Human Spaceflight in Europe: Celebrating Accomplishments, Preparing The Future

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European Space Agency
Directorate of Human Spaceflight

We are a reflection of our society's desire to achieve greatness, to push the boundaries scientifically, technologically and industrially for the greater good of humankind.

EUROPE: Leading innovation to define exploration An insight from Simonetta Di Pippo

Europe is a proud continent, a diverse continent, a melting pot of cultures and ideas with a legacy as explorers. Our ability to come together and cooperate, as a united continent and with other space-faring nations on major human spaceflight programmes is a great example of how far we have come socially, politically and economically in the last few decades. We are a reflection of our society's desire to achieve greatness, to push the boundaries scientifically, technologically and industrially for the greater good of humankind.

Technology and research are shaping our world and will play an increasingly important role in shaping our future. Only those countries with the vision to stay at the forefront of these technological advancements will reap the benefits of their engagement. The technology we develop now will form the basis of our future achievements. Only by staying one step ahead will we have the opportunity to enjoy the benefits of our technological advancements in the future. Falling one step behind could create a widening technological gap and lead to a need for even greater investment in the future just in order to have parity with other technologically advanced nations.

Europe's involvement through ESA in the International Space Station partnership has been and continues to be a story of major technological and scientific achievement. It has been a great stimulus for European industry, which has taken great strides in the development and manufacture of cutting-edge space systems and hardware, which have performed flawlessly on orbit. The launch and attachment of the Columbus laboratory in February and Node 2 last year have shown the capabilities Europe has in developing human-rated orbital infrastructure and undertaking major scientific programmes in weightlessness, which will hold major benefits for humans in space and on earth. This was strengthened by the successful five-month mission this year of the Automated Transfer Vehicle (ATV), Europe's first ever logistics spacecraft and unique even globally.

It is proposed therefore to build on the recent success of Columbus' attachment to ISS and its start of operations and the flawless mission of the Automated Transfer Vehicle "Jules Verne" to engage Europe in the development of a new space transportation system. This will safeguard our industrial investment, enhance our position among international partners and prepare Europe to play the role it deserves in future undertakings. Additionally we have to continue developing the technologies and enabling capabilities which will allow us to claim a seat among those returning to the Moon in the next decade.

In parallel we will provide all our support, knowledge and expertise in raising the political profile of human spaceflight and exploration in connection with the European Union and all other stakeholders.

Today's strategic decisions will define Europe's position tomorrow and will allow us to see one or more European citizens on the Moon together with our international partners. The technical knowledge and experience of the European Space Agency coupled with the political weight of the European Union can make this process even more robust.

Let's shape our future together.

Exploring Together:

The Global Exploration Strategy

Space activities help to define nations and their place in the world. Countries that explore space are envied as frontier nations with cultural vigour and leading technologies. The number of countries involved in space exploration is growing steadily and we are entering a new era of historic significance, in which we will extend human presence beyond Earth's orbit, both physically and culturally.

The Global Exploration Strategy is key to unlocking humanity's future in space. With increasing intent and determination, our partners plan to return to the Moon and beyond with the goal of sustained and ultimately self-sufficient human presence beyond Earth. It is an enormous challenge that no single nation can undertake on its own. We must do it together.

This is why fourteen space agencies developed the Global Exploration Strategy: The Framework for Coordination, which presents a vision for human space exploration, focussing on destinations within the solar system where we may one day live and work. It elaborates an action plan to share the strategies and efforts of individual nations so that all can achieve their exploration goals more effectively and safely.

A partnership between humans and robots is essential to the success of such ventures. Robotic spacecraft are our scouts and proxies, venturing first into hostile environments to gather critical intelligence that makes human exploration feasible. Humans will then bring unique decision-making capabilities that allow them to respond to new situations and proactively push the boundaries further.

