2nd EUROPEAN SPACE GENERATION WORKSHOP

REPORT

SPACE GENERATION
ADVISORY COUNCIL


2ND EUROPEAN-SGW
24/25TH MARCH 2017 PARIS

Executive Summary

Paris—one of the world's most inspirational cities—offered a memorable stage for the 2nd European Space Generation Workshop (E-SGW) and a truly global platform for high-level discussions and exchanges. The city of light still is a must-see destination that everyone should visit at least once in their lives.

The 2nd E-SGW was held on Friday and Saturday 24th and 25th March 2017. The ideal place to debate about space activities and opportunities, selected by the local organising team, is the European Space Agency (ESA) headquarters. In fact, ESA is used to organising wide-reaching events, for example workshops, conferences, councils, and has the adequate facilities to receive such a workshop. And what is a better place than the heart of European space policy to welcome the future space leaders?

With the success of the SGAC annual conferences focusing on global deliberations, the need to develop a regional workshop with the primary aim of discussing regional space initiatives and activities has become increasingly important. SGAC therefore launched its regional workshop series, the Space Generation Workshops (SGW).

The main goals of the E-SGW are:

1. To strengthen the regional network of the students and young professionals in the European region;

2. To examine and consider key questions in Europe that the regional space community is facing and to provide inputs from the next generation of space professionals; and

3. To allow tomorrow's space sector leaders in the European region to have the opportunity to interact with today's space leaders in the region through cooperation with ESA.

Among others, the young professionals and students attending the workshop as delegates were able to discuss specific topics within their four Working Group: Space Diplomacy kindly sponsored by ESA, Space Accessibility kindly sponsored by DLR, Space Exploration kindly sponsored by CNES, and Space Economy kindly sponsored by ASTECH.

The organisation of the workshop has been led by a solid local organisational committee and the precious help of the SGAC, and was supported by main actors in the space sector in Europe and in the world.

The Space Generation Advisory Council in support of the United Nations Programme on Space Applications is a non-governmental organisation, which aims to represent university students and young space professionals at the United Nations, states, agencies, industry, and other space sector organisations. SGAC was conceived at the Third United Nations Conference on the Exploration and Peaceful Uses of Space (UNISPACE III) in Vienna in 1999 and has permanent observer status in the UN Committee on the Peaceful Uses of Outer Space (COPUOS). SGAC's focus is on pragmatic space policy advice to policy makers based on the interests of our worldwide network of university students and young professionals, roughly between the ages of 18 and 35.

The workshop offered the chance for SGAC to gain visibility at the European and French level. SGAC offered its delegates to connect the beauty, the symbolism, and the global influence of the city of light to the power of space.

Sponsors and Partners

The 2nd European Space Generation workshop was made possible by the generous support of many sponsors and partners.

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Letter from the SGAC Chairs

Dear E-SGW delegate,

We are excited to welcome you to the 2nd European Space Generation Workshop! If this is your first SGAC event, then welcome to the SGAC community as well.

The Space Generation Workshop series started with the aim of providing an opportunity to our members to share regional perspectives on space activities, and we are pleased to see these efforts grow. The E-SGW 2017 team has worked hard in the past few months to bring you an event with a great programme. Their goal was to enable you not only to share your views with industry leaders, but also to make new connections along the way.

We hope that you make use of the great speakers and moderators present at the event, along with the presence of colleagues with diverse backgrounds to fill in the gaps in your knowledge. We believe that you will be able to develop new ideas that could help scope the future of space activities in Europe and beyond. Of course, SGAC is not just about knowledge but also about people—we hope that the social events organised as part of E-SGW 2017 help plant the seed for strong lasting relationships, and foster new collaborations.

This event is the culmination of the hard work of an amazing team, a team which has been working tirelessly on this event for over six months. Please be sure to thank Caroline, Florian, and their team for their hard work and dedication to making this event happen.

Ad astra,

Stephanie and Ali

Letter from the Event Managers

Dear E-SGW delegates,

It is a great honour to be able to welcome all of you at the headquarters of the European Space Agency in Paris. The 2nd European Space Generation Workshop aims to offer you an opportunity to connect with the beauty, symbolism, and global influence of the city of light to the power of space.

In 2015, ESA celebrated the 50th anniversary of Space Cooperation in Europe. France, as one of the founding members, has a long experience with international partnerships within the space sector. Being a cornerstone for European space activities and of historical importance in the global sector, France, and more specifically its beautiful capital, Paris, is a legitimate host for the 2nd European Space Generation Workshop.

Thank you all for taking on your long way to Paris: for SGAC newcomers, may this be a first step to discover a whole new world of space; for SGAC regulars, may this be a further incredible step of your space journey.

In today's connected world, you all have probably met each other through social media channels already, but we strongly advise you to take all and every occasion to grow, learn, and network during the next two days, to strengthen and deepen your network of space enthusiasts.

The biggest thank you goes of course to our amazing organising team who has worked extremely hard in the last months to make the 2nd E-SGW possible!

Event Overview

The 2nd European Space Generation Workshop was a two-day regional workshop for university students and young professionals with a passion for space. It was held at ESA headquarters in Paris, on the 24th and 25th March 2017. ESA kindly offered the venue at its headquarters in Room A, the meeting room of the ESA council. The city of light offered an ideal setting for the 2nd E-SGW, enlightening high-level discussions and exchanges.

The main goals of the ESGW are:

▪ to strengthen the regional network of the students and young professionals in the European region;

▪ to examine and consider key questions in Europe that the regional space community is facing and to provide inputs from the next generation of space professionals; and

▪ to give tomorrow's space sector leaders in the European region the opportunity to interact with today's space leaders in the region through cooperation with ESA.

96 delegates, university students and young professionals under 35 years old in the European region participated through a series of workshops, panels, and guest presenters. Working Groups addressed the following topics:

Space Economy: discussing the structure, its size, its contribution, and its evolution to the space the global economy.

Space Accessibility: discussing the state of the market, upcoming changes, and ongoing development in the launch sector.

Space Diplomacy: discussing the role, the use, and the potential of space in international relationships.

Space Exploration: discussing the future of space exploration in terms of destination, architecture, and partnerships.

E-SGW is a unique opportunity for up and coming space sector leaders to contribute with their opinions to the regional space sector policy. Additionally, E-SGW provides the optimal forum to network with other future space leaders, as well as to develop the necessary leadership and team collaboration skills to rise to the top.

Event Highlights

Panel Discussion, Heads of NGOs: Diversity in the Space sector – Unlocking Global Potential

The space industry faces some of the most challenging problems that require constant innovation and new ways of approaching tasks. The future of the industry requires organizations to attract, develop, mentor, and retain the next generation of global leaders at all levels of organizations. Additionally, as the number of smaller countries and private actors join the space industry, the case for greater diversity becomes more compelling. NGOs are taking a lead in this initiative by implementing programmes that proactively encourage a wide range of members from all walks of life, geographical locations, academia, and gender as an integral and exciting next step in shaping the future of the space industry.

Minoo Rathnasabapathy, SGAC Executive Director, led the discussions among Jean-Yves Le Gall, President of the International Astronautical Federation (IAF); Kai-Uwe Schrogl, President of International Institute of Space Law (IISL); Jean-Michel Contant, from the International Academy of Astronautics (IAA); and Stephanie Wan, Chair of SGAC.

Cultural night

The Cultural Night brings together E-SGW delegates from around the world to share some of their culture with each other. Delegates are highly encouraged to wear their country's traditional costume or casual attire, and to bring foods or drinks of their region to share. The evening includes performances and presentations by the E-SGW delegates about their country's culture and traditions.

Closing Dinner

The E-SGW Closing Dinner took place on the boat Le Saphir of Les Bateaux Parisiens. Delegates enjoyed dinner while cruising along the Seine, passing by the Eiffel Tower, the Notre-Dame cathedral, le Grand Palais, and many more historical buildings. A glamorous way to end the 2nd E-SGW!

Paxi

The ESA Education mascot Paxi joined the workshop on 25th March 2017.

Speakers and Subject Matter Experts

Participants of the second European Space Generation Workshop had the opportunity to engage with experts from across the space community, ranging from high-ranking agency officials to experienced industry professionals.

Keynote & Invited Speakers

Jean-Yves Le Gall | *President of CNES and IAF*

Jean-Yves Le Gall has been the president of the Centre National d'Etudes Spatiales (CNES), the French space agency, since 2013. He is the Interministerial Coordinator for satellite navigation programmes and Chair of the Administrative Board of European Global Navigation Satellite Systems Agency (GSA). He is also co-chair of the Council of ESA and President of the IAF.

Claudie Haigneré | *Senior Advisor to ESA's Director General*

Claudie Haigneré has been a senior advisor to the ESA Director General since April 2015. She became the first European woman astronaut candidate in 1985 and started her training in Star City (Russia) in 1992. She spent 16 days as a research cosmonaut on board the Mir space station during her Cassiopée mission in 1996. She joined the European astronaut corps in 1999 and the same year she became the first woman to qualify as a Soyuz Return Commander. She performed her second space mission on board the International Space Station (ISS) in 2001, which lasted ten days.

