The Single European Astronaut Corps

J. Feustel-Büechl
ESA Director of Manned Spaceflight and Microgravity,
ESTEC, Noordwijk, The Netherlands

H. Oser
Head of European Astronaut Centre, ESA Directorate of Manned Spaceflight and Microgravity, EAC, Cologne, Germany

D. Isakeit
Coordination Office, ESA Directorate of Manned Spaceflight and Microgravity,
ESTEC, Noordwijk, The Netherlands

The need for astronauts

Whereas robotic and telescience activities in space are considered by most people as highly justified, the rationale for sending astronauts into space is often put into question by the media and public opinion. However, sending men and women to work on a space station — be it the current Russian station Mir or the imminent International Space Station — is not an end in itself, but a response to clear and objective considerations.

The International Space Station will be used as a multi-disciplinary research institute in space for fundamental and applied science, as a test-bed for new technologies, a platform for the observation of the Earth and the Universe, and as a stepping stone to further exploration and exploitation of space by mankind. The permanent presence of a crew on board will be one of its most important features. The first crew members will be aboard shortly after the arrival of the Russian Service Module, which means approximately eight months after the first Station element is put into orbit.

The roles of the Station astronauts will cover system operations as well as utilisation activities. In the system operations domain, the astronauts will work, under the authority of the Station Commander, with specific responsibilities not only for the systems provided by the space agency by which they are employed, but also for other systems across the whole Station. In the context of the utilisation activities, they will conduct scientific and applications-oriented experiments on board, with the active involvement of the experimenters concerned on Earth, as far as the specific nature of each experiment allows.

Mankind owes the unique place that it occupies among the living species on Earth to two essential types of 'built-in tools': the human brain and the human hand. It is this combination of high cognitive and manipulative skills that has enabled man to continuously improve his own living conditions and adapt himself to external changes in the natural, social and economic environment. No robot offers a similar combination of high intelligence, adaptability, mobility, dexterity and tactile skills. These capabilities are of particular value when it comes to activities which have never been done before and for which no standard reaction pattern can be conceived in advance.

The car industry and chemical plants are good examples of areas where robotic systems can perform well-defined routine tasks to support man in his day-to-day work, or even take over certain dangerous or monotonous activities. Less visible are the considerable efforts expended by human workers on the preparation, maintenance and repair of these robots. Moreover, robotic systems soon reach their inherent limitations when it comes to evaluating results and deciding what to do next, particularly when confronted with new or non-nominal situations.

An essential aspect of ground-based scientific research is the ability to modify experiment procedures, and even to reorient the line of research, as a function of the results achieved in earlier steps. This is all the more true for space-based research tasks. The presence of a crew onboard a space station allows us to cope with unexpected hardware failures, to change the technical configurations and operational parameters of experiments, to carry out manipulations that cannot be programmed in advance, to react directly to intermediate experimental results, and to cope intelligently with any unforeseen or unforeseeable behaviour, be it of the experiments or of the subsystems of the space station itself. That is why complex space systems, like the US Space Shuttle, the European Spacelab, the Russian space station Mir, and even the Hubble Space Telescope, would be unthinkable without at least the temporary presence of

astronauts. In addition, the astronauts themselves, who are regularly exchanged on a space station, offer a ready supply of test subjects for studying human physiology in space.

European astronauts for the International Space Station

Europe is one of the five International Partners in the cooperative International Space Station Programme. According to the objectives of international cooperation and the rules set forth in the Intergovernmental Agreement (IGA) and the NASA/ESA Memorandum of Understanding signed in Washington on 29 January 1998, ESA as the agency representing the European International Partner, has the right to provide personnel from the time it begins to share common system operations responsibilities. This means that ESA will provide one astronaut for a three-month stay on board the Station every 8 months (on average), after the launch of the Columbus Laboratory. An ESA astronaut will also participate in the in-orbit assembly and system verification of the Columbus Laboratory.