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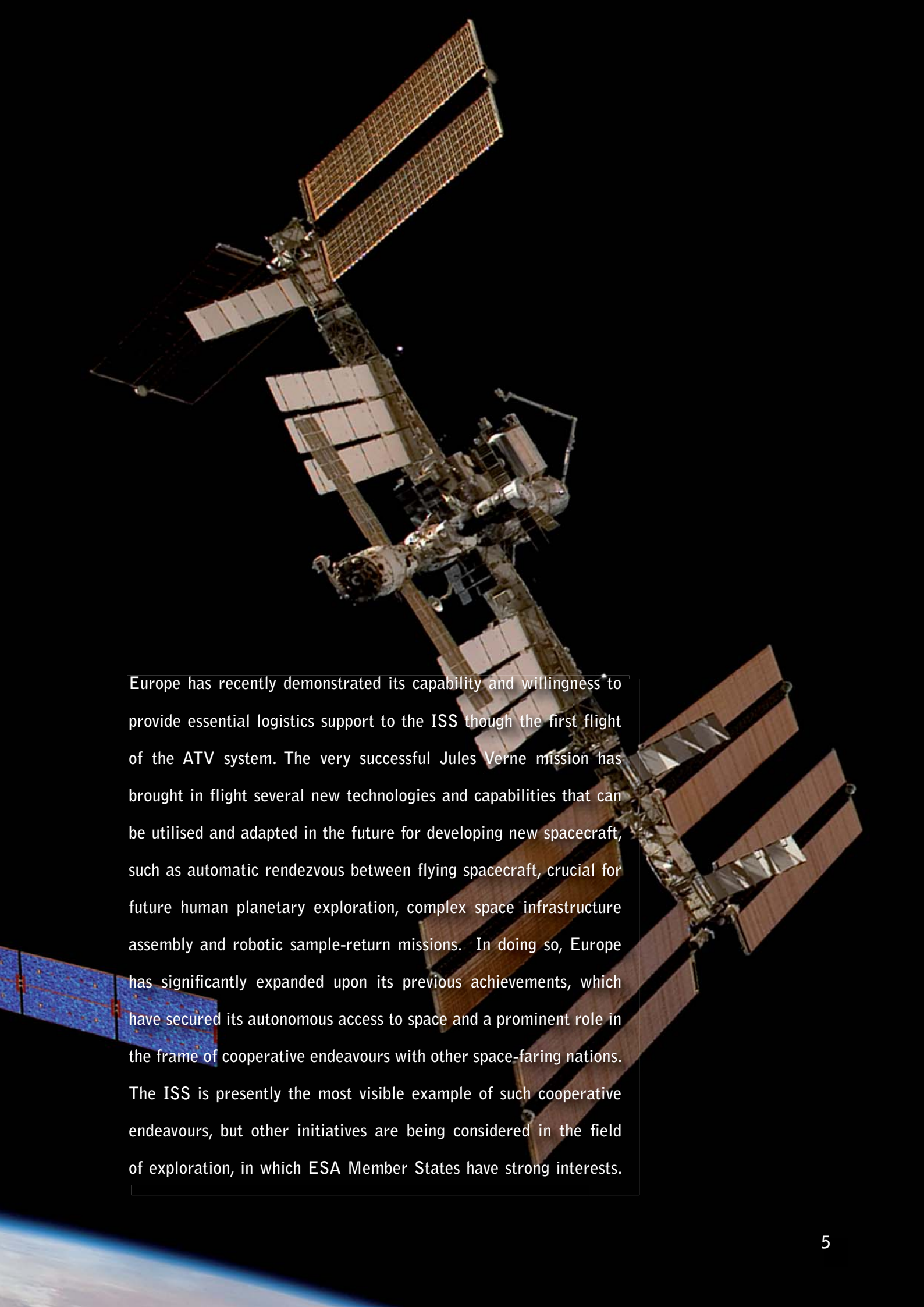
This Global Exploration Strategy will bring significant social, intellectual and economic benefits to people on Earth. We will learn about the evolution of the solar system and how to survive in difficult environments. This new knowledge will help us understand Earth better, and enable us to create more sustainable societies here. This new era of space exploration will strengthen international partnerships and global security through the sharing of challenging and peaceful goals. It will inspire people everywhere, particularly youth. It will steer many students toward careers in science and technology and provide them with challenging jobs that encourage knowledge, innovation and creativity.