Jean Michel Contant | *Secretary General of IAA*

William Ricard | *Senior Associate at PricewaterhouseCoopers (PwC) France*

William Ricard is Senior Associate in the Space consulting team (public sector) of PwC France. His areas of interest are space economics, innovation, and business modelling. William has worked as a subcontractor in economic assessment for the Canadian Space Agency (CSA) and as associate in the space consulting group of Strategy& (formerly Booz & Company) in Amsterdam.

Stephanie Wan | *Chair of SGAC*

Stephanie Wan is the Chair of SGAC. She is also a Systems Analyst at Overlook Systems Technologies, Inc., providing support to NASA's Space Communication and Navigation (SCaN) Office, as well as doing a detail at the US Department of State Space and Advanced Technology Office and the Department of Commerce National Coordination office for Global Positioning System (GPS).

Andrea Jaime Albalat | *Business Development Manager at OHB SE*

Andrea Jaime Albalat is a Business Development Manager for OHB SE, coordinating all H2020 activities and European Commission programmes, and covering Human Spaceflight and exploration activities.

From 2012 to 2015, Andrea was the Executive Director of SGAC and a Young Graduate Trainee at ESA ESTEC.

Kai-Uwe Schrogl | *CSO at ESA, President of IISL*

Prof. Dr. Kai-Uwe Schrogl is the Chief Strategy Officer of ESA and the president of the International Institute of Space Law. He was the Director of the European Space Policy Institute (ESPI) in Vienna from 2007 to 2011. Prior to this, he was the Head of the Corporate Development and External Relations Department in the German Aerospace Center (DLR) and worked with the German Ministry for Post and Telecommunications and the German Space Agency (DARA).

Isabel Reutzel | *Head of DLR Office Paris*

Dr. Isabelle Reutzel is Head of the Office of the German Aerospace Center (DLR) in Paris. As the permanent representative of DLR in France, she is a key partner for any matters relating to space, aerospace, transport, energy, and security research in the Franco-German field. As member of the German Delegation to ESA, her work also encompasses the representation of interests of the Federal Republic of Germany. She has been working for DLR since 2007.

Alain Maillet | *Project Manager at MEDES*

Alain Millet has been working at the Physiology and Medical Space Institute (MEDES) in Toulouse for 23 years. He started as a scientific coordinator before becoming the anti-orthostatic food ground simulation experiments project manager. In September 2001, Alain joined the Centre for the Development of Microgravity Applications and Space Operations Plans (CADMOS).

Subject Matter Experts

Alexander Soucek | *Legal Officer at ESA*

Alexander Soucek works as a legal officer for public international law and space law at ESA. He previously held the position of a programme coordinator in ESA's Directorate of Earth Observation Programmes. He teaches space law at universities in Europe and has published books, commentaries and articles on the subject. He is also vice-president of the Austrian Space Forum, a non-profit space advocacy association.

Claus Lippert | *Head of Launcher Systems Department at DLR*

Dr. Claus Lippert has been serving as the Head of the Launcher Systems Department of the DLR Space Administration in Bonn since 2005. This part of DLR is entrusted with planning and implementing the German National Space Program and the German contribution to the programmes of ESA. Lippert began his career in the German Space Agency in 1991, his first assignment being systems engineer and project leader for two national German re-entry vehicles, flown in 1995 and 1997.

Josef Weidemann | *Management at Tech Support at DLR/ESA*

Josef Wiedemann has been seconded to the Launcher Directorate of ESA by DLR since 2015. Currently, he is providing management and tech support for the P120C element, developing the common solid rocket motor for Ariane 6 and Vega C. Before his secondment to ESA, he worked at the DLR Mobile Rocket Base (MORABA) as a mechanical and system engineer.

Antonio Fortunato | *Head of Crew Office at EAC*

Antonio Fortunato is the acting Head of the Crew Office at the European Astronaut Centre (EAC) in Cologne. In this capacity, Antonio oversees the team responsible for real-time communication (EUROCOM) between the Columbus Control Centre and the ISS, as well as for the support of European astronauts before, during, and after their space missions.

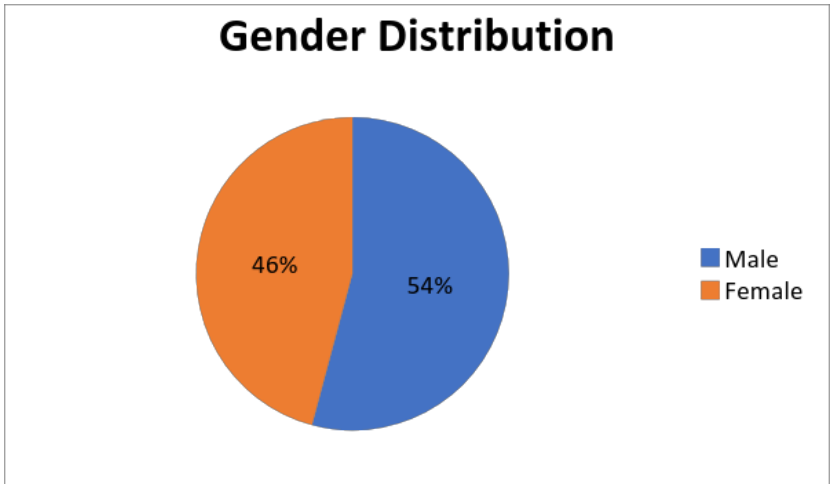
Daniel Vidal Madjar | *Committee Chair at the French Ministry of Ecology*

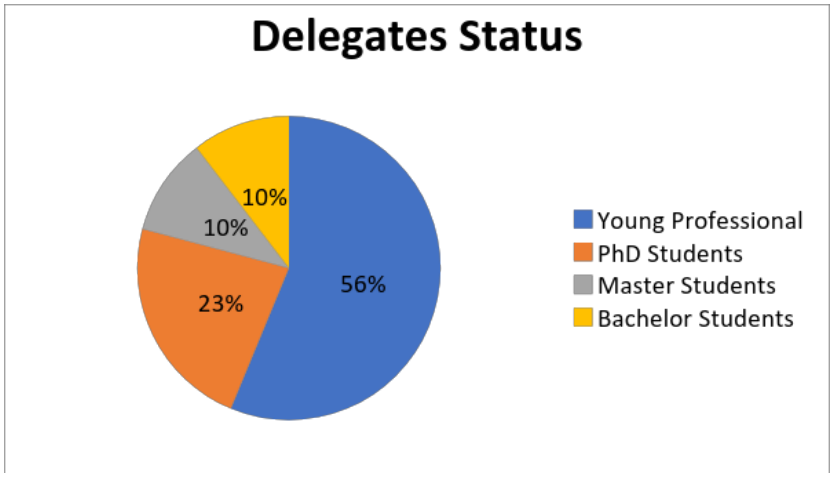
Dr. Daniel Vidal Madjar has been the chair of the Copernicus scientific committee of the French Ministry of Ecology since 2012. Previously, he was the Head of the Observatory of the Versailles Saint-Quentin-en-Yvelines University. He was the French National Coordinator for the Copernicus programme and for the intergovernmental initiative GEO (Group for Earth Observation). Until 2005, Dr. Vidal-Madjar was the Head of the Earth Observation Department at CNES Programmes Directorate.

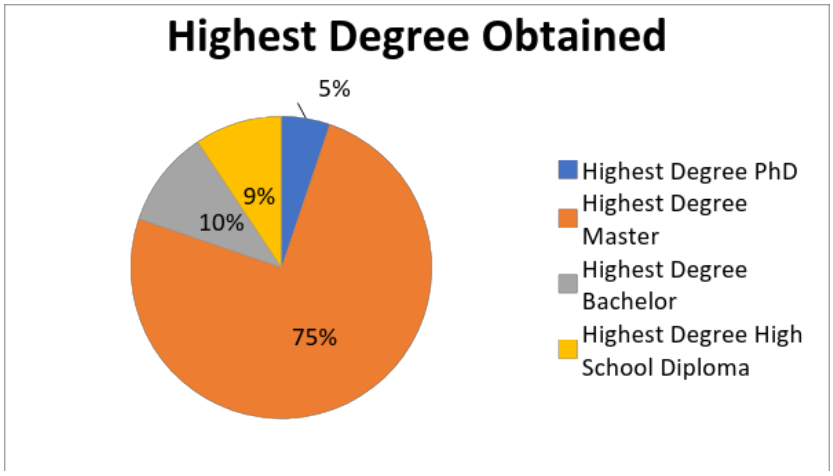
Event Statistics

The 2nd E-SGW reached a record number of 172 applicants for a regional event. Out of these the 96 best delegates with 33 different nationalities were selected.

