ACADEMIE DE L'AIR ET DE L'ESPACE
AAE
AIR AND SPACE ACADEMY

DGLR
Deutsche Gesellschaft
für Luft- und Raumfahrt
Lilienthal-Oberth e.V.

AIDAA
ASSOCIAZIONE ITALIANA
DI AERONAUTICA E ASTRONAUTICA

# The Opinions


2023 AAE Opinion No. 16 | DGLR Opinion No. 3 | AIDAA Opinion 2023-01 10€

Dépôt légal : septembre 2023

ACADÉMIE DE L'AIR ET DE L'ESPACE
Ancien observatoire de Jolimont
1 avenue Camille Flammarion
31500 Toulouse – FR
contact@academieairespace.com
Tél : +33 (0)5 32 66 97 96
www.academieairespace.com

DEUTSCHE GESELLSCHAFT FÜR LUFT- UND RAUMFAHRT
Lilienthal-Oberth e.V.
Godesberger Allee 70
53175 Bonn – DE
info@dglr.de
Tel: +49 (0)228 308050
www.dglr.de

ASSOCIAZIONE ITALIANA DI AERONAUTICA E ASTRONAUTICA
Via Salaria 851
00138 Rome – IT
info@aidaa.it
Tel: +39 (0)366 1442131
www.aidaa.it

Imprimé par / *Printed by*
EQUINOX
Parc d'Activités Industrielles de Gabor
81370 Saint-Sulpice – France

ISBN 978-2-913331-95-2
ISSN 2426 3931

Cover photo credits: montage photo AAE

# TABLE OF CONTENTS*



* *The English text constitutes the reference version. Executive summaries are provided in English, French and German, and a French version is provided of the full text. No German version is envisaged.*

# EXECUTIVE SUMMARY

This document presents the joint "Opinion" of the Air and Space Academy (AAE), the Deutsche Gesellschaft für Luft und Raumfahrt (DGLR) and the Associazione Italiana Di Aeronautica e Astronautica (AIDAA) on European independence in human spaceflight.

In the past, European astronauts have flown on Russian or American transport systems. Recent geopolitical changes and uncertainties caused by the sudden strategic reorientations of previous partners, the privatization of such critical capabilities and increasing competition are confronting Europe with a crucial but necessary decision: to strengthen European sovereignty by developing its capabilities as a spacefaring player or staying aside as a visitor.

Space-based assets play a key role in the generation and distribution of data, and in ensuring continuous access to information, and are thus fundamental to the digital value chains that are now the indispensable backbone of our societies, economies and communities. Moreover, these assets, including human spaceflight activities, are increasingly becoming an area of strategic positioning for nations, and have strongly boosted technical and technological developments.

A European human spaceflight capability would be another important milestone on Europe's path to reinforcing its role as a strong and influential world power.

Europe has been working on human spaceflight-related programmes since the mid-1980s and has made significant contributions to the International Space Station (ISS) and other crewed missions. The capabilities, knowledge, and technologies thus acquired leave only a small gap to be closed to achieve independent European human access to space.

Throughout these years, ESA has maintained a corps of astronauts. Some 30 women and men have been recruited and have flown more than 60 missions on Soyuz and the Space Shuttle, and more recently the first three missions on Crew Dragon.

The main motivations behind the decision to go ahead with European independence in human spaceflight are:

- to strengthen European sovereignty;
- a strong belief in the underlying economic and societal value;
- to inspire the younger generation, and thus greatly improve its interest in Science, Technology, Engineering and Mathematics (STEM) subjects.

The ISS, including the European Columbus module, has generated a continuous demand for in-orbit experimentation, demonstrating a potential market for private operators. Numerous economic studies support the assumption that the growing activities (return to the Moon, Lunar Orbiting Platform, commercial LEO station, orbital cleaning, manufacturing and maintenance…) will create a strong demand for in-orbit services, similar to the commodity market on the ground. To safeguard European interests in space, independent access, including for its astronauts, should therefore be an essential requirement.

Moreover, there is no other area that can unite Europe more strongly around a very clear and common goal than the establishment of environmentally responsible human spaceflight capability. It will drive innovation that will benefit many other applications and sectors, in space and on Earth.

In the future, space transportation elements will become more reusable. Consequently, the reusability of crewrated spaceships must be in synergy with future fully reusable launcher and in-space transportation capabilities together with other human spaceflight enabling technologies, all in a stepped approach.

European countries have the technological and financial capability to move ahead with this. The question is one of ambition, acceptance of a shared vision and long-term planning, as already presented in various strategic documents (e.g., the “Terrae Novae 2030+ Strategy Roadmap”).

In order to establish an independent European human spaceflight capability, the following key developments are necessary:

- a crew vehicle featuring safety design for all mission phases;
- adaptation of the launch system to integrate the crew vehicle on the launcher;

- a ground segment for crew preparation, access, in-flight operation, and post-flight recovery;
- cargo resupply services, including a cargo return capability, for sustained orbital presence, adding a significant commercial service segment to the exploitation phase.

Development will be phased to ensure early entry into service of the cargo resupply service (e.g., ~7 years), which will form the subsequent basis for the crew vehicle variant (additional ~3 years).