Europe cannot afford to remain at the margin of what is bound to be one of the greatest undertakings of this century. Expanding human presence in the Universe, namely on the Moon and later on Mars, will positively and permanently mark humankind, our societies and our citizens. We need to keep this direction and at the same time consider a step forward to enhance our role and increase our autonomy, both to reinforce partnerships and to better serve European interests.

End-to-end European Transportation Capability: **The Advanced Re-entry Vehicle**



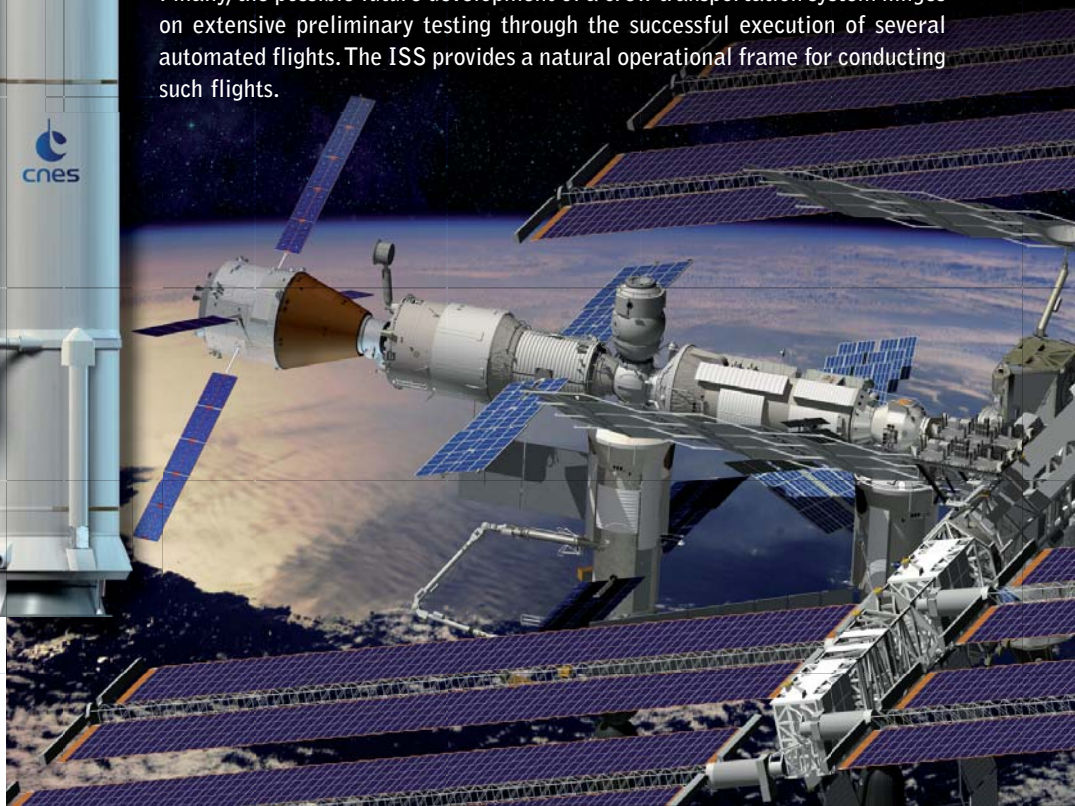
Europe has recently demonstrated its capability and willingness to provide essential logistics support to the ISS though the first flight of the ATV system. The very successful Jules Verne mission has brought in flight several new technologies and capabilities that can be utilised and adapted in the future for developing new spacecraft, such as automatic rendezvous between flying spacecraft, crucial for future human planetary exploration, complex space infrastructure assembly and robotic sample-return missions. In doing so, Europe has significantly expanded upon its previous achievements, which have secured its autonomous access to space and a prominent role in the frame of cooperative endeavours with other space-faring nations. The ISS is presently the most visible example of such cooperative endeavours, but other initiatives are being considered in the field of exploration, in which ESA Member States have strong interests.