The distribution among those delegates are shown below:




Delegates Status
10%
10%
56%
23%
Young Professional
PhD Students
Master Students
Bachelor Students


Highest Degree Obtained
5%
9%
10%
75%
Highest Degree PhD
Highest Degree Master
Highest Degree Bachelor
Highest Degree High School Diploma

SCHEDULE

2nd European Space Generation Workshop Paris – France, 24-25 March 2017				
Thursday, March 23rd				
19:00 – 22:00	**Optional Dinner** at Café A (Maison de l'Architecture)			
Friday, March 24th				
08:00 – 08:30	**Registration (**ESA Headquarters Nikis**)**			
08:00 – 09:00	Breakfast + Poster session			
09:00 – 09:40	**Welcome Note** (Room A) *E-SGW Managers, SGAC Representatives*			
09:40 – 10:00	**Keynote Address** *Claudie Haigneré*			
10:00 – 11:00	**Invited Speakers**			
11:00 – 11:30	Coffee Break			
11:30 – 13:30	**Working Groups**			
	Space Accessibility Room C	**Space Diplomacy** Room 114	**Space Economy** Room 154	**Space Exploration** Room 153
13:30 – 14:00	2nd E-SGW official pictures & group pictures			
14:00 – 15:00	Lunch Break (ESA HQ Canteen)			
15:00 – 15:30	Coffee Break / Working Group Time			
15:30 – 18:00	**Working Groups**			
	Space Accessibility Room C	**Space Diplomacy** Room 114	**Space Economy** Room 154	**Space Exploration** Room 153
18:00 – 19:00	**Invited Speakers** (Room A)			
19:00 – 19:30	1st Day Round-Up			
19:30 – 20:30	Free Time / Preparation and Public Transfer to Cultural Night			
20:30 – 23:00	**Cultural Night** (ESA Headquarters Daumesnil)			
Saturday, March 25th				
08:00 – 08:30	**Registration (**ESA Headquarters Nikis**)**			
08:00 – 09:00	Breakfast + Poster Session			
09:00 – 09:15	2nd Day Introduction			
09:15 – 10:00	**Invited Speakers (Room A)**			
10:00 – 12:30	**Working Groups**			
	Space Accessibility Room C	**Space Diplomacy** Room 114	**Space Economy** Room 154	**Space Exploration** Room 153
12:30 – 13:30	Lunch Break (ESA HQ Canteen)			
13:30 – 14:00	Coffee Break/Working Group Time			
14:00 – 16:00	**Working Groups**			
	Space Accessibility Room C	**Space Diplomacy** Room 114	**Space Economy** Room 154	**Space Exploration** Room 153
16:00 – 16:30	Coffee Break			
16:30 – 18:30	**Working Group Presentations** (Room A)			
18:30 – 19:00	**Closing Remarks** (Room A)			
19:00 – 19:45	Free Time/Preparation and Public Transfer to Closing Dinner			
19:45 – 23:00	**Closing Dinner**			

2ND E-SGW ORGANISING TEAM

A team of dedicated volunteers made up the organising team of the 2nd European Space Generation Workshop. These passionate students and young professionals worked tirelessly to ensure 2nd E-SGW delegates enjoy the best possible experiences and opportunities while in attendance. On behalf of the SGAC Executive Office, we thank them for their time and dedication

Caroline Thro (Germany) Event Manager	Florian Ruhhammer (Germany) Deputy Event Manager	Matteo Emanuelli (Italy) Regional Coordinator - Europe
Guzel Kamaletdinova (Russia) Regional Coordinator - Europe	Laszlo Bacsardi (Hungary) Regional Events Coordinator	Lucie Cordier (France) Working Group Coordinator
Ana Raposo (Portugal) Working Group Coordinator	Maxime Puteaux (France) Working Group Coordinator	Margaux Morssink (Netherlands) Delegates Coordinator

Joao Lousada (Portugal) Delegates Coordinator	Ariane Bouilly (France) Logistics Coordinator	Martin J. Losekamm (Germany) Logistics Coordinator
Audrey Berquand (France) Communication Coordinator	Emmanuelle David (France) Strategic Partnerships	Lucie Poulet (France) Strategic Partnerships

Harmonie Leduc (France) Communication Coordinator	Sergio Tabasco Vargas (Spain) Communication Coordinator	Istvan Arnocz Communication Coordinator
Wenzel Schoroth (Germany) ESGW Support		

SECTION TWO: WORKING GROUP SUMMARIES

One of the core activities during the second European Space Generation Workshop were the Working Group sessions. Guided by experienced Subject Matter Experts (SMEs), the groups discussed pertinent space topics in a European context. Delegates collaborated with each other and with the SMEs to address pre-defined questions in four highly relevant areas:

- Space Economy: Smart, Green, and Integrated Transport
- Space Accessibility: A Market Introduction Strategy for a New European Heavy-Lift Launch Vehicle
- Space Diplomacy: On the Road to an International Space Traffic Law
- Space Exploration: How to Prepare for Long-Duration Manned Space Missions

The preliminary conclusions and recommendations of each group were presented to the rest of the delegates at the end of the workshop.

SPACE ECONOMOY – SMART, GREEN, AND INTEGRATED TRANSPORT (SEWG)

Moderator:	Mansoor Shar (Inmarsat)	
Subject Matter Expert:	Daniel Vidal-Madjar (French Ministry of Ecology)	
Participants:	Fredrick Aarestad (Norway)	Istvan Arnocz (Hungary)
	Radim Badsi (France)	Daniel Bock (Germany)
	Eline Conijn (Netherlands)	Montserrat Del Riego (Spain)
	Annalisa Donati (Italy)	Manfred Ehresmann (Germany)
	Tomas Hrozensky (Slovakia)	Alexandra Jercaianu (Romania)
	Florian Marmuse (France)	Lukas Plaznovink (Austria)
	Aureliano Rivolta (Italy)	Alberto Rodriguez Mitre (Spain)
	Eugenia Sarafova (Bulgaria)	**Daria Stepanova (Russia)**
	Guillaume Tanier (France)	Giampietro Tonoli (Italy)
	Emma Velterop (Netherlands)	Alesandra Vernile (Italy)

Introduction

In an increasingly urbanised world, data-driven improvements for mobility are becoming crucial. The growing population of cities brings new challenges to everybody involved in big city life—civilians, policy makers, and enterprises—by influencing the infrastructure and environment. It also brings wide-reaching social and economic changes. Different types of information can be used to improve the quality of life and planning processes, e.g. images taken by unmanned aerial vehicles, stationary cameras, or position data. To study the contribution of the space industry in this emerging topic, the Space Economy Working Group first analysed the current applications of space data in smart mobility concepts. After that, current trends for smart mobility identification revealed technologies that will possibly lead the market in the future. With these trends in mind, the group identified further stakeholder needs along the space data value chain—from services providers to end users—and formulated three main recommendations.

Objectives

The impact of transportation on the economic, environmental, and social health of cities cannot be underestimated. Downstream space data products and services are currently used to enhance economy-driving, environmentally sensitive transport, and intelligent mobility solutions. The main objectives of the Working Group were to discover existing technologies and concepts showing how data can be exploited for current needs and to explore the usability of emerging technologies to further advance towards operational implementations and market growth in the smart mobility sector.

Discussions

The Working Group initially placed a strong emphasis on the definition of the term smart mobility to determine the scope of the discussion and allow implementable results to be produced within the limited time frame of the workshop. Delegates agreed to define smart mobility as ‘data-driven improvements to infrastructure and the transport of people, goods, and services’.

The group first referenced technologies that are currently using space data for smart mobility. Most instruments providing data for smart mobility were not designed for this purpose, but for much broader

use cases. This first analysis showed that, for now, smart mobility by itself does not justify investing in dedicated space missions. Therefore, the group considered currently existing and proposed satellite instruments which may be used for smart mobility purposes. The two main sources of data used for smart mobility were found to be Global Navigation Satellite Systems (GNSS) and imagery products. GNSS services were found to be the most-used source, most likely because they enable real-time applications. They are heavily used in mobility systems to plan routes with real-time data, such as car sharing and on-demand transport (Waze, Uber, or Lyft), real-time road traffic management systems (Google, TomTom), or autonomous driving. Imagery is used mainly for non-real-time applications, such as route planning and infrastructure optimisation. Examples of instruments providing such data are optical telescopes and Synthetic Aperture Radar (SAR).

The Working Group sought to highlight trends and found that current evolutions can be linked to two distinct yet interconnected revolutions: the Internet of Things (IoT) and Big Data. IoT services based on real-time data facilitate the transportation of goods and people (fleet management, goods tracking, etc.). Big Data services based on the collection of historical data enable advanced weather prediction, city planning, and other types of long-term monitoring. The growing amount of data and the increasing interconnectivity of various devices are two aspects of a major trend: rapid data utilisation. This trend is projected to lead to changes in socio-economic and societal domains—such as the emergence of commercial data retail, increasing complex policy decisions in urban development, the legality of disseminating and using data, and cultural behaviour changes.

Once aware of current and foreseeable future technologies, the Working Group considered the needs of the end users. Considering a simplified space data value chain (see Fig 1.), it becomes clear that two distinct categories require a definition: service providers and end users, which can be either private citizens or businesses. Citizens are the ultimate customers of smart mobility applications in everyday life—from the daily commute to work to leisure travels. Businesses providing services to citizens—such as shipping and airline industries, public authorities responsible for transport infrastructure, and public transport networks—are key end users of space data. Service providers on the other hand make data available to end users. They are defined as any type of business that uses satellite data to provide services—such as GNSS-based ridesharing, monitoring of crops with satellite imagery, etc. Service providers are key players in the value chain, taking data and turning it into valuable information.