The perception of space activities by our citizens is mainly driven by the huge communication and educational impact of flights by astronauts. Based on the overwhelming public interest in missions of European astronauts in the past, the emergence of an independent European capability would certainly receive strong public support and contribute to developing pride in being European.

When Europe has its own capabilities, it will be able to cooperate and negotiate on a level playing field, whether by freely selecting its cooperation partners – for example by visiting non-European space stations – operating independently, or pursuing some other path that advances European objectives, whatever is best for Europe.

## RECOMMENDATIONS

1. **On the basis of existing capabilities and know-how, and following the very comprehensive "Terrae Novae 2030+ Strategy Roadmap", a European flagship programme should be initiated within the next few years to progressively develop an independent European cargo and human spaceflight capability, in low Earth orbit (LEO) as a first step and later to other destinations.** This first step will ensure independent access to a potential European built and operated station and/or other facilities in low Earth orbit.

2. **It is essential for the stability and success of this programme that it is endorsed by European political and space decision-makers.** In addition to national governments, it should be implemented as a joint ESA-EU initiative involving the European Space Agency, together with the European Commission, and fully supported by the European Parliament and the European Council. In a first phase, ESA should be in charge of developing the programmatic, technical approach and the roadmap.

3. **The technical and operational management of this programme, which requires high-level technical and managerial skills, should be under ESA leadership**, with great attention paid to all safety requirements related to human spaceflight.

4. **The division of roles between the EU, ESA, Member States, industry and research organisations needs to be carefully considered as it will significantly impact the acceptance and costs of such a programme.**

5. **A human spaceflight programme is an exciting prospect for Europe. Designed for the long term and aiming to combine success with efficiency, it will require new procurement approaches and ways of working**, while ensuring the safety standards of human spaceflight.

# 1- INTRODUCTION

The European Space Agenda is constructed over time, stepwise, with regular key rendezvous in which strategic technological and programme proposals, market prospects, the international context, collaboration opportunities, and budgetary capabilities form the basis for deciding on the roadmap and its milestones. One such key milestone is the Space Summit, where ESA and its Member States meet to define high-level strategic orientations. The next Space Summit will take place in Seville in November 2023.

In recent years, there has been a new momentum in human spaceflight, driven by the major space powers and their programming plans. Europe is included in NASA's ambitions but only with a contributing role. However, given the experience gained in Europe over more than 30 years and the challenges posed by the geopolitical context, the question of independent European human access to space has naturally resurfaced.

Given, moreover, that this important question of independent human access to space will be on the agenda of the Space Summit in November 2023, the Air and Space Academy, in collaboration with its partners DGLR from Germany and AIDAA from Italy, wish to contribute to public reflection and debate[1]. This document is the result of analysis and discussion by a team of recognised European space experts.

1 *Other recent relevant papers were the ESA High Level Advisory Group report (ESA Council document of March 2023) and the European Astronauts' Manifesto (Association of Space Explorers - Europe, February 2022).*

# 2- EUROPE'S POSITION IN THE (SPACE) WORLD

The recent pandemic crisis highlighted the reality of global value chains and the related vulnerabilities of being dependent on unilateral resources or product supplies in many areas. The European Union, its Member States and the Commission have decided to undertake a major review of their industrial policy and reassess their dependence on key technologies in various sectors.

We may note that our current economic system, governments, communities, societies and individual needs are entirely dependent on the global digital value chains that have developed rapidly in recent years. Space-based assets play a major role in data generation (of many types) and distribution and in securing continuous access to information with limited vulnerability, due to the distributed nature of such systems. Thanks to large-scale innovation, competition and new business models, space is rapidly becoming an even more important part of the fully digital and high-tech economy of the future.

Space is also increasingly an area of strategic positioning, and this includes human spaceflight activities, which are a powerful driver of technological developments. And yet, despite numerous remarkable achievements in this area, Europe has not yet reached the point of independence. European astronauts have always flown on Russian or American transport systems. This seemed to meet the needs of the past decades, but times are changing. Recent geopolitical changes, uncertainties created by sudden strategic reorientations of partners, the privatization of such critical capabilities and growing competition from emerging space nations is forcing Europe to make a choice: European sovereignty, or long-

term dependence on other nations and foreign companies?

Given the global geopolitical situation, we believe that Europe should systematically choose to become and remain a major, independent space power. This will give Europe full freedom to pursue its own goals and cooperate on equal terms with any other space superpower. Europe has many assets but needs to be proactive and visionary in order to stay in the race in all areas of space and not fall behind other nations.

An independent European human spaceflight capability is affordable, with an acceptable risk level, considering its flight-proven, major technological and system capabilities and product portfolio. This European human spaceflight capability could also become a strong source of "European pride and identity" for its citizens. It would demonstrate in a very visible way Europe's status as a major player in the world in many respects. It is important to show that our social organisation, in which pluralism and individuals count, can deliver ambitious, world-class programmes. Such new developments, paired with a strong communication campaign, will inspire young engineers and researchers, boost the interest of schoolchildren in technical areas of study, and counteract the ongoing drain of talent and technologies to other parts of the world. In addition, spin-off technologies will benefit many European sectors.