The ISS also provides for a timely test-bed of technologies and programmatics for the future implementation of global exploration initiatives. An appropriate exploitation of its capabilities appears therefore as the first natural step towards securing a future European role in the context of exploration, on the basis of its demonstrated technologies.

With the Space Shuttle retirement, announced by NASA, it is necessary to reconsider essential aspects of the ISS exploitation on the basis of the traffic models enabled by the available or planned transportation means to and from low Earth orbit. Notably, the ISS partners will be deprived of the capability to return conditioned payloads and equipment to Earth (including samples resulting from ISS experiments). With this ISS logistic situation, the significant European space transportation background (patiently built through decades of activities) provides the opportunity to deploy an operational system. The obvious intrinsic strategic benefits of such a capability are magnified by the possibility to effectively leverage the enhanced support in the frame of the ISS exploitation, for the benefit of all partners.

The ATV currently has a capability to re-supply the ISS with up to 7.5 tonnes of propellants and cargo, and is the largest orbiting space vehicle after the US Space Shuttle. In the new scenario the pressurised Integrated Cargo Carrier would be replaced by a cargo re-entry capsule, equipped with a heat shield and able to bring back hundreds of kg of cargo and valuable experiments. Such a project, named the Advanced Re-entry vehicle (ARV), would use heritage from the Atmospheric Re-entry Demonstrator (ARD), which flew successfully in 1998, as well as the work done in the definition of past space transportation system concepts.

Finally, the possible future development of a crew transportation system hinges on extensive preliminary testing through the successful execution of several automated flights. The ISS provides a natural operational frame for conducting such flights.



Europe's first steps on the Moon: **The Lunar Lander**

Human exploration beyond low Earth orbit has become the major global focus for human space flight activities with the Moon being the first key stepping stone in these activities. Exploration is a great diplomatic and geopolitical opportunity and those nations that participate and contribute to a significant level in space exploration will shape the current international principles regulating the use of outer space.

A lunar mission and further exploration missions will be a source of inspiration and of mutual understanding. Cooperation will be key in exploration activities in order to reach challenging goals unattainable by any one nation. Resolving the engineering and logistic issues of sustained surface operations, with the requirements in terms of mobility, energy and life support systems, will boost research and innovation in fields that are also vital to the well being of millions of men and women on Earth.

The direction in which global exploration activities are heading provides ESA with a great opportunity of developing an autonomous lunar lander, capable of delivering payload to the lunar surface in support of a human presence on the Moon, as well as payloads directly supporting European exploration objectives. Assessments suggest that a lunar lander capable of cargo and logistics delivery would significantly extend surface exploration opportunities by enabling enhanced human mobility, extended human lunar surface presence and new surface exploration opportunities.

A European lander of this type would represent an element, which can be somewhat independent in its development from the wider architecture, and so more robust and flexible to the inevitable changes and evolution of that architecture. Technologically, the elements which go together to enable not only a landing capability but also the ability to manipulate and transport payloads across the lunar surface, would allow Europe to draw strongly on its existing experience and know how, while developing new technologies which can be deployed in later exploration missions.