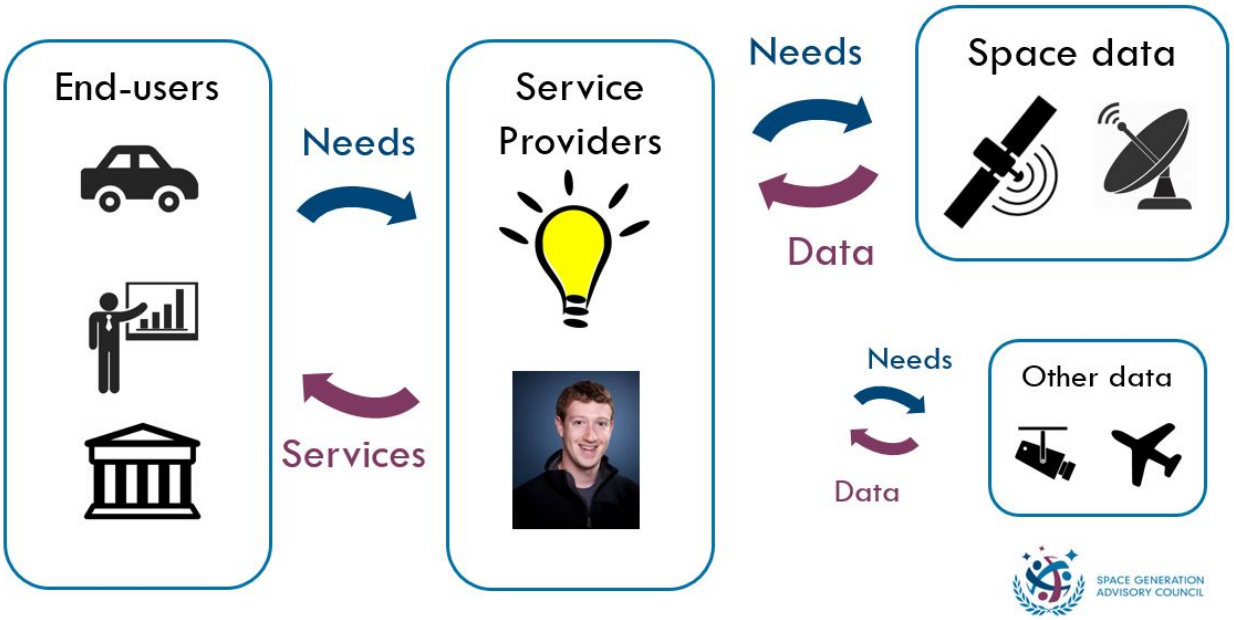


Figure 1. The space data value chain for smart mobility.

After the user's definition, the SEWG characterised first the end users' needs, which are summarised in the following paragraph. A significant number of applications can be classified as current or future needs, and are blind to the origin of the data. The needs of citizens are driven by the idea of optimising movements and increasing efficiency, either temporal or economic. The businesses demand to know the exact state of the products produced and sold and their exact whereabouts. The needs of public authorities are to gather the maximum amount of relevant data before any mobility related decision is made

Here are some examples of current and future needs of the three main classes of users: citizens, businesses, and public authorities:

Citizens: Real-time traffic, weather predictions, public transport, services locations.

Businesses: Tracking of goods, just-in-time goods management, improving business efficiency.

Public authorities: Land registry, geomorphology, pollution, people's motion, reverse geomarketing (using the location of businesses to plan city growth), socio-economic indicators, weather, vegetation, urban heat islands monitoring, natural resources prospecting, electricity use estimation.

As most end users' needs are blind to the source of the data, it was found more relevant to study the relations between the space data providers and the application providers. From this, three levels of needs have been found: first, the smart mobility app providers need better temporal resolution of the data. Applied to the space sector, it implies more spacecraft to diminish revisit time, and more sensors. A surprising idea behind this is that, beyond temporal resolution, the app developers don't actually need more data than what is available today. The data is here and needs to be used. Following this idea, a second and more fundamental need is expressed: the smart mobility sector needs an efficient data management environment, concerning on-board processing, ground processing, storage, data flow, user interfaces, open-access, interoperability, and standardisation. For space, it can mean increasing the on-orbit processing to avoid transmitting and storing useless data, but more generally it implies having a

stronger connection with the big data ecosystem and developing a more data user-oriented way of designing spacecraft and sensors. Third, the SEWG found that the sector would benefit from renewed regulations in terms of privacy and ownership of data. For space, it means associating with the relevant actor from the data environment on Earth.

Conclusion and Recommendations

The first output of the SEWG is to have defined metrics and vocabulary to discuss space data applied to smart mobility. The temporality of the data is a way to sort and think them by arranging real-time and nonreal-time applications. This is linked, but cannot be identified to, two major societal phenomena of our generation: the Internet of Things, and the big data.

Going forward, it has been concluded that the smart mobility sector was much more sensitive to the data than from its source. The improvements in this sector are foreseen to come from the data side, and not from the space side. With this in mind, the SEWG strongly recommends that the space sector adopts a proactive, if not leading position, in the upcoming discussions on a more efficient data management systems on Earth as a whole, and about renewed regulations about data privacy and data ownership. A way to achieve this would be to adopt a more user-centric way of designing space solutions potentially useful for the smart mobility sector.

Last, it has been brought up during the questions session that the space sector should communicate directly with the end-users so that its capacities are better known and the public authorities can use this knowledge to wisely attribute public money.

Our recommendations can be summarised as :

- Development of new space imagery missions should focus on increasing revisit time above all. This is expected to be achieved by using constellations of spacecrafts.
- Development of new space missions that can be used for smart mobility application should be designed with a large emphasis on the user's needs and ease of use.
- As a data provider, the space sector should help improve the data management systems, and develop standards in this direction. Open-access and interoperability should be emphasised.
- Space should take part in the upcoming discussion about data privacy and ownership.
- The space sector should work on communication towards the end-users on the quantity and quality of available data. This way, the end-users can work at creating a social environment more favorable to the use of space data for the smart mobility.

SPACE EXPLORATION – HOW TO PREPARE FOR LONG-DURATION MANNED SPACE MISSIONS?

Moderator:	Cypriex Verseux	
Subject Matter Expert:	Antonio Fortunato (ESA)	
Keynote Speaker:	Alain Maillet (MEDES)	
Participants:	Sara Aparicio (Portugal)	Nishan Belbase (Nepal)
	Ian Luca Benecken (Germany)	Audrey Berquand (France)
	Laura Bettiol (Italy)	Surmit Bhui (India)
	Aline Decadi (France)	Sarah Douglas (UK)
	Michael Elsen (Germany)	Mark Fittock (Australia)
	Jerome Gilleron (France)	**Maria Grulich (Germany)**
	Harmonie Leduc (France)	Joao Lousada (Portugal)
	Valentina Luchetti (Italy)	Dorottya Milankovich (Hungary)
	Fabiana Milza (Italy)	András Ordasi (Hungary)
	Daniele Paltera (Italy)	Hannah Petersson (Sweden)
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Introduction

Long-duration manned spaceflight missions lasting six months or more raise new key issues in space exploration. Maintaining crew well-being and performance is critical for the success of these missions. In addition to physiological effects due to microgravity or radiation, experiments have demonstrated that in adjusting to the extreme change of environment, long-term spaceflight can have adverse psychological and sociological effects on the crew.

The Space Exploration Working Group of the ESGW addressed the following issues:

1) Identify physiological and psychosocial risks for long-duration manned missions;

2) Propose mitigation measures against these negative effects and impacts; and

3) Adapt the astronaut selection process and training to the needs of future missions.

Physiological risks are dominated by the effects of radiation and microgravity causing a myriad of potential health issues for astronauts on both short and long-term. It is clear that physiological issues associated with spaceflight need to be addressed technically via mitigation methods. Also, team composition and training will be crucial to overcome the medical challenges supported by a suite of medical equipment.

Potential psychological disorders involve a wide range of mental health problems (for example mood chronic stress, sleep disorders, anxiety, psychosis, psychosomatic illnesses, mood disorders, etc.) that leads to reduced productivity. Interpersonal challenges involve the tendency to avoid social contact, tension and conflicts within the team. The conflicts increase with the duration of the mission and as distance from Earth grows and crew feels more isolated. These issues and their interactions present serious threats to crew psychosocial health and performance.

A range of potential changes to current selection and training techniques for long-term missions was discussed focusing on selection for a good interpersonal mix within teams and training to support both physical and psychological endurance.

Current Status

Right now manned space missions have a maximum duration of six months—with some few exceptions that lasted up to a year. All those missions take place on-board the ISS in Low Earth Orbit (LEO). For those missions, many actions have already been taken to counteract physiological and psychological issues that arise during such a mission duration. The current astronaut selection also focuses on aspects needed for missions that go to the ISS. However, potential future missions might last up to 2.5 to 4 years with a slight chance for the crew to return to Earth.

