidance provided by the advanced tools and human/machine interfaces was approved by the controllers and pilots, and that it has the potential for improving traffic throughput and quality of service, at acceptable or reduced levels of controller workload.

7.3 PHARE demonstration 3 (PD/3)

The PHARE demonstration 3 (PD/3) was planned as a three-site exercise by the EUROCONTROL Experimental Centre EEC, the French Centre d'Étude de la Navigation Aérienne CENA and the Dutch National Aerspace Laboratory NLR with assistance from the UK National Air Traffic Services NATS. Adaptation of the scope of the exercise to the time and resource available has been a continual process throughout the project life. At the launch in October 1993, the project consisted of three multi-centre interconnected exercises that would be preceded by a large number of small-scale so-called Initial Operational Clarification Projects to investigate various issues before going into the major trials.

The way PD/3 has evolved was very much influenced by a decision of the PHARE Management Board already taken in 1994 to finish the PHARE programme with the third

major PHARE demonstration at the end of 1998. The continuing project reassessment process led to a number of far reaching decisions on the way.
In April 1996 the PHARE Management Board decided to remove the multi-centre connection and reduced the ten Initial Operational Clarification Projects to four. In December 1996 these internal clarification projects were cut short to finish by April 1997, when it was realised that all work had to be concentrated on the preparation of the actual trials to be run early 1998.
However, the fact that three major simulations were scheduled very closely spaced in time meant that there was competition between the three sites for resources, which is different from the situation in PD/1 and PD/2 where all effort was concentrated on a single major demonstration.

7.4 CENA Trials (France)

CENA successfully completed their part of PHARE Demonstration 3 (PD/3) aimed at demonstrating the feasibility of air/ground integrated airport departure into en-route air traffic control, more or less according to the original plan in May-June 1998 about 4.5 years after start of project.

In the actual PD/3 demonstration activities at CENA a total of 45 hours simulation trials were successfully performed in two three-week periods, with 25 controllers from Romania, Germany, USA and France participating. Initial results show that the participating controllers in general reacted positively to the new tools and concepts. They considered the departure manager system easy to use and appreciated the concept of keeping the controller in the loop. Data analysis is currently going on and a final report is expected at the end of 1998.

7.5 EEC Trials (EUROCONTROL Brétigny)

The part of the PD/3 exercise planned to run at EEC consisted of a full gate-to-gate simulation including multi-sector planner positions. Unfortunately, these trials could not be run in the simulation slots foreseen in April-May 1998 as problems with development of human machine interface software made it impossible to run the ATC system with advanced functionality in time. This led to the decision to abandon the trials in the context of PHARE at EEC as it was expected that the problems could not be solved in time and no further simulation slot was available to continue the work in the near future. A report analysing the reasons leading to the unability to develop the human machine interface in time for the trials and the measures implemented to resolve the difficulties for the future is being prepared.

7.6 NLR Trials (The Netherlands)

The part of the PD/3 exercise, planned to run at NLR in May-June 1998 demonstrating trajectory control across en-route/ETMA/TMA, could not be completed as NLR, in the spirit of the PHARE co-operation, had decided to rely on the EEC for the human machine interface software.
Meanwhile, at NLR the human machine interface blocking factor has been removed by adapting the human machine interface software from EATCHIP 3 which was itself based on the PD/1 human machine interface. The adaptations include the addition of required PD/3 functionality and close integration with the PHARE Advanced Tools. A so-called PD/3 continuation trial consisting of some exploratory trials and a public demonstration of the system is now planned to take place in November 1998. At the time of the conference we will know if this has been successful.

8. Common approach and deliverables

As the PHARE programme was aiming at delivering tools to be integrated at all partner's platforms and at achieving coherent results between the different sites, it was necessary to agree on a common approach, for tools production, for measurements and for final reporting.

8.1 Tools

Integrating an agreed set of ATM tools at all partners' platforms turned out to be much more difficult than expected. The definition of the tools needed in an advanced ATC system was agreed at

a relatively early stage, but as all the partners were already working on rudimentary versions of the tools on their existing ATC simulator there were some not insignificant difficulties in integrating the tools and their concepts.
Around 1993 there was agreement on the definition of the so-called Common Modular Simulator (CMS) application program interface specifications and architecture. The PHARE tools would be developed to interface with each other via this architecture. Tools were developed in the PHARE Advanced Tools project to meet this specification, and in the PHARE Demonstration 2 at DLR Braunschweig a subset of them were shown actually working on their ATC simulator which was based on a Prototype of a CMS. Unfortunately this commonality could not be continued in PD/3 due to disagreement of the partners on the standard approach, and two of the three partners decided to abandon the CMS approach in favour of their own platform implementation. This is one of the examples of partners' decisions which due to the 50% funding situation could not be influenced by the EUROCONTROL PHARE management.