ELIPS

Through ESA, the large European science community and research institutions are actively pushing the boundaries of science and technology, putting Europe at the forefront of advancement in these areas and placing Europe in a key role for industrial applications built on such research. The European Programme for Life and Physical Sciences (ELIPS) has already produced many advances in a variety of scientific disciplines since its inception in 2001, advances that have, and will have, a positive impact on European citizens and processes on Earth as well as on future spaceflight activities. Since 2006 ELIPS Period 2 provided an ideal platform for Europe to become not only the main scientific user of the ISS but also to expand its international competitiveness in health research, innovative materials and processes and to achieve important scientific results in plasma physics, exobiology or bone and muscle research to name but a few. Now ELIPS Period 3 will further strengthen Europe's very strong position in research, building on the capabilities already in place on the ISS, principally utilising the European Columbus laboratory as well as other ISS and additional research platforms (ground-based, Drop Towers, Parabolic Flights and Sounding Rockets).

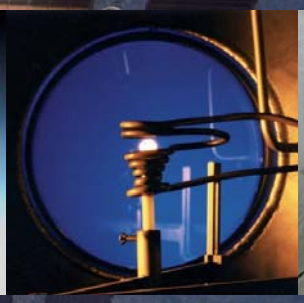
Taking the ISS to the next level: **ISS Exploitation and ELIPS**

The International Space Station (ISS) is a shining example of international cooperation, and a unique technological accomplishment which Europe, through ESA, is proud to be a prominent part of. Five international partners representing 14 nations have succeeded to bring to life the largest civilian cooperative project ever conceived. Tens of thousands of skilled workers throughout the world have been working to build and operate the ISS, learning from each other. Citizens from all over the world have witnessed in amazement male and female astronauts from many nations working together to assemble and utilise this first international human outpost in outer space.

The European involvement in the ISS is a testament to the endeavours of European industry and a sign of the commitment shown by ESA to European human spaceflight activities and its international partners. With the assembly of the ISS nearing its completion, Europe and its partners will soon be entering a period of full exploitation of the Station, which becomes even more significant when the ISS increases from a three-person to a permanent six-person crew as of next year. This provides for a far greater level of utilisation activities and scientific turnover for all the ISS partners. To make optimal use of the investment Europe has made in the Station, and maintain its contribution to the ISS programme, Europe needs to make full use of the European ISS elements, technologies developed and human capital and knowledge gained over the last two decades.

The Automated Transfer Vehicle (ATV), the Columbus laboratory and the European-built Node 2, are key contributions to this endeavour that has brought humanity to live and work in space uninterrupted for almost a decade. The ATV has become a key logistics vehicle for the ISS and, with the Space Shuttle retiring in 2010, the ATV's role in ISS logistics becomes even more important. Not only has the ATV programme provided Europe with the opportunity to develop such a strategically important spacecraft, it also provides a way for Europe to contribute to the ISS programme through logistics support and a method of uploading European science and technology payloads funded by European science programmes such as ELIPS.






The Columbus laboratory, as the first permanent European research facility in space is the cornerstone of European innovation and research in space. Since being attached to the Station it has been consistently increasing its acquisition of scientific data across a multitude of disciplines from fundamental physics, fluid and combustion physics, material sciences, space biology, exobiology, human physiology, and a broad range of technology research. Results of these experiments, which are funded from European science programmes such as ELIPS will have a positive impact for the future of European space activities and for the benefit of European citizens on earth.

Investment in ISS Exploitation i.e. in the logistic supply of the Station through the ATV and the launch capabilities through Ariane 5; the European control centres for Columbus, which is located at DLR near Munich, Germany and for ATV, which is located at CNES in Toulouse, France; associated personnel that manage the European ISS elements; and the training and support of our astronauts, will safeguard and promote Europe's key role in human spaceflight activities in Europe and amongst its partners.

Preparation for Human Exploration

ESA is preparing for future human exploration missions. Preparation is done in several areas such as system design, technology development and orbital and ground research and demonstration. Orbital and ground research and demonstration has been invaluable in current human spaceflight activities.