Psychology

Human spaceflight is only possible because of an artificial vehicle in which a human body can survive the harsh environment of space. As long as people just fly in low Earth orbit (LEO), they can return to Earth relatively easily. But if people would fly to Mars, this last reserve will not be available anymore. Furthermore, they cannot leave the vehicle that keeps them alive and they have to share the spacecraft with other crew members.

On a trip to Mars, astronauts have to bring their food with them from Earth to space. Sufficient nutrition supply is important for the health of the crew as well as for their mood. Food is a basic need, and insufficient amount and insufficient quality food can become a significant stressor.

It is strongly recommended that astronauts are provided with the technology to grow their own food during the mission. Based on psychological research, the human body is hardwired for a 24, 6 hours long circadian rhythm; this is the body's natural biological clock. Any variation from that plus the lack of light creates significant psychological stress that is a result of physiological responses.

Even if there is no natural day and night cycle in space, it is recommended to virtually recreate such environment to support the healthy sleep-wakefulness cycle. During long-term human spaceflight missions, entertainment has to be considered to maintain low stress levels. On the ISS, music, instruments, video cameras, books, and movies are already available. On long missions, the time delay in communication has to be taken into consideration: this means that it might not be possible to download the most recent songs from the charts in real time. It would be recommended to have a high variety of available entertainment on board as well as to consider the option of taking advantage of virtual reality. A possible way to support the group dynamics could be to schedule concerts and movie evenings for the whole crew. Right now, on board the ISS there is no dedicated module for the crew quarters and social activities. The astronauts sleep and spend their free time in the same modules where they work. For a mission to Mars that would last several years, such a dedicated module is highly recommended to separate work and recreational areas. Studies have shown that humans need a distinct separation between the two areas, otherwise they keep working or cannot start working. During a four-year mission, dedicated holidays are also recommended in between as shown in Figure 2.

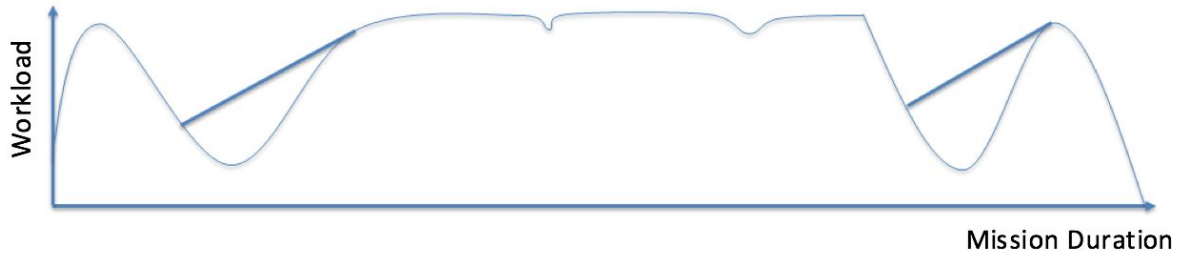


Figure 2. Workload for astronauts.

In contrast to a mission on-board the ISS, where the astronaut crew time is the most valuable asset and every minute is tightly planned, the schedule for a mission to Mars would look completely different: the main workload for the crew would be from the arrival to Mars until departure. During long cruise phases, astronauts have less tasks to complete and more free time. During that part of the mission, the astronaut's days should be scheduled in such a way that long term well-being is maximised. This would of course include regular maintenance work and the execution of experiments, but also social activities within the crew. With that in mind, certain entertaining equipment should be provided for the crew: magnetic board games, music instruments, and a large collection of movies. Moreover, the Working Group proposed to implement group sports activities realised with the aid of virtual reality (VR). Using VR devices, the crew members could compete with each other for fun, for example running or cycling.

Isolation, the distance from their families, and the lack of privacy are important issues to consider on a long duration mission. Right now, the astronauts on board the ISS have the opportunity to hold video conferences with their families at least once a week and to use an IP-phone to call everyone on Earth almost at every time. When astronauts start long duration missions to Mars, these ways of communication will not be available anymore, because of the signal latency back to Earth over such a long distance. On this regard, the Working Group proposed to implement a special instant messaging system available for the astronauts to keep in touch with their friends and families.

The future long duration missions to Mars will likely be performed with an international crew: their cultural and linguistic differences might cause problems due to misunderstandings. One potential issue might arise in case of a conflict on Earth between origin countries of the crew. This raises the issue of how to deal with such a situation, for example by either blocking the news to the crew or informing them.

During a long mission, it can occur that love relationships are established. Currently, it is recommended to avoid relationships on board, but it is impossible to control them, especially on a long-term mission. A stable couple might be an advantage, a forming couple might be an issue.

Another issue that has to be considered during such a long mission is the possibility that one of the astronauts develops psychological issues despite all the countermeasures. First, the Working Group proposed to implement a review day once a week, like it is done for fighter pilots: the astronauts would have the opportunity to talk to each other and explain how they felt at certain moments and how they understood certain actions the others did. This would be useful to increase the common understanding between the crew members. Further, if it is detected that one of the astronauts feels excluded, shows certain symptoms of depression, or any other psychological issues, it might also be beneficial to have virtual assistance from a psychologist in case of need.

Physiology

In space, astronauts are exposed to different types of radiation that can cause long-term and short-term effects on their bodies. Long-term effects include damages of the central nervous system, degeneration of tissues, formation of cataracts, cardiovascular damage, and cancer. Short term effects, such as nausea and vomit, are more usually experienced in case of heavy solar flare activities. Exposure limits for astronauts, with a distinction in terms of gender and age, have been selected and considered by space agencies for their astronauts. Older astronauts have higher radiation exposure limits than younger ones and male astronauts have higher exposure limits than women. For long-term human spaceflight missions, older astronauts are preferred due to higher radiation exposure limits. Countermeasures against radiation are chosen as a trade-off between exposure time and effective shielding against particles with different energy levels. Long duration missions should be planned during low solar activity periods and a solar flares warning system should be implemented. In the case of a flare, astronauts should go into an area of the spacecraft that offers more radiation protection. Passive shielding, such as water-filled walls of the spacecraft, are also technically possible. However, it might not be sufficient for highly energetic radiation. In addition, more sensitive areas of the body can be shielded by wearing a suit with new shielding materials, like polyethylene or by creating an active magnetic field. These technologies have a low technology readiness level at the moment, but research in these fields is progressing.

The estimated radiation dose for a Mars mission is expected to be seven times higher than a general six-month mission on the ISS. This shows that the radiation environment has a severe impact on the astronaut and has to be taken into account.

The human body in space is also subject to a microgravity environment. Body fluids shift inside the human body and this can lead, for example, to vision impairment. In addition, microgravity has an effect on the human immune system and causes muscle and bone loss. Astronauts can lose up to 10-20% bone mass at their arrival on Mars. To overcome some of the major challenges related to microgravity, one solution could be to create artificial gravity by spinning the whole spacecraft or just the habitat around one of its axes. However, such a solution would be very expensive. Cheaper solutions could employ electrical muscle stimulation, vibration plates, or a skin suit that increases the resistance during exercises, as well as a good training plan, such as the one already implemented on the ISS. The aim is to make the training more effective and less time consuming. Another way to make the daily exercise more exciting is to use VR so that astronauts can feel they are running in the nature or climbing a rock. Specific body suits can also be used to create an under pressure to reduce the effects of the fluid shift.

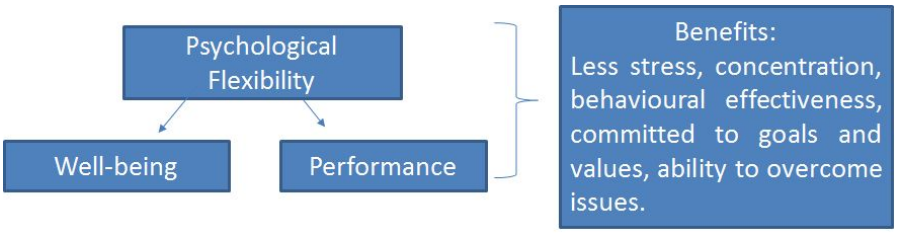
During long term human space flight missions, it is also possible that medical emergencies requiring immediate surgery occur. This issue raises the question if we need a doctor as a crew member or if it is sufficient to just train the crew in basic medical care. During a long mission, continuous health monitoring is essential to react to health issues as soon as possible. It is important that at least one crew member has a medical background and the others have to be trained to a certain level. Teleoperation or returning to Earth might be impossible, therefore the crew has to be able to handle medical emergencies by themselves. In such cases, robotic assisted surgery could be a solution. The crew could have a database available to help with the diagnosis and to choose the therapy or surgery procedure. With the help of the robots, any member of the crew would be able to perform the surgery. In the future, producing drugs in-situ might become a reality: in that case, in-situ produced medicines should be included into long-duration missions availability.