Figure 1. The first three ESA astronauts selected in 1977: from left to right: Ulf Merbold, Claude Nicollier and Wubbo Ockels

ESA is also negotiating with the other International Partners a number of additional flight opportunities for European astronauts before assembly of the whole Station is complete. The goal here is to increase ESA's operational experience in general, and to establish a solid Astronaut Corps at the level needed to meet the Agency's rights and obligations in terms of operations and utilisation. Consequently, the NASA/ESA Memorandum of Understanding Enabling Early Utilisation Opportunities of the International Space Station, signed on 18 March 1997, provides two Space Shuttle flight opportunities for ESA astronauts to be accommodated in the Station programme prior to the in-orbit assembly and verification of Columbus. A further step in the preparation of European astronauts for their future tasks will be ESA astronaut Pedro Duque's flight on the STS-95 Shuttle mission, scheduled for launch in October 1998.

In addition, the experience already gained by European astronauts is being made available to support the development of the various elements of the European participation in the International Space Station.

History and future of national and ESA astronauts

For historical reasons, there has not so far been a unified European approach to astronaut recruitment and employment. ESA had selected its first three astronauts (U. Merbold, C. Nicollier, W. Ockels) in 1977 with a view to their employment in the framework of Spacelab, as part of the US Space Shuttle programme. The ESA Astronaut Corps was later significantly enlarged in 1992 in preparation for the future missions related to the Columbus and Hermes programmes. When these programmes did not materialise, or at least not to the extent expected, not only was the size of the ESA Astronaut Corps frozen, but astronaut departures for personal reasons were not compensated by new recruitment.

In parallel with the ESA Astronaut Corps, three European countries – France, Germany and Italy – had each built up an astronaut corps of their own. In addition, astronauts from the United Kingdom, Austria and Belgium have also participated in manned space missions.

With no European manned space vehicles yet available, all of these ESA and national European astronauts have participated in missions on either American (Space Shuttle) or Soviet/Russian (Salyut and Mir) facilities (Table 1). With the coming of the International Space Station, the situation will change radically. On the one hand, Europe as a full partner in the International Space Station Programme will, with the Columbus Laboratory, be the owner of its own 'real estate' in space and will therefore have its own rights to participate in Station operations and utilisation, including astronaut activities. On the other hand, the planned ending of Spacelab and Mir operations leaves limited opportunities for additional mission arrangements for astronauts outside the framework of the International Space Station. It was for this reason that ESA, in December

Table 1. European astronauts in space

Name	Space Agency	Home Country	Mission Designation	Year
S. JÄHN		Germany	Soyuz-31	1978
J.-L. CHRETIEN	CNES	France	Salyut-7	1982
U. MERBOLD	ESA	Germany	STS-9/Spacelab-1	1983
P. BAUDRY	CNES	France	STS-18	1985
R. FURRER	DFVLR	Germany	STS-22/Spacelab D-1	1985
E. MESSERSCHMID	DFVLR	Germany	STS-22/Spacelab D-1	1985
W. OCKELS	ESA	Netherlands	STS-22/Spacelab D-1	1985
J.-L. CHRETIEN	CNES	France	Mir/Aragatz	1988
H. SHARMAN	Juno Consortium	United Kingdom	Mir/Juno	1991
F. VIEHBÖCK	ASA	Austria	Mir/Austromir	1991
U. MERBOLD	ESA	Germany	STS-42/Spacelab IML-1	1992
K. D. FLADE	DLR	Germany	Mir/Mir-92	1992
D. FRIMOUT	SPPS	Belgium	STS-45/ATLAS-1	1992
M. TOGNINI	CNES	France	Mir/Antares	1992
C. NICOLLIER	ESA	Switzerland	STS-46/TSS-1, Eureca-1	1992
F. MALERBA	ASI	Italy	STS-46/TSS-1, Eureca-1	1992
H. SCHLEGEL	DLR	Germany	STS-55/Spacelab D-2	1993
H. U. WALTER	DLR	Germany	STS-55/Spacelab D-2	1993
C. NICOLLIER	ESA	Switzerland	STS-55/Spacelab D-2	1993
J.-P. HAIGNERE	CNES	France	Mir/Altair	1993
C. NICOLLIER	ESA	Switzerland	STS-61/Hubble servicing	1993
U. MERBOLD	ESA	Germany	Mir/Euromir-94	1994
J.-F. CLERVOY	ESA	France	STS-66/Atlas-3	1994
T. REITER	ESA	Germany	Mir/Euromir-95	1995
U. GUIDONI	ASI	Italy	STS-75/TSS-1R	1996
M. CHELI	ESA	Italy	STS-75/TSS-1R	1996
C. NICOLLIER	ESA	Switzerland	STS-75/TSS-1R	1996
C. ANDRE-DESHAYS	CNES	France	Mir/Cassiopeia	1996
J.-J. FAVIER	CNES	France	STS-78/LMS-1	1996
R. EWALD	DLR	Germany	Mir/Mir-97	1997
J.-F. CLERVOY	ESA	France	STS-84 to Mir	1997
J.-L. CHRETIEN	CNES	France	STS-86 to Mir	1997
L. EYHARTS	CNES	France	Mir/Pegase	1998
Mission Assignments:				
M. TOGNINI	CNES	France	STS-93	1998
P. DUQUE	ESA	Spain	STS-95	1998
J.-P. HAIGNERE	CNES	France	Mir-99	1999
C. NICOLLIER	ESA	Switzerland	STS-104	2000