Habitation and Space Operation Systems

New habitat designs will be needed to support the crews doing long duration exploration outside LEO. The designs will have to cope with increased radiation and space debris levels and provide more volume and facilities as the crew will not be able to rely on immediate Earth-based supplies. New concepts using inflatable modules are under development. Several other complementary capabilities such as human robotic assistance, In-Situ Resource Utilisation (ISRU) and novel power generation and management systems are also being developed.

Life Support and Environmental Control Systems

For more than 20 years, ESA has been developing technologies in all the main life support areas resulting in the flight systems for Columbus, MPLM and ATV. The ISS is being used as a test bed for technologies needed for long duration missions. The Air Revitalisation System ARES is under development and planned to be flown on the ISS. It will provide the first operational demonstration of regenerative air revitalisation for Europe in the form of a complete system. ARES can reduce the re-supply needs of the ISS when operational. In addition the air constituents analyser ANITA has been successfully demonstrated as an operational device on the ISS and is ready to be further developed into an optimised, fully operational ISS system. Further developments are ongoing in the areas of air and water recycling, waste management, food production, contaminant measurement and control. As an example of this the Concordia Station in the Antarctic is used as a test bed for demonstration of such technologies including the recycling of waste water (shower, sink etc.) using the ESA Grey Water Treatment Unit. This system is in itself a complementary technology to the Micro-Ecological Life Support System Alternative (MELiSSA).

Isolation Studies

Human exploration of space will become a reality and the first steps in planning such missions begins with simulating every element of such a mission before it launches. Starting early in 2009 the Mars 500 isolation study in Moscow will help to determine what psychological effects of undertaking a mission to Mars lasting 520 days. Such challenging studies are extremely important in understanding crew interaction and dynamic on such an extensive human spaceflight mission, and can also provide valuable information which can be used for selection procedures for future astronauts.

Bed Rest Studies

In the same way that isolation studies can provide an insight into psychological aspects of human spaceflight missions, bed rest studies (which simulate the effect of low gravity) also provide an important insight into physiological aspects of such missions, and help to test ways of counteracting these physiological effects such as reduced muscle and bone mass as well as cardiovascular effects. In combination with novel exercise equipment, and even artificial gravity through ESA's Short-Arm Human Cetrifuges at DLR and MEDES, there will be enormous medical advancements and long-duration human spaceflight risk mitigation.

Ambassadors in Space: **The European Astronaut Corps**

The important work our astronauts have undertaken acts as a beacon of inspiration to us on a national and European-wide level. The impact of their work is immeasurable, helping to build the ISS, undertaking important scientific and educational programmes and acting as European ambassadors in space. The European Astronaut Corps is a valuable asset for Europe, not only for the individual European countries, but also for our international partners.

The level of enthusiasm shown during the latest astronaut selection campaign in May and June this year, with applications from over 9000 European men and women, from all ESA Member States, showed how inspiring human spaceflight is. These people are the proof that human spaceflight is not only a highly technical and innovation-rich activity, but can still make people dream. They represent not only the individual wish to accomplish something exceptional as becoming an astronaut, but also the dream to participate as a European in future space exploration.

Since being in orbit the ISS has been visited by 12 different European astronauts from seven different nations. These astronauts have played key roles in some of the most important ISS missions including the attachment of the Columbus laboratory and Node 2. The expertise and experience within the European Astronaut Corps has increased dramatically with European astronauts having undertaken operational tasks such as spacewalks for ISS assembly as well as performing various European experiment programmes covering a variety of scientific disciplines whilst on mission to the Station. Two members of the astronaut corps have already been members of ISS Expedition Crews and 2009 will see a member of the European Astronaut Corps becoming the Commander of the ISS. This increasing experience provides Europe with a solid foundation for future human spaceflight endeavours beyond low-Earth orbit.

The members of the European Astronaut Corps are ambassadors for the benefits of spaceflight and not only during their duties while in orbit. ESA's astronauts are a great example to our citizens when participating in countless public relations activities, conferences and scientific lectures, sharing their unique experience with the audience and thus shaping the overall attitude towards science in general and spaceflight in particular.

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