Astronaut Selection

Currently, astronauts are selected among military officers and scientists, such as biologists, meteorologists, and geologists. The main requirements from NASA are a bachelor degree or higher in a scientific field, 1000 hours of pilot-in-command time in a jet aircraft, and a general good health status. The astronauts are trained as individuals in different facilities around the world and spend relatively short time with their crew before a mission. It is important to have a crew with a medical background as well as scientists in various backgrounds such as biologists or geologists. Engineers with different backgrounds and hands-on experience are very important to ensure continuous monitoring and maintaining of the spacecraft. A flight to Mars will be likely done with an international crew and cultural differences need to be understood and overcome. After the training, the crew shall be ready to undertake the long journey to Mars.

Conflict management training and outreach activities to motivate the younger generation should be put on the agenda as well. The training is divided in two parts: basic training and specific training. The basic training follows the selection and includes general training classes, lasting up to 1.5 years. Afterwards, they become qualified astronaut candidates. The specific training is highly mission adapted and assigned. The training in general is adjusted to the specific mission: for example, the training to go on a six-month ISS mission is different than it was for Shuttle missions. For long term duration missions, the selection processes might need to be adapted. One possibility would consist in conducting analogue missions to assess the group dynamics, the reaction to isolation, and psychological issues of individuals that might occur. The missions should have different lengths, scenarios and an increasing level of difficulty as well as different crew sizes and compositions to investigate which astronauts work the best together. The crew size and composition are an important factor for the success of a mission. People not able to relate to each other under tension and stressful events can endanger the success of the mission. Ratio of female and male astronauts is also an open question. These questions have to be addressed and investigated in long duration analogue training sessions. During these trainings a continuous psychological and social evaluation and new diagnostic criteria to evaluate capacity of an astronaut shall be implemented.

As mission duration increases, the training should increasingly focus on the development of the stress appraisal ability of astronauts. A relatively good ground for preliminary investigations could consist in the exploration of existing techniques already established among groups like premiere athletes, lead management of military, monks, submarine crews, and arctic expeditions. The concept of acceptance and commitment therapy (ACT) based trainings fits well and promotes the success of individuals and groups in these contexts. The key goal of ACT is to improve psychological flexibility, the capacity to be present more fully as a conscious human being, and the capacity to persist with adaptive behaviour in serving one's valued goals, even while encountering difficult psychological experiences.



ACT incorporates a range of exercises that increases psychological flexibility. For example, exercises that can help with goal setting and value identification, which in its turn improve behavioural activation and better performance. It is crucial for astronauts to provide outstanding performances, to remain resilient, and to maintain their psychological well-being in order to successfully accomplish their mission in such extreme and isolated environments.

Conclusion and Recommendations

Recommendations

Space is an extreme environment. The study of the psychological response to such a stress-inducing environment can bring benefits for humanity on Earth. It could be helpful in better understanding the psychology behind episodes of burn outs and increasing stress levels in western countries.

Learning more about how to design a long term mission in such a way that puts the least possible stress on the human is still a topic for which more research data is needed. After astronaut selection, group training is getting more and more important. Adapting astronaut training towards long duration mission should consider psychological aspects and group dynamics. The aim should be to select the best group that reacts in a controlled manner when under stress. The first Mars missions will be a dangerous adventure and everyone has to work together to make it a success.

Conclusion

Despite all the problems and solutions discussed in this report, the main issue for realising a mission to Mars is the need for international collaboration and cooperation.

Even if all the problems discussed in the report could be solved, the legislative and policy barriers that are still in place would not be removed. A long term mission to Mars is always a risk trade-off between risk acceptance and risk mitigation. Space exploration encompasses all nations and all companies.

One solution that seems to provide the first stepping stone in resolving stress appraisal, challenges in mental health and communication of the crew is the using ACT based trainings and practice mindfulness meditation, which also leads to enhanced productivity.

To gain our space, we need to work together. The Space Exploration Working Group would like to thank SGAC and the E-SGW organising team as well as our sponsor CNES and ESA for hosting us.

SPACE DIPLOMACY – ON THE ROAD TO AN INTERNATIONAL SPACE TRAFFIC LAW

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Introduction

Objectives

Provide forward, new-thinking and practical recommendations to the following three interconnected sets of questions that the future of space is highly dependent on:

● Is the legal framework of Space Traffic Management (STM) sufficient? How can it be improved?

● What should be the role of all (private and public) entities in STM?

● What are the currently proposed technical solutions? Which might work best? How can they be implemented/enhanced?

Discussions

According to a study by the International Academy of Astronautics, Space Traffic Management (STM) is the set of technical and regulatory rules to ensure:

● safe access to outer space;

● safe operations in outer space; and

● safe return from outer space.

STM has become a relevant topic because the orbits around Earth, in particular, the near Earth orbit, are quickly reaching a critical capacity due to spacecraft and debris owned by an increasing number of private and national actors. What was once an expensive pursuit, traditionally reserved to governments and their space agencies begins to thaw. Even as corporations turn their eyes upwards, space grows ever more accessible to the space enthusiast—through the reach of their do it yourself (DIY) instruments, experiments, sensors, and cubesats, and soon through space tourism. The increasing importance of commercial private sector requires new ways of managing the different associated risks, including traffic management. Currently, space actors need to undertake more and more avoidance manoeuvres of their

spacecraft to prevent fatal collisions with each other or with debris. Collision may lead to mission failure, the loss of valuable economic assets, or in the case of human spaceflight, even the loss of life.

The Outer Space Treaty (OST), as well as the Liability and Registration Convention have provisions holding space actors responsible for their activities into, in, and back from space. However, up to now, there is no reliable enforcement mechanism for these provisions. There is also no other set of regulations tackling STM in a more comprehensive manner.

Convinced that this situation needs to be resolved as soon as possible to eschew long-lasting severe obstacles for the future of spaceflight and the peaceful exploration and use of outer space, this Working Group proposes the following recommendations to establishing and maintaining a sustainable and comprehensive STM mechanism for the benefit of all space actors:

Recommendations

Following excellent input by experts in the field (Kai-Uwe Schrogl, Marco Ferrazzani, and Alexander Soucek), the group established that an enforceable international agreement on STM needs to be put into place. Until STM is in place, irresponsible actors will undermine long-term progress for short-term technical solutions, deferring the problem unto future generations in a manner similar to climate change.

The Working Group proposes four primary recommendations, which are interconnected, chronological, and form the acronym CARE: Common Ground (C), Awareness (A), Regulations (R), Execution (E).

Common Ground

The decision to create an enforceable international agreement on STM requires long-term political and financial commitments. Creating consensus between many actors on how this will be done is a large challenge. That means that part of the solution is to design the tools, conversations, experiences, and opportunities that can help both the space sector and the decision makers to embrace and measure investments in STM. A multitude of diverse stakeholders need to be brought together to shape a general consensus about the technical, economic, and political aspects of STM. An effective way to establish common ground might be the creation of dedicated interdisciplinary working groups of professionals and academics aiming to reach common ground on an expert level.

The Working Group advocates that it is necessary to invest heavily—and on a continuous, long-term basis—in creating opportunities for discussion between those highly specialised scientific silos of knowledge. For example, one of the fundamental debates currently seems to be whether the approach to STM should be legal or technical. It is necessary to invest heavily—and on a continuous, long-term basis—in creating opportunities for discussion between those highly specialized scientific silos of knowledge. Convening both legal and technical stakeholders regularly will provide them with exposure to one other's perspectives and experiences, create the opportunity to develop mutual understanding, and build respect and trust to have open discussions.

The main challenge to such an international agreement on STM regulation is similar to the one faced by the climate change agreements. Countries with a developing space industry would be reluctant to agree to regulations that would impose extra costs on their domestic companies when historical players such as the US and Russia have had unrestricted access. Although difficult, finding a middle ground solution should be possible, particularly when looking at the recent Paris agreement on climate change.

Awareness

The second step in reaching international agreement on STM is by raising awareness to all members of society—government, industry, academia, and citizens—that humanity is growing more dependent on access to space, and that increasing space traffic endangers the common good. All states have vested interests in space applications—communications, navigation, Earth observation—, scientific research, and commercial activities taking place in near-Earth space. Such awareness might translate into direct or indirect influence on the decision-makers to tackle STM properly.

Awareness can be achieved both by the use of diplomacy (both traditional and digital) and media. One form of diplomacy is unofficial diplomacy between citizens and groups of individuals, also known as Track II Diplomacy, which can be effective when official measures do not work. Advisory groups such as the Space Generation Advisory Council, the Secure World Foundation, and others can be influential in informing industry representatives and politicians on STM issues. Informed citizens can form grassroot movements and bring awareness through dialogue with policy makers, businesses, and schools. Another form of diplomacy is Digital Diplomacy. STM proponents may reach out to influential politicians, entrepreneurs, and opinion makers with large numbers of followers on Twitter, Facebook, Instagram, and Snapchat and invite them to help make a buzz around space traffic management by using existing hashtags like #spacedebris or creating a new hashtag like #STM. Finally, STM proponents can use the traditional media by using creative storytelling to capture the stakeholder's attention on an emotional level.