1997, launched an initiative to revisit the existing European astronaut policy and to adapt it to the requirements and constraints of the International Space Station era.

European mission opportunities and astronaut needs

The starting point for the elaboration of a new astronaut policy was the analysis of the expected missions for European astronauts. On the basis of the planned involvement of ESA astronauts in the International Space Station operations and utilisation scenario, and the existing bilateral arrangements between European national agencies and NASA or RKA for missions by national astronauts, the number of expected mission opportunities for European (from ESA Member State) astronauts has been evaluated (Fig. 2).

In the context of the International Space Station, more mission-specialist and onboard-engineer positions will become available. Especially during the assembly and initial utilisation phase, covering the period between end-1998 and end-2002 when only a limited number of utilisation flights appear in the launch manifest, system operations are expected to have priority over scientific missions, thus requiring a higher mission-specialist or onboard-engineer profile.

The basic duties for the European astronauts during this early period are to prepare for and to participate in space flights and to accompany the development programme for the European contribution to the International Space Station. This will lead to a deep involvement through collateral duties, providing familiarisation with

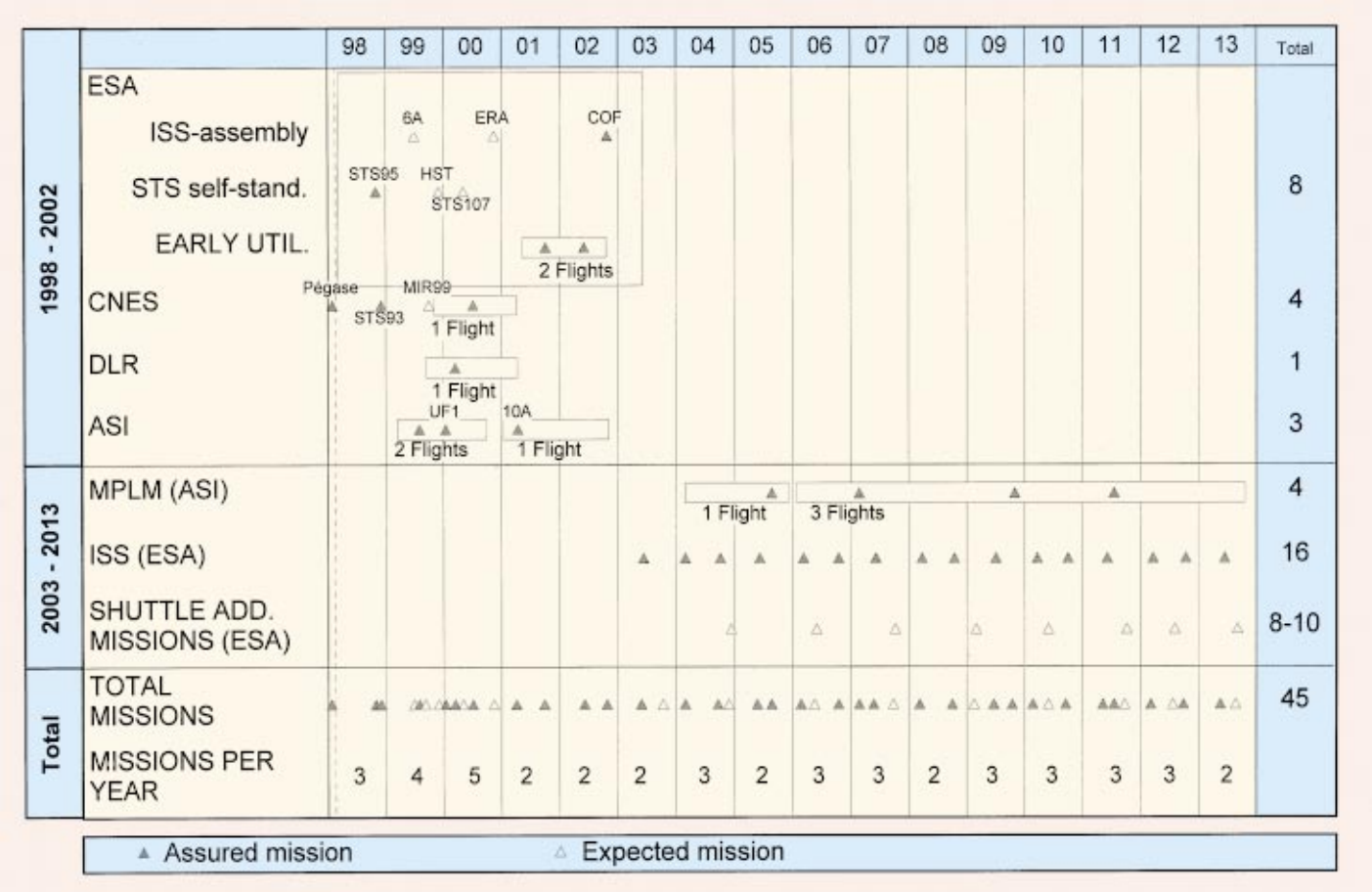
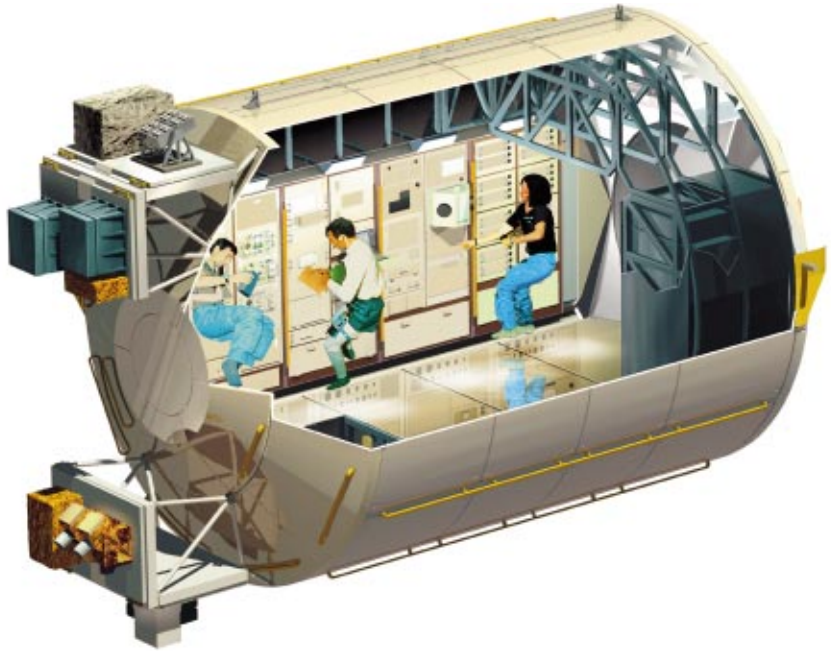


Figure 2. Summary of European mission opportunities

the programme on the one hand, and support to the engineering teams on the other.