Despite the development of large-scale automation in all sectors, human spaceflight will remain a major asset in the development of space applications, due to the complexity of such automated systems. This is also true on Earth, where even the most sophisticated factories need humans to understand and solve certain problems. Human spaceflight systems are closed cycle systems and therefore contribute to understanding sustainability at small scales. Space, energy, and resources are very limited out there in a challenging environment and holistic thinking is required to support life in difficult conditions. As in other areas of space activities, this expertise can be transferred to Earth, for the benefit of European society.

Europe, as a Union, has the competences and resources for such an inspiring endeavour. A European human spaceflight capability would be another important milestone on Europe's path to reassert itself as an influential global power, based on humanistic values, economic strength and respect for international law.

Today Europe is once again at a historic crossroads as it prepares to position

itself in the post-ISS context at the 2030+ horizon. In coming decades, the LEO and lunar surface will become frequent destinations. European cargo and crew vehicles will enable Europe to offer attractive cooperation capabilities on a recurring basis. Without such human spaceflight capabilities, Europe would be limited in its choices as to where it goes, why it goes there and what activities it wishes to perform at destination.

# 3- THE POLITICAL RATIONALE

Robotic and human exploration of our neighbourhood in the Solar System, the Moon and the planet Mars, are the frontiers of the 21st century. As with all great voyages of exploration in the past, those who invest first in the exploration of these "New Lands" will reap strategic and economic rewards. Now is the time for European leaders to decide whether Europe will remain at the forefront of spacefaring nations shaping the future of human exploration or be relegated to the role of junior partner or even mere spectator for decades to come.

Space is today a domain for the projection of global-scale ambitions: after the United States, Russia and China, India will soon be able to put humans into space and the number of nations planning to engage in spaceflight is increasing steadily.

Space programmes in general, and human spaceflight in particular, have a unique ability to inspire. Seeing their fellow humans working and living in space, achieving what was once considered "impossible", is one of the most powerful motivators for the younger generations. It shows young Europeans that they can be anything they want, if only they dare to dream ambitiously, becoming the scientists, engineers and explorers of tomorrow.

If European leaders decide to remain on the sidelines, the cost of inaction in space exploration will be huge, both strategically and economically, just as it would be if we stopped investing in other areas of major strategic importance such as electronic components, artificial intelligence or energy transition.

If we miss this opportunity to remain in the premier league of spacefaring nations, we will have to continue to procure human space transportation and

access to orbital inhabited facilities from other players, with no guarantee that our needs and values will be a priority. As a result, we will miss out on opportunities to participate in the new economy that is developing today in low Earth orbit, and will merely be paying customers in a position of weakness, repeating the mistakes of the past in other strategic areas, which left us dependent on external players for our energy needs for instance.

In short, if Europe is to remain a credible player on the world stage, it must be present with its own capabilities in the field of human spaceflight operations. This includes the capability to launch humans into low Earth orbit and beyond, as well as to operate human-rated space vehicles and stations built and controlled in Europe. Without such a demonstrated capability, Europe will remain a minor player in human exploration of the Solar System and in the exploitation of new space-based services in low Earth orbit and beyond.

The perception of space activities by the average citizen is largely driven by the huge communication impact of flights by astronauts. Based on the overwhelming public interest in past missions of European astronauts, the emergence of an independent European capability would certainly receive strong public support. European crews travelling in space by European means, talking to planet Earth in many different languages, would inspire a sense of cohesion and pride.

Investing in a European human spaceflight programme will give a significant boost to the European economy and science. The unique requirements of human-rated spaceflight systems will create high-quality jobs in science and engineering as well as new technologies with a high potential for spin-offs in non-space sectors. One of the most important arguments is the huge potential to inspire the younger generation and significantly increase its interest in Science, Technology, Engineering, and Mathematics (STEM). Our grandchildren and their children will be motivated to pursue education in these fields, avoiding a brain-drain of young talent to other parts of the world.

As China has shown with its impressive space achievements, space capabilities are a new form of soft power. Having its own European human spaceflight capabilities will also give Europe more options for cooperation with other nations and increase its international leverage. When Europe has its own capabilities, it can negotiate on a level playing field, either to cooperate with others, for example by rendezvousing and docking with non-European space stations, or to go it alone, whichever is best for Europe. In

addition, having an independent human spaceflight capability offers new options for barter agreements and makes Europe an attractive partner for cooperation.

Finally, having several systems in the world with different but interoperable capabilities makes human spaceflight more robust and safer by providing redundancy in case of failure or temporary disruption in one system.

# 4- EUROPE'S JOURNEY INTO HUMAN SPACEFLIGHT

Since the mid-1980s, Europe has made various efforts to enter the human spaceflight regime. All these initiatives need to be seen in the context of Europe's activities in the development and exploitation of launchers, its involvement in human spaceflight programmes with international partners, as well as in the context of larger (geo)political developments inside and outside Europe.