8.2 Measurements and analysis

The common definition of a measurement and analysis specification that would be used by all partners in PHARE was successful. All partners accepted the use of the agreed specification of measurement systems and analysis methodology for their exercises. Although the differences between the partners' implementations and area of investigation would influence results this gives confidence that there is some commonality between results of experiments at different sites.

8.3 Final reports

All PHARE project teams ground and airborne tool development programmes, ground and airborne trials, air/ground communication) will prepare final reports in their specific fields by the end of 1998 with the major findings and the lessons learned. It is intended that there will be a commonality in the content of the final reports by using a similar report structure for all projects. A Document Review Group led by the PHARE cell including representatives from all partners will assist the PHARE Programme Manager in performing the final acceptance of the documents.

9. Lessons learned (do's and don'ts)

One could argue that the same and maybe better results could possibly have been obtained at a lower cost if the programme could have been run at one site, with strong centralised management. However, even if PHARE did not fully deliver what it set out to do, the positive effects of this multi-national co-operation are evident and far-reaching.
It is expected that, as all partners have "ownership" of the results obtained, there will be less of a "non-invented here" syndrome when using the results for further development and use of the concept. The fact that all PHARE partners have obtained a better knowledge of the objectives and working methods of their European partners will certainly facilitate future co-operative arrangements needed for research.
The experience with the PHARE programme has led us to set-up the following list of do's and don'ts, which in many respect are directly translatable to non-European conditions:

PHARE: LESSONS LEARNED FROM THE ORGANISATION OF MULTI-NATIONAL R&D ON AIR TRAFFIC MANAGEMENT

	Do's	Don'ts
1	Get commitment from high management levels in the participating companies.	Don't let the politics in various companies constantly change the project objectives.
2	Give co-ordination responsibility to the line managers of people working on the project.	Don't let the line manager drastically change the project involvement of participants.
3	Work with a small focussed team, **fully allocated to the project**, with a project manager with **power of decision**.	Don't let projects be managed by committee working with large numbers of partially allocated staff.
4	Make all project information very transparent.	Don't hide important information in a flood of documentation.
5	Allow for sufficient travel budget to have meetings when needed and establish stringent procedures for approval and cost reimbursement.	Do not give the impression that mission expenses are reimbursed by pure routine without much verification.
6	Insist on good communication habits (phone, email, meetings).	Don't let people spend too much time on email "battles".
7.	Break-down the R&D tasks into manageable projects with defined deliverables and timescales.	Do not allow a proliferation of task forces or working groups to develop.
8.	Make sure the work programme is aimed at **one single major simulation trial** at any one time.	Do not schedule major simulation trials at different platforms closely together in time.

10. General achievements of the PHARE cooperation

As already shortly indicated above, the PHARE co-operation in its early phases (not even called PHARE at that time) consisted of exchanging ideas, showing interest in the other partners' research work and comparing results of the proper national research results with those of the neighbouring countries. As a result of this, a common understanding of the requirements for a possible further co-operation was developed. Although this sounds strange to-day, there had never been a forum for the definition of European R&D before, except for a few bilateral contacts basically due to the personal initiative of a number of individuals.

Therefore one of the first deliverables of the combined PHARE research effort was the elaboration of the PHARE Medium-Term Scenario, a conceptual model for a future ATM system making full use of the assumed capability of aircraft to fly precise 4-dimensional trajectories in an air/ground datalink environment. This scenario description, even to-day after 10 years, is surprisingly close to to-day's vision of a future ATM system and it is evident that the PHARE ideas have contributed substantially to the European mind-setting.

The further understanding that such a future scenario would require a validation by a common R&D programme was a major step that had never been achieved before. The availability within the EUROCONTROL Agency of one focal point and his ability to ensure a yearly adequate funding level contributed considerably.

One of the institutional spin-offs of PHARE has been the setting up of the "ATM R&D Programme Review Group", consisting of "wise-men" with a large PHARE representation, which is acting as a consultancy group to the Director General of the EUROCONTROL Agency.

Another spin-off of PHARE has been that the PHARE partners have initiated the forming of the so-called PHARE-X consortium consisting of PHARE partners and selected industrial partners to co-ordinate responses to ATM call for tenders.

And last, but not least: This ATM 98 Seminar and the subsequent FAA/Europe R&D Committee meeting here in Orlando has evolved from the co-operation within PHARE and the participation of the FAA in the PHARE Management Board.