The following potential European missions have therefore been identified for the period from mid-1998 until end-2002:

– 1998: 2 missions:
  • P. Duque on STS-95
  • M. Tognini on STS-93
– 1999: 3 missions:
  • J.-F. Clervoy on assembly flight 4-A
  • J.-P. Haigneré on Mir-99
  • C. Nicollier on the Hubble Space Telescope servicing mission
– 1999-2002: 10 missions:
  • 4 flights by European astronauts as Shuttle Mission Specialists
  • ESA mission (to be confirmed) in the context of the European Robotic Arm (ERA)
  • 2 ESA Early Utilisation Flights
  • 2 Shuttle flights for ASI astronauts in the framework of the NASA/ASI arrangements on the MPLM
  • 1 ESA mission for activation of the Columbus Laboratory.



This tally results in a total of 15 ESA and national missions, but other potential missions can also be expected in the same period.

For the period after the Columbus Laboratory's arrival at the Station, i.e. the period of Europe's own utilisation rights, from 2003 until 2013, consolidation of the ESA and national mission opportunities leads to:

– 16 ESA missions for utilisation of the Columbus Laboratory
– 1 Shuttle mission in 2003 – 2004 for an ASI astronaut
– 3 missions for ASI astronauts to the Station from 2005 onwards within the framework of the MPLM arrangements
– a number of Shuttle missions for European newcomer astronauts to prepare for Space Station missions; the exact number depends

on recruitment plans in the period after the Columbus launch, but a first estimate is 8 to 10 missions in the period 2003 – 2013.

A grand total 28 to 30 ESA and national mission opportunities are therefore to be expected in this period. Taking all realistic mission opportunities from 1998 to 2013 into account, this results in approximately 44 mission opportunities for European astronauts over the next 15 years. If one then takes into account the need for back-up astronauts for each of these missions, together with the necessary training and preparation time, these 44 missions would require a total of 26 astronauts to be available by 2000, if the distinction between ESA and national astronauts were to be maintained.

The integration of all European astronauts into a single Astronaut Corps, and the resulting rationalisation of the mission assignments, will allow the same number of missions to be conducted with just 16 astronauts. This assumes an average of 3 European astronaut missions per year, whereby each astronaut has a flight opportunity approximately every 3 years. After 2000, provided there is a stable mission frequency, natural astronaut attrition will have to be compensated for with an average of two new recruits every two years, thereby allowing appropriate crew rotation in terms of skills, ages and national considerations.

The benefits of a single European Astronaut Corps

The financial savings from having a single European Astronaut Corps result not only from the smaller number of astronauts required to conduct the European missions identified, but also from the associated reductions in management and support personnel and the more efficient use of facilities.

Each International Partner is responsible not only for the training of its own astronauts, but of all astronauts – i.e. including the astronauts from the other International Partners – on the facilities which they contribute to the Space Station. For Europe, this means the Columbus Laboratory, the Automated Transfer Vehicle (ATV) and the European Station payloads. Simulators and training mock-ups for these elements will have to be maintained for the duration of the programme and put under configuration control. Often, they will have to be reconfigured for the next mission increment. One single pool of such facilities will therefore lead to greater efficiency and considerable cost savings. A single Astronaut Corps, with a common home base at the European Astronaut Centre (EAC) in Cologne, will henceforth ensure cost-efficient basic and mission-specific training on the European Station elements (Fig. 3).

This pooling of resources is equally valid in less-visible areas too, such as the medical operations support. To be integrated as a certified crew surgeon in the International Space Station operations involves extensive training and proficiency maintenance, supported by dedicated biomedical engineers. In practice, the various space-medicine organisations in Europe are already actively working together to share resources. However, only long-standing contact between the crew surgeons and the astronauts can guarantee a relationship based on mutual trust, and this can only be achieved by both groups working