In 1987, the ESA Council at Ministerial level in the Hague decided to initiate the Ariane 5 programme together with the first steps in the development of the Hermes spaceplane and a "Man Tended Free Flyer" (MTFF). It should be noted that there was a real enthusiasm for independent human access to space among almost all participants at this time. The initiative to use a larger winged, shuttle-type vehicle instead of a capsule was supported mainly because of some technical and operational advantages.

The ambition of supporting in parallel the large development programmes for Ariane 5, Hermes and MTFF, coupled with the emerging economic constraints of several Member States in 1990, led to the abandonment of Hermes and MTFF at the Ministerial Council in Granada in late 1992.

However, based on previous studies and developments carried out during the Hermes and MTFF activities, Europe decided in 1995 in Toulouse to participate in the ISS programme. Elements of this participation were the development of the "Columbus" laboratory module, based on the MTFF, to be permanently docked to the ISS, and the development of an uncrewed supply vehicle, the ATV (Automated Transfer Vehicle). Both elements, compliant with all human safety requirements, were intended to offset the joint operating costs of Europe's participation in the ISS programme.

Construction of the ISS began with the launch of the Russian-built FGB in November 1998, followed by the docking of the first US element, the Node-1, a few weeks later, and the first habitat, the Russian Zvezda module, in July 2000. Since November 2000 the ISS has been permanently inhabited and has seen its crew size increase over time.

Following the resumption of Shuttle flights after the tragic Columbia accident in February 2003, ISS assembly recommenced and Columbus was docked to the station in February 2008. From March 2008 to February 2015, five European-built Automated Transfer Vehicles (ATV) delivered more than 30 metric tons of supplies to the ISS. To date the ATV is the largest spacecraft to deliver cargo and services to the station. With a yearly cadence, European industry has demonstrated its reliability in the repetitive production, launch and operation of its cargo spacecraft. In all its missions, the ATV has demonstrated remarkable accuracy in autonomous rendezvous and docking, and a unique capacity to perform boost manoeuvres on the 400-tonne ISS. ATV development demonstrated the ability of Europe to design complex / automated systems fulfilling all safety requirements applying to human spaceflight; features required to ATV, to be authorized to dock to the inhabited ISS. This has been seen as an outstanding success by NASA's administrator in 2008, who stated "*Europe has demonstrated its ability to perform human-rated flights*" the day after the first docking.

Notwithstanding the fact that the ATV-programme was very successful and highly recognized by Europe's international partners, the recurrent production and operation of ATV to offset ISS joint costs proved to be of little interest to ESA Member States and their industry. During the ESA Ministerial Council in 2008 in The Hague it was therefore decided to start studies for an ATV-evolution towards a cargo-download system (ARV – Automated Re-entry Vehicle), and later towards a human-rated system, the Crew Transport Vehicle (CTV) for a three-person crew.

During the 2012 Ministerial Conference in Naples, it was decided to develop Ariane 6, halt the ATV evolution towards a crew transportation vehicle and instead to build a service module for NASA's Orion capsule, which is today one of the European contributions to the US-led Artemis-programme.

Europe has also been active in various activities and studies related to human spaceflight programmes, such as the very successful ARD (Atmospheric Re-entry Demonstrator), which flew on the third

Ariane 5 flight. ESA, together with some national agencies, also participated in the NASA X38 (Crew Rescue Vehicle) programme, directly derived from the aerodynamic shape of Hermes, which was cancelled by NASA in 2002 due to funding issues in the ISS programme. Other European – ESA and non-ESA – projects such as IXV and its follow-on Space Rider programme, the Unmanned Service Vehicle (USV) and others also contribute to the European capabilities needed for human spaceflight.

Throughout these years, ESA has maintained a corps of astronauts, with the necessary procedures and tools for their selection and training. Some 30 women and men have been recruited and have flown more than 60 missions on Soyuz and the Space Shuttle, and more recently the first three missions on Crew Dragon. They have notched up more than 3,400 days on board Mir and the ISS. The technical and operational experience Europe has accumulated through its astronaut corps is an invaluable asset, not only for continuity of scientific utilization, but even more so for the development of European capabilities in the field of human space flight. There is a strong consensus between the Member States about the funding of their astronaut corps, which has always been highly appreciated by the public.

However, in the absence of a European human transport capability, some European states are considering buying flight opportunities for their astronauts from commercial providers in the US.

This summary demonstrates the technological knowledge and operational capabilities acquired by Europe in the past. It has never given up on human spaceflight, sending its astronauts on cooperative missions, and has developed a very efficient, multidisciplinary scientific community that uses space as an environment for research. However, it has never dared, since the abandonment of Hermes and MTFF, to embark on an autonomous human spaceflight programme! If we compare Europe with the space powers that are autonomous in human spaceflight – Russia, the United States, China, and soon India –, we realize that the high-level political support and the decision-making mechanism in Europe are very different from those of monocephalic powers. Experience shows that human spaceflight is a great opportunity to boost "*national pride and identity*" at the European level, given that such an endeavour is made possible thanks to such a large Union. Times are changing rapidly in Europe: the European doctrine and budgetary perspectives have recently evolved in the face of unexpected new challenges, integrating concepts such as

European defence as well as new funding instruments. In such a transformational context, the time is ripe to reconsider positively the question of independence in human spaceflight and Europe's motivations in opting for it.