Regulations

There is currently no consensus on an international level about the scope of Space Traffic Management. In setting up an enforceable international agreement, the Group recommends to approach spaceflight as a comprehensive traffic regime similar to cars, ships, and airplanes regulations. The Group advises the stakeholders to agree on which types of spacecraft/mission should access which zones taking always into account the mission type, class, operator status, and history of complying with debris mitigation STM policies.

Global information sharing among all stakeholders and authorities seems to be the first step towards international STM coordination and at the same time, a major challenge due to the potential dual use of space activities. The Working Group emphasised the need for mandatory pre-launch/EOL/maneuver notifications to assess collision potential and other consequences. Moreover, the Group argues for establishing a global civil agency to which all current space actors—both governmental and private—are required to contribute and provide updated information on their spaceflight activities throughout all mission stages, and Space Situational Awareness (SSA) data. The UN Register of Objects Launched into Outer Space has been already a step in this direction, but it falls short of offering enough information for effective day-to-day STM.

It needs to be determined what information should be shared, with whom and what should they receive in return. Various categories of users might be created to share the appropriate data among the state and private actors and to protect the most sensitive data. Any future international STM agency could be established on the example of the International Telecommunications Union (ITU)—an international organisation capable of successfully managing the international radio-frequency spectrum and satellite orbit resources, as well as convening diverse actors and major events related to telecommunications.

Finally, the Group proposes that these new international STM regulations shall not limit or make it more difficult for developing countries to engage in space activities. Future STM regulation should provide some obligations for space-faring nations with respect to the emerging space nations, such as a general obligation for assistance and international cooperation on STM issues. The obligation of sharing information, technology, and best practices with emerging space countries should also be a requirement.

Execution

The Group argues that a global summit should be initiated by major spacefaring nations and key stakeholders willing to reach an international regulatory agreement (e.g. model treaty) on STM. This could happen in the context of UNISPACE+50 and its High Level Forums to give it a greater international audience and to highlight its openness to all.

The objective of the global summit should be to reach an international agreement with legal enforcement mechanisms, potentially to be additionally implemented into domestic law by each signatory. In sum, such international STM regulations shall:

1. Be implemented on a national level;

2. Define how to deal with non-compliance with the agreed STM mechanism;

3. Define funding regulations for the international civil agency proportionate to member states resources and their space activities;

4. Introduce general obligation for international cooperation with respect to STM issues;

5. Cover SSA and information sharing and risk assessment. Take into account mission type, class, orbit zone, satellite class, manufacturer, operator status, and history of complying with debris mitigation policies for the various provisions and introduce de-orbiting solutions as a critical part of the mission profile to get clearance;

6. Create a deposit system to incentivise deorbit. The deposit could be returned to space actors on successful compliance with deorbit regulations;

7. Define the international STM agency's role in providing technical expertise and best practices;

8. Provide special support mechanisms to emerging and developing space countries;

9. Be open for revision at least every five years for regulation in coherence with technological development;

10. Be flexible by taking resources and the status of stakeholders into account when determining costs and speed of implementation; and

11. Create a common funding mechanism for research on a) active debris mitigation and b) removing existing debris. All signatories have to contribute to this common funding mechanism on a scale based on the number of their in-orbit spacecrafts. This participation could be adjusted downwards depending on the level of signatories' involvement in sharing information related to SSA.

A preliminary solution and inspiration might also be found in the success of the International Charter Space and Major Disasters (the Disaster Charter). Following this example, the space faring nations could create an adapted version of an SSA Charter. The SSA Charter members would include the global space agencies of the countries which have SSA capabilities to be able to collect, analyse, and disseminate the most accurate and detailed information. Each member agency should commit resources to support the Charter by providing SSA data and products. A different level of data sharing could be established depending on the different category of users for SSA information.

Conclusion

The Working Group argues that its C-A-R-E recommendations may function as stepping stones to make an effective STM mechanism a reality. It is a topic that does not warrant for short-term solutions, but needs the collective effort of all participants in the space sector. It is in the self-interest of the young space generation to contribute to STM.

SPACE ACCESSIBILITY – A MARKET INTRODUCTION STRATEGY FOR A NEW EUROPEAN HEAVY-LIFT LAUNCH VEHICLE

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Introduction

In an environment where space transportation system development activities are driven by the commercialisation of space by new, fully or partially privately funded players in the space transportation market, the ESA Conference on Ministerial Level 2014 has decided to renew the European launch sector, considering the needs of both the institutional market and the global commercial market to face the increasing competition.

Recalling the reliability of the current Ariane 5 programme and its successful market introduction as well as significant commercial market share, potential strategies for the market introduction of a future European heavy-lift launch vehicle will aim to continue the success story of the European launchers. For Ariane 6, which is scheduled to have its maiden flight in 2020, crucial factors, such as: potential launch cost, performance, time to market, launch rate, competition, satellite market situation, vehicle reliability, and launch record are discussed and their impact on potential market introduction strategies evaluated.

Besides the economic and technological aspects of the introduction of a new launcher, the influence of national and European policy on a successful market introduction as well as areas of potential support by lawmakers are the topics of this Working Group.

Objectives

The highly successful Ariane programme ensures independent, reliable, and affordable access to space for Europe as well as great success in the commercial satellite market. One of the key factors to sustain the European leadership in the commercial launch sector is a successful market introduction strategy for a new European heavy lift launch vehicle (HLLV).

The objective of this Working Group is to address and provide recommendations, including justifications and examples, on the following questions:

1. How can the public sector and law-makers in Europe support a successful global market introduction of a new European heavy-lift launch vehicle? Should a new approach be found, compared to the previous European vehicles?
2. What are the key elements the industrial organisation needs to address during the development as well as exploitation phase with respect to market introduction? In which respect the European industry needs to further evolve to face a more competitive global environment?
3. How could a marketing and outreach strategy for a new European heavy-lift launch vehicle look like? Can Europe learn from its competitors? What commercial risks will exist in the early marketing phases, and how can they be mitigated? Which players of the European launch sector could be involved and who could be addressed?

Discussion

To prepare for this discussion, the delegates were provided with reading material and ten preparatory questions. These preparatory questions were focussed around the European and international launcher environment, the market situation, and the technical aspects.

Based on these preparatory questions, the experts shared their view on the current situation and a common understanding of the subject was reached within the Group. The need and benefits of a market introduction strategy were clearly identified, also with respect to reduced sales of Ariane 5 after failures in the early market introduction phase.

It is highlighted that Ariane 5 undertook its first successful maiden voyage in 1999, 19 years after the initial concept. Non Government Organisations (NGO) have been able to reduce time to market, partially supported by funding and/or infrastructure provided by agencies and/or wealthy private patrons. Their marketing methods are based on a variety of news platforms and social media, creating direct feedback and instantaneous presence.

An efficient market introduction of a new European HLLV depends on the organisations' ability to adapt and implement changes quickly and effectively. The current system is considered as too rigid, with a decision making processes that include several partners, therefore the communication needs to be improved.

NGOs, such as SpaceX, are currently revelling in media attention. It can be observed that science and innovation communication receives more interest from the public than standardised telecommunication applications. This attention could be used for the maiden flight of Ariane, while mitigating risk by using an inexpensive payload. However, from a marketing point of view, whilst a reduced cost in payload will reduce the risk from a monetary perspective, if the launcher fails, the media will nevertheless report it as failure. It was speculated that the media attention around SpaceX could be based on the novelty of its technical concept and progressive brand image.

Regardless of the media coverage, the price of a launch is a major contributing factor in the decision for the customer. For SpaceX, expensive institutional flights might have allowed commercial flights to launch at a reduced cost. However, clarity whether the institutional flights are used to subsidise the commercial flights or if the true cost of flight is low and being sold for profit in institutional, is only speculative. In Europe, the commercial flights subsidise the institutional flights and therefore cannot be as competitively priced as the NGOs.

Conclusion and Recommendations

In the following, the main outcome of the discussion of the delegates is summarised as direct answers to the main questions of the Working Group.

How can the public sector and lawmakers in Europe support a successful global market introduction of a new European heavy lift launch vehicle? Should a new approach be found, compared to previous European vehicles?

1. Incentivise the commitment from ESA member states.

Since Ariane 6 is in a very competitive environment, it is fundamental to target both the commercial as well as the institutional market to ensure and possibly expand a solid launch business base.

For the commercial market, the proposed recommendation is to incentivise European customers to use European launchers. These incentives will help leverage on institutional clients, and could be in the form of tax benefits.

For the institutional market, the proposed recommendation is to create the necessary regulations to ensure that institutional clients launch with European launchers. Since European institutional missions are publicly funded, it seems fit to push for European procurement policy for its launchers. So far, ESA is the only institution to provide a clear commitment to using European future launchers.

2. Create and clearly define a branding strategy for Ariane 6.

It is clear that Europe is in a very different situation than the US when it comes to space missions, space marketing, and public image. The European players have little to no visibility in the general public, both European as well as world wide. This is due to the multilateral nature of ESA and the international organisation of the European space industry. Many countries contribute and hence many interests are at stake. In comparison, the US sends one single message. For this reason, Ariane 6 misses a clear brand and communication behind it.