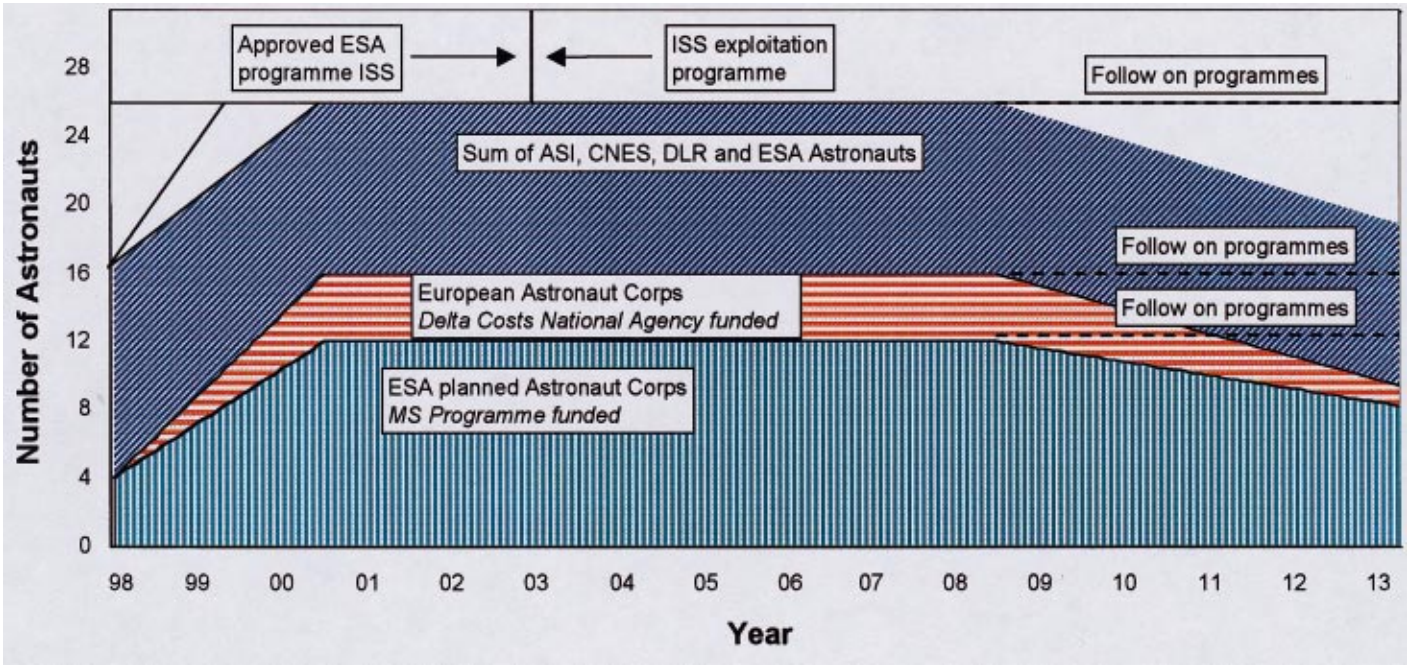


Figure 3. The European Astronaut Corps

together at the same home base. The same is true for the Crew Interface Coordinators and support engineers, for whom extensive contact with the astronauts is equally important.

A single home base also provides a stable environment for the astronauts' families and encourages a more uniform level of European astronaut background, proficiency and experience.

Money-wise, the pooling of resources will save several million Euros per year, compared with the current expenditures by ESA and the national agencies for maintaining their separate astronaut teams. In addition, the fact that Europe will speak with one voice to the other International Partners when negotiating astronaut assignments, and the associated costs, must not be underestimated.

Figure 4. The European Astronaut Centre (EAC), near Cologne, in Germany

The ESA initiative for a single European Astronaut Corps

To start the process of revisiting the existing European Astronaut Policy and seeking more economic and efficient use of available resources, ESA's Director General launched an initiative, together with the Heads of Delegations representing the relevant national agencies – ASI (I), CNES (F), and DLR (D) – in December 1997. A small working group, led by ESA's Director of Manned Spaceflight and Microgravity, with representatives from ASI, CNES, DLR and ESA, was convened several times in January and February 1998. It submitted a report to the Directors General of the four Agencies, presenting an analysis of the European resources and a proposal for an agreement between ESA and the national agencies.