# 5- ECONOMIC MODELS AND PROSPECTS FOR THE SPACE ECONOMY AND BENEFITS FOR HUMANITY

The main motivations behind the decision to strive for European independence in human spaceflight are:

- to enhance European sovereignty;
- a strong conviction of economic and societal value;
- to inspire the young generation and increase their interest in Science, Technology, Engineering, and Mathematics (STEM).

At present, the global space economy is still clearly institutionally driven.

The notion of a value chain must therefore be seen in a strategic context with long-term ambitions. NASA has systematically promoted national competition through various initiatives, be it the earlier "*faster-better-cheaper*", or later commercial transport service. The US Commercial Crew Programme represents a revolutionary approach to government and commercial collaborations for the advancement of space exploration. The need centres around a safe, reliable, cost-effective means of transporting humans to low Earth orbit and returning them safely to Earth. The private companies own and operate their hardware and infrastructure, thus constituting a new model being implemented for the first time.

In total, NASA has awarded more than $ 8.2 billion in contracts resulting in the Commercial Crew Transportation Capability. NASA's Strategic Goal 2.13 directs the agency to "*lay the foundation for America to maintain a constant human presence in low-Earth orbit (LEO) to be enabled by a commercial market*". The vision of an orbital marketplace is emerging.

For Europe, the challenge is independence of action and sovereignty. If Europe remains dependent on foreign key ena-

bling capabilities, European industry may be blocked from developing and innovating in various parts of the value chain. Independence of action and sovereignty guarantees access and experimental capabilities independent from any other partner, while it does not and cannot preclude cooperation and mutual support in an international partnership. Moreover, independence in human spaceflight would support functional redundancy in such international endeavours and enhance interoperability at high programmatic levels.

The ISS, including the European Columbus module, has generated a continuous demand for in-orbit experimentation, demonstrating the potential market for a private operator. The results of this more fundamental type of research fuel later innovations and applications. Independent access should therefore be an essential requirement as Europe will need access to future European modules on a new station or even an independent station.

Space resources will be a major topic of activity internationally over the next decade and may become a major motivation for future investment in space exploration. This is a highly interdisciplinary and innovative field in which there is growing interest internationally, in space and non-space industries alike, in science and academia and in the public sector.

Some links also exist between the development of space programmes and the improvement of human welfare. Some space technologies have been directly transferred to the ground, and many dedicated developments have resulted in beneficial spin-off technologies finding their way into our daily lives. Such impacts are as yet unmeasured even though they benefit many sectors.

Numerous economic studies support the assumption that the growth in such institutional activities (return to the Moon, Lunar Orbiting Platform, commercial LEO station, cleaning of orbits, manufacturing, and maintenance…) will create a demand for in-orbit services like the commodity market on the ground.

# 6- ONE SMALL STEP BEFORE A GIANT LEAP FOR EUROPE

## 6.1. Competitiveness and innovation

A European Crew Vehicle programme can be expected to generate strong enthusiasm among European citizens. Furthermore, Europe's younger generations have developed a strong concern for climate change and biodiversity issues. The Crew and Cargo capability programme should therefore reflect the values of the European Green Deal and extend to all kinds of enabling infrastructures and systems. No other area can federate Europe more strongly around a very clear and common goal than the establishment of eco-responsible human access to space. It will drive innovation that will benefit many other applications and sectors, in space and on Earth.

- **Innovation for sustainability and competitiveness**: if done intelligently, such a new European capability will benefit from and accelerate significant synergies for improved competitiveness through reusability and the promotion of sustainable and eco-responsible technologies.
- **Reusability for competitiveness**: on a global scale, the reusability of space transportation elements will increase significantly. Consequently, cargo and crew reusability must be in synergy with full reusability of launchers and in-space transportation in the future, in a stepped approach. A virtuous circle must be established for the benefit of total cost of ownership through a profitable business model when operating the service.
- **Human spaceflight has always driven the development of robust, efficient technologies** that have benefited many other applications. Reliability, health monitoring, materials research and reusability all point in the same direction. Furthermore, by investing in eco-responsible technologies, return on

investment will be felt throughout the space sector and beyond.

- **New ways of working and governance**: the establishment of such a new European service challenges the Union to implement new ways of working between its industry and institutions, between its start-ups and larger groups, taking advantage of each other's strengths. Furthermore, by taking a service approach, commercialization will be at the forefront from the very start of the programme.

## 6.2. Facilitating possible future applications further down the line

The use of orbital infrastructures in low Earth orbits will bring significant benefits in the coming decades. In addition to the deployment of mega-constellations, it is likely that very large space infrastructures will deliver a new quality of Earth observation, process data and potentially enable space-based solar power stations. Such very large space infrastructures will need to be assembled and operated. And as we know on Earth, even the most highly robotized factories (e.g., automotive), data centres, scientific outposts and offshore platforms (oil rigs) need highly specialized operators to solve problems and support manipulation, in this case in orbit. European society can only participate in the future of human and robotic collaboration in space if Europe has its own capability to provide the logistics for such resupply and human operators. Otherwise, Europe will be sidelined, possibly acting as a low-level supplier. Even if such applications are a little further in the future, Europe needs to lay the groundwork today, because others outside Europe are already moving fast.

## 6.3. Fundamentals for a robust programmatic approach

Europe benefits from a strong human spaceflight heritage built up over the last four decades. High reliable space programmes are in our DNA, and this is recognized worldwide. NASA relies on Europe for key pressurized modules for the ISS and a part of its resupply fleet.

We can estimate the cost of implementing such a European sovereign capability, but we cannot estimate the cost to the European eco-system of not possessing it in the future. This is the so-called "*cost of inaction*", which can be easily illustrated by the increased loss of competitiveness of European contributions to human spaceflight, whatever the destination, dependence on other nations for large space infrastructures and astronaut access, with consequences for launch ticket prices and sensitive/strategic

payloads. The risk to European society of the latter clearly outweighs the cost of developing a European human and cargo space transportation service as well as the relevant target outposts.

European countries have the technological and budgetary capacity to move ahead with this (the EU has the third largest economy after the US and China): it is a question of ambition, shared vision and long-term planning. The creation of such a capability will greatly increase Europe's opportunities, the European astronaut corps will gain in diversity, secure accessibility of scientific and industrial importance and will be able to play the role of European ambassadors, inside and outside our borders, participating in the forging of a European identity.

In addition, as stated earlier, no other space issue will attract more of our own talented engineers and scientists in Europe than the eco-responsible development of human spaceflight. Europe risks losing such talent to overseas destinations if we lack the kind of vision they can find elsewhere. Know-how is linked to people working on new developments and a highly talented workforce will make the difference to Europe's competitiveness and position in the world.

Finally, there is no problem coming second or third to a market. Europe has not always been the first to succeed. Just look at Boeing vs Airbus, when Airbus was just starting out in the 1970's and where it is today as the market leader. When Ariane first flew in 1979, the US was already ready to fly the reusable Space Shuttle. Europe is now a leader in Earth observation and commercial telecommunications satellites. Europe has repeatedly demonstrated a strong capacity to deliver high-tech products on limited budgets thanks to our highly skilled and talented workforce, and we believe that we can do the same in human spaceflight.

## 6.4. A European vision and how to implement capabilities

Given the programmatic context and the ambitions of global actors, Europe should adopt an incremental approach over the next 10 to 15 years. Mid-to long-term, the European vision is to design, build and operate its own infrastructure in LEO and beyond. To make this vision happen, the following incremental approach is proposed:

- develop a cargo return capability;
- develop the capability to launch independent European crewed missions to LEO;
- integrate this independent cargo and crew transport capability in global framework of European space infra-

structures in LEO (stations, hubs, constellations,…).

- capitalising on the independent crew and cargo access to LEO, significant contributions to cargo and crew missions to the Moon could represent European participation in a large-scale exploration programme.

To establish a European human spaceflight capability, the following key developments are necessary:

- a crew vehicle which must feature a safety concept for all phases of the mission, from launch (i.e., crew rescue system in case of a launch anomaly), orbital flight, re-entry and landing concept for the safe recovery of the crew;
- adaptation of the launch system to integrate the crew vehicle on top of the launcher, including a launcher health monitoring system to trigger safety systems when needed;
- a ground segment for crew preparation, access, emergency egress, in-flight monitoring/operation, and post-flight recovery as well as crew recovery measures in the event of an in-flight abort;
- a European designed, built and operated human-tended outpost in LEO, for science, research, Earth observation, maintenance operation for infrastructure and other applications;
- European Crew and Cargo transport capabilities beyond LEO.

As a precursor to crew access, it is also essential to provide cargo resupply and return services for a sustained orbital presence adding a significant commercial service segment to the exploitation phase. To maximize the benefit for a crew vehicle, to ensure its economic sustainability, and to exploit synergies, the concept should build upon a cargo vehicle.

The overall development costs are currently being investigated as part of ESA's ongoing "Inspirator on Human and Robotic Space Exploration" studies. Dedicated design approaches for segregation of safety features between the launch system and the crew system and capitalising on existing European technologies will allow for cost minimisation. The development will be phased to ensure an early entry into service of the commercial cargo resupply service (e.g., ~7 years), which will then form the basis for the crew vehicle variant (additional ~3 years).

# 7- LESSONS LEARNED

Since Europe's first major attempt to develop a transport capability for astronauts into low Earth orbit, a considerable human spaceflight heritage has been built up. Based on this long experience, a number of high-level lessons can be identified, that will hopefully contribute to eventually establishing such a capability in the future.

## 7.1. Resilience against "disruptive" political developments in Europe (and beyond)

The fate of the Hermes and MTFF programmes was certainly influenced by the financial and economic constraints of several Member States.

Today we are facing the consequences of climate change, the challenges of ensuring sustainable energy supplies, and a war in Eastern Europe – once again with undeniable financial, economic, and societal consequences.