The report proposed to:

- set up an integrated single European Astronaut Corps, managed by ESA
- establish the common home base for the European Astronaut Corps at ESA's European Astronaut Centre in Cologne, Germany (Fig. 4).
- develop a plan for discontinuation of the national astronaut programmes and the termination of new recruitment at national level
- complete the integration of national astronauts into the single European Astronaut Corps by mid-2000
- maximise the use of all of the infrastructure and mission opportunities available through ESA
- provide possibilities for utilising astronauts from the European Astronaut Corps for national missions
- establish a regular selection plan for astronauts which enables the adequate representation of all ESA Member States.

This would have numerous benefits for Europe:

- increased cost efficiency
- improved long-term career prospects for the astronauts
- improved flight opportunities
- better implementation of a coherent astronaut mission-assignment policy among the International Partners
- improved European coordination of astronaut activities
- availability of the national astronauts for national programmes
- a better European balance within the Astronaut Corps.

Following the endorsement of this approach by the ESA Manned Space Programme Board in February 1998, the ESA Council in March 1998 approved the Resolution on the Build-up of a Single European Astronaut Corps and adopted the relevant revised policy on European astronauts. In the meantime, the build-up of the European Astronaut Corps has begun.

The implementation of the single European Astronaut Corps

ESA is proceeding with the integration of national astronauts meeting the following criteria:

- age limit of 50 years at the time of recruitment, in order to allow an active career in ESA of at least 10 years
- compliance with ESA medical criteria consistent with the rules applicable to International Space Station cooperation.

ESA is limiting this first recruitment exercise, which began in May 1998, to 7 astronauts from France, Germany and Italy:

– two from France: one French astronaut, J.-F Clervoy, is already in the ESA Corps
– two from Germany: one German astronaut, T. Reiter, is presently in the ESA Corps, but on temporary leave for military duties
– three from Italy: there are presently no Italian astronauts in the ESA Corps.

In addition, ESA intends to select one astronaut, and possibly a second, from other countries in the 1998 to 2000 time frame (Table 2) , based on a reduced short-list established during the 1992 recruitment exercise. Three astronauts from countries others than France, Germany or Italy are presently in the ESA Corps: P. Duque from Spain, C. Fuglesang from Sweden and C. Nicollier from Switzerland.

Table 2. Nominal recruitment plan for the ESA Astronaut Corps

	1998	1999	2000
France	2	1	-
Germany	2	1	-
Italy	3	-	1
Other Countries	-	1 (2)	-

In the period 1999 – 2000, when the integration process has to be completed, the remaining national astronauts, provided they meet the medical criteria, will be progressively integrated into the Corps, leading to a total of 16 astronauts.

Beyond 2000, the normal ESA procedure will apply for further astronaut selections, maintaining a fair balance within the Corps.

National missions

National astronaut missions can be of great importance for the promotion of space activities in a specific country, and it is therefore important to establish a *modus operandi* between the new unified astronaut policy and national needs. National missions are usually based on bilateral agreements between the respective country and the mission-opportunity provider, such as the existing arrangement between NASA and ASI on the MPLM, and the Russian and CNES Mir-99 mission.

One possibility is the secondment of astronauts from the single European Astronaut Corps to the respective national organisation, or the concluding of a specific arrangement between the national organisation and ESA. In the first solution, a European Astronaut Corps member can be seconded to the national organisation from the start of mission-specific training until the end of post-flight activities. In the case of a specific arrangement, the astronaut would continue to be fully embedded in the ESA structure, but the planning and execution of the mission would rest with the national authorities. Depending on the astronaut's profile, activities such as involvement in national public-relations events or sitting on national boards or advisory groups, etc. could also fall into this category.

Figure 5. Astronauts Pedro Duque and Christer Fuglesang in training at EAC

Conclusions

The 44 astronaut missions which have been identified as necessary between 1998 and 2013 to support ESA and national activities will mean an average of three astronaut mission opportunities per year. The fact that the total of 16 astronauts needed to support these missions will now be concentrated within a single European Astronaut Corps, with the European Astronaut Centre (EAC) in Cologne-Porz (D) as their common home base, will ensure efficient future use of ESA and national capabilities in Europe, in terms of human resources, facilities and infrastructure. The decision to pursue this revised astronaut policy and to form the single European Astronaut Corps must therefore be seen as a very positive example of the forward-looking space integration process that is currently taking place at the European level.