Political and economic circumstances can always be used to justify putting off development of a human spaceflight capability. However, the long-term benefits for the advancement of science and technology, the political perspectives of peaceful collaboration around the globe, and the cultural advantages of inspiring and fostering the interest of the younger generation in STEM subjects should always be seen as contributing elements to offsetting such disruptive developments, well beyond the apparent situation.

## 7.2. Availability of an exploration strategy roadmap "Terrae Novae"[2]

Since the beginning of the last decade, ESA, together with its Member States,

2 *Terrae Novae 2030+ Strategy Roadmap : https://esamultimedia.esa.int/docs/HRE/Terrae_Novae_2030+strategy_roadmap.pdf:*

has been progressively developing an exploration strategy. In 2022, this process led to the "Terrae Novae" strategy roadmap, which provides a clear, in-depth vision of Europe's exploration destinations, scientific, technological and societal goals, and the role that Europe can play in this area in the coming decades.

While human spaceflight is not a "*sine qua non*", this paper clearly indicates the significant impact a European human spaceflight capability would have on the achievement of these strategic goals. Likewise, space agencies around the world have been exchanging their programmatic plans and visions for human space exploration and developing their own (national) roadmaps/strategies. However, to date "Terrae Novae" is the first and only strategic document of its kind, based on a general consensus of Member States and shared by the countries of one of the world's largest economic regions.

## 7.3. Public support

Public awareness of the direct benefits of space applications is steadily increasing. Similarly, images of high-tech activities, specifically involving space and especially astronauts, are increasingly being exploited in all areas of our society (advertising, education, high-tech companies, "new Space" etc.). While the immediate public interest in ESA missions to the ISS tends to peak in the astronauts' country of origin and is linked to their missions, the general awareness of European astronauts and their careers usually lasts well beyond their missions. Although studies to quantify the immediate effect of European human missions on the choices of the young generation in STEM careers are as yet limited, the correlation is widely acknowledged. By analogy with comparable situations, we are convinced that public support in Europe for human spaceflight will be overwhelming.

## 7.4. The need for sustained high-level political support from the majority of European countries

A commitment to human spaceflight will be an activity over decades, rather than years. It will not end with one, or maybe a few, demonstration flights, taking astronauts safely into space and back. The maiden flight of European astronauts will be the starting point for a long-term, repetitive and active role in space. Such an endeavour can only succeed with long-term, high-level political support from European countries, their space agencies, ESA, and the EU.

# 8- IMPLEMENTATION

An independent European human spaceflight programme represents Europe's desire to play its rightful role as a major power in the long term, in the face of the United States, China, Russia, and rapidly emerging India. It will also help bring together and unite European citizens and nations around a common European goal. It is therefore logical, indeed essential, that this programme be supported by all major European political and space decision-makers. So, in addition to the presence and decisive involvement of national governments in the governing bodies of the respective entities, it should be implemented as a "Joint ESA-EU initiative". The European Space Agency, together with the European Commission, fully supported by the European Parliament and the European Council, will be the owner of this endeavour. Similar cooperation forms the basis of other major European space programmes such as the Galileo satellite navigation programme and the Copernicus European Earth observation programme, for the benefit of a strong European sovereignty. Consultation and co-ordination shall be organised among all stakeholders to exploit synergies and to make an implementation as effective as possible. In a first phase, ESA, having taken the initiative, should be in charge of developing the programmatic, technical approach and the roadmap.

The funding for such a human spaceflight programme resulting in a new European capability, at least in the early years, can only come from the public budgets of European states. This budget should come on top of the existing financial budget lines for European space programmes. This applies to the development of ground and flight infrastructures. In the later exploitation and operational phases, potential contributions could

come from cargo missions or possibly later human service missions. PPP (Public Private Partnerships) will not apply to these initial phases. Past experience, such as with Galileo, shows that such models are difficult to implement when the tentative commercial market prospects remain highly speculative.

As in the cases of Galileo and Copernicus, the winning perspective is to combine the best of the two entities involved in the European space programme to make such an ambitious programme a reality. ESA and the EC have complementary governance principles which together provide a strong toolset needed for such an ambitious goal. Combining forces will allow the efficient management of complex development programmes with a rapid response capability, while ensuring a long-term political and budgetary perspective for a stable exploitation/operational phase.

The technical and operational management of this programme, which requires high-level technical and managerial skills, should be under ESA leadership, with great attention paid to all safety-related requirements, since human spaceflight puts astronauts' lives at stake. The public side will of course be the project owner, responsible for the overall coherence of the programme and its main components. The division of roles between the Agency, industry and academia needs to be deepened as it is a major driver of the cost of such a programme. For example, the United States' space agency, NASA, which receives full delegation from the state to conduct all human spaceflight programmes, has in recent years allowed industry-led developments for ISS servicing, leading to significantly lower development and operational costs, while maintaining the lead in flight/astronaut safety. Such an approach should also be considered in Europe, at least at the level of the main elements of such a programme.

Beyond the development of human spaceflight systems, there is the question of their subsequent operation during the successive missions of European astronauts. Certainly, the already highly skilled space operations units from ESA and the European national agencies, involved in Columbus or ATV operations for example, should be able to carry out programmes of this nature. Nevertheless, here too, greater industrial responsibility for developments should be accompanied by an industrial role in the operation of their systems. The key to the long-term success of such programmes will be to optimise "full life cycle" budgets whilst ensuring the highest safety standards.

All in all, a human spaceflight programme is an exciting prospect, but also a challenge for Europe. Designed for the long term and combining success with efficiency, it will require new procurement approaches and ways of working, without reducing the safety standards of human spaceflight. Such revised approaches and roles will strengthen the responsibility of industry and reduce programme lead times and costs. ESA itself also needs to prepare for this new role, in terms of managerial and technical competence. For example, managing the end-to-end operational aspects involving the astronauts means taking on responsibilities that have never before been handled at the European level.

# 9- RECOMMENDATIONS

1. **On the basis of existing capabilities and know-how, and following the very comprehensive "Terrae Novae 2030+ Strategy Roadmap", a European flagship programme should be initiated within the next few years to progressively develop an independent European cargo and human spaceflight capability, in low Earth orbit (LEO) as a first step and later to other destinations.** This first step will ensure independent access to a potential European built and operated station and/or other facilities in low Earth orbit.

2. **It is essential for the stability and success of this programme that it is endorsed by European political and space decision-makers.** In addition to national governments, it should be implemented as a joint ESA-EU initiative involving the European Space Agency, together with the European Commission, and fully supported by the European Parliament and the European Council. In a first phase, ESA should be in charge of developing the programmatic, technical approach and the roadmap.

3. **The technical and operational management of this programme, which requires high-level technical and managerial skills, should be under ESA leadership**, with great attention paid to all safety requirements related to human spaceflight.

4. **The division of roles between the EU, ESA, Member States, industry and research organisations needs to be carefully considered as it will significantly impact the acceptance and costs of such a programme.**

5. **A human spaceflight programme is an exciting prospect for Europe. Designed for the long term and aiming to combine success with efficiency, it will require new procurement approaches and ways of working**, while ensuring the safety standards of human spaceflight.

# 10- CONCLUSION

Space has become an indispensable element of our modern societies, vital to the functioning of our economies and the public awareness of our planet Earth. The "human element" in spaceflight, i.e., the ability to send our own species into "unknown territory", remains linked to our innate desire to explore and learn, and combines rational/utilitarian and emotional reasoning. No other discipline in the field of spaceflight incorporates scientific, economic, political and cultural aspects in this way. The ability to put humans into space and to live and work there is a prerequisite to achieving all our exploration goals.

An analysis of the many aspects to be considered in the context of the strategic decision on independent human access to space for Europe leads to the following synthesis: for Europe this decision is part of the broader question of Europe's future role in the world. Remaining a global power relies on also being a space power, and human spaceflight is an important element of this capability.

Europe has already taken most of the necessary steps towards this goal. The few remaining hurdles are limited in terms of risks and costs. Europe has the technological and budgetary capability to get there. Implementation should be collaborative between ESA and EU, and innovative between the public and private side of the economy. Both will ensure sustainability and affordability in the long run.

A step-by-step approach is encouraged to align visible progress with budgetary milestones. This will guarantee, at a very early stage and where deemed to be in the European interest, a level playing field in some of the ongoing international initiatives.

The decision is clearly a political one, capable of fostering a truly European sense of pride in its citizens, of inspiring its youth and motivating talents to help build European sovereignty while securing major areas for future economic and strategic development. This would seem to be well worth the effort!

# ANNEX:
# MEMBERS OF THE WORKING GROUP

- Jürgen Ackermann – president – (AAE and DGLR)
- Christophe Bonnal (AAE)
- Gérard Brachet (AAE)
- Alain Charmeau (AAE)
- Bernard Comet (AAE)
- Philippe Couillard (AAE and DGLR)
- Michel Courtois (AAE)
- Éric Dautriat (AAE)
- Hervé Gilibert* (AAE)
- Ralph Jaeger (AAE)
- Rolf Janovsky (DGLR)
- Franco Malerba (AAE)
- Claude Nicollier (AAE)
- Maria Antonietta Perino (AAE and AIDAA)
- Thomas Reiter (DGLR)
- Michel Vedrenne (AAE)
- Philippe Watillon – secretary – (AAE)

**Represented by Joost van Tooren for lack of availability.*

ACADÉMIE DE L'AIR ET DE L'ESPACE
Ancien observatoire de Jolimont
1 avenue Camille Flammarion
31500 Toulouse – France
contact@academieairespace.com • Tel: +33-(0)532 669796
www.academieairespace.com

DEUTSCHE GESELLSCHAFT FÜR LUFT- UND RAUMFAHRT
Lilienthal-Oberth e.V.
Godesberger Allee 70
53175 Bonn – Germany
info@dglr.de • Tel: +49 (0)228 308050
www.dglr.de

ASSOCIAZIONE ITALIANA DI AERONAUTICA E ASTRONAUTICA
Via Salaria 851
00138 Rome – Italy
info@aidaa.it • Tel: +39 (0)366 1442131
www.aidaa.it


ISBN 978-2-913331-95-2
ISSN 2426 3931

10 €