We recommend to create and clearly define a branding strategy for Ariane 6. This means sending a simple unified message to the world in which ESA and its European partners are working together towards one goal. The goal is that the community creates unity. This could be done in the form of PR stunts, webcasts, mission logo competitions, etc. A constant, easily recognisable branding that is associated with Ariane should be implemented.

3. Create an European Investment Insurance Agency.

The third recommendation by the Group is to create an European Investment Insurance Agency where commercial clients can get credit or insurance for their payloads at favourable conditions. The idea is to promote European launchers and give a more attractive offer beyond the launcher itself. The current launching landscape is quite competitive, with emerging launchers from China, US, India, etc. So it is fundamental for Europe to differentiate itself by creating a more attractive commercial offer. Such an investment or insurance agency for European launchers could work similar to the maritime shipping insurance companies that they take care of payloads.

4. Ensure a Plan B for launch.

Plan B consists of having a backup launcher. This means that if Ariane 6 is not available for any specific reason (i.e. booked with another client), it is fundamental to have a backup launcher. It is crucial to have satisfied clients and good reputation, and most importantly, show that a solution is available regardless of the situation. Hence creating an international institutional agreement for backup launchers with other countries (e.g. Japan) and also maintain the aforementioned assurance and financial support, the client is locked with Ariane 6 for future launches. A similar agreement has already been put in place for Ariane 5 with JAXA and ULA, although it has never come into action

5. Introduce an European Launch Package

The idea behind the European Launch Package is to consolidate and unify various services into one (e.g. payload manufacturing, insurance, launch service, and ground support). This is beneficial at various levels. First, it shows the unity in Europe and the collaboration between member countries and companies. Second, it creates very attractive and competitive offers that other countries will find difficult to compete with. It also helps to create attractive offers for new clients. Clients that do not yet have space capabilities but still want a simple way to access space.

What are the key elements the industrial organisation needs to address during the development as well as exploitation phase with respect to market introduction? In which respect the European industry needs sto further evolve to face a more competitive global environment?

1. Propose a Single Launch Service Operator.

Understanding that Arianespace is the sole proposed operator of the Ariane 6, the proposed solution is to create an environment that encourages the creation of alternative European launch service providers with different service offerings. This solution would allow utilising more efficient and individual operating strategies for different customers, as well as capturing different markets and expanding economies of scale. An analogy would be the airline industry: companies like Ryanair and Easyjet are low cost operators with very similar hardware like the big flag carriers, but with a stripped down service, infrastructure, process, and different launch sites.

2. Introduce a European Launch Service Operator.

Arianespace cannot access foreign institutional and commercial markets like the US. For this reason the export of Ariane 6 should be encouraged—as a whole rocket or its components/parts/stages and technologies—to foreign or partially foreign launch service operators as another revenue stream. This option would give access to geographically locked markets, diversify operating environments, and expand economies of scale. EU and the US had already similar operating joint ventures like ATK/Ariane liberty concept, Zenit/sea launch, EADS/Northrop Grumman KC-45.

3. Prevent geo-return influencing the supply chain.

Geo-return favours the political supply chain solution over the technical/lowest cost solution. A more private PPP would mean more funding from the private sector and hence ease the geo-return requirements, reduce the influence of politics and the public sector/agencies, and increase responsiveness and flexibility in the supply chain and the potential for lower cost solutions.

4. Prevent finite captive markets.

There is a limited captive market demand for Ariane 6 (ESA, Galileo, Copernicus), hence the encouragement of the creation of alternative use scenarios using Ariane 6 within the industrial organisation is highly recommended. This would diversify the customer base and drive economies of scale.

How could a marketing and outreach strategy for a new European heavy lift launch vehicle look like? Can Europe learn from its competitors? Which commercial risks will exist in the early marketing phases, and how can they be mitigated? Which players of the European launch sector could be involved and who could be addressed?

The proposed recommendations below are based on engaging three different target groups: customers, enthusiasts, and the general public. A definition of the targeted groups are shown below along with the justification of these targeted groups.

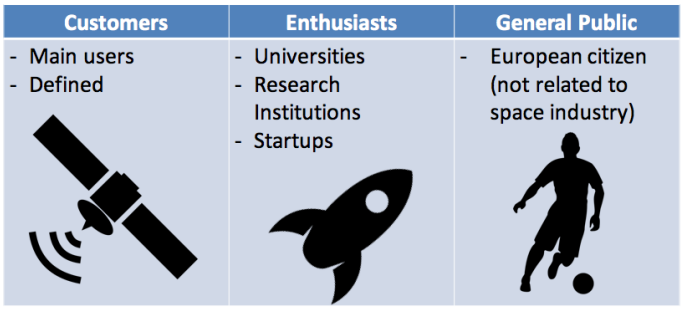

Figure 3. The targeted users.

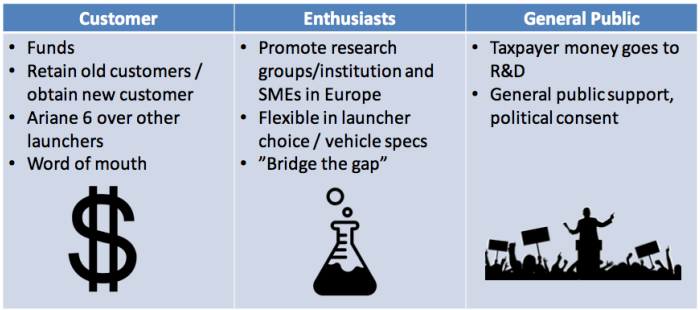

Figure 4. Justification of targeted users.

1. Engage the customers.

Customers are the large satellite/spacecraft manufacturers that purchase launches. They are a well-defined set of companies that know the launch industry well. They have the necessary funds to pay for launches. Existing customers are likely to continue using Ariane launchers, and new customers can be attracted by the reliability of the Ariane legacy. The small size of the industry means that word of mouth and personal contact is the most effective way to attract attention, actual marketing is considered secondary.

To engage with the customers, the high reliability of the Ariane 5, which is likely to carry over to the Ariane 6, would be the main unique selling point (USP) of the launcher. In addition, the launcher could be

made as flexible and modular as possible to accommodate a wide set of payloads and services to appeal to a large group of customers.

2. Engage the space enthusiasts.

Enthusiasts can be defined as startups, researchers, etc. that are interested in launching small payloads such as microsats and cubesats. The launches are meant to test technologies and for scientific research. It is important promote Ariane with space enthusiasts, and therefore research groups and small companies within Europe. Additionally, small payloads are usually very flexible in terms of launch vehicle, orbit, and delays. Ensuring that the launch of small payloads becomes more accessible could potentially bridge the gap between large and small/micro payloads. This development would make small payloads more viable from a commercial stance, both as platforms for technology demonstration and general commercial use.

To promote the services of Ariane 6 to space enthusiasts, reasonable prices for small payloads should be provided. The development of small payloads through sponsorships and competitions should also be considered (e.g. the current Fly Your Satellite programme by ESA or the Google Lunar XPRIZE).

3. Engage with the general public.

In addition to space industries and enthusiasts, European citizens with no links to the space industry should also be encouraged to engage with Ariane 6. It is important to show taxpayers that their money going to R&D is being used effectively. General public support for the programme is also important and can lead to more political consent in decisions related to ESA in general.

Successful engagement with the general public would involve not only promoting Ariane 6, but also the space sector in general. This can be achieved by improving transparency regarding Ariane, its construction, and development through media exposure.

A summary of the recommendations of how to target the different users and a figure showing the other factors that would determine the support from the users can bee seen below:

Customer	Enthusiasts	General Public
• Legacy of Ariane 5: reliability • Flexibility / modularity for wide set of services/payload	• Reasonable price / for free through sponsorship / competition	• Promote European space sector as well as Ariane 6 • Improve transparency • Media exposure
• Single/Dual launch with re-ignition capability • ISS Cargo • Future mission concepts?	• Fly Your Satellite (ESA) • XPRIZE (Google)	• Advertise by association • Live stream on-board camera • Documentaries through development stage
• Across all target groups: consistent branding e.g. logo, motto...		

Figure 5. How to target the different users?

Customers	Enthusiasts	General Public
Risks: • New launcher, no statistical reliability Mitigation: • No high profile payloads for first launches	Support from: • National governments and ESA, launcher providers (Arianespace or ASL)	Support from: • National Governments and Media channel in order to promote ESA activities on a wider scale

Figure 6. Other factors of the different users.

REFERENCES

Space Exploration Working Group

1) Maslow, A.H. (1943). "A theory of human motivation". Psychological Review. 50 (4): 370–96.

2) Figueiro MG, Rea MS, Bullough JD (2006). "Does architectural lighting contribute to breast cancer?". J Carcinog. 5: 20

3) Vakoch, D. A. (2011) Psychology of Space Exploration - Contemporary Research in Historical Perspective. The NASA History Series National Aeronautics and Space Administration Office of Communications History Program Office Washington, DC.

4) Jon R., Navarro, B.J. (2008) The Radiation Challenge, NASA. Accessed online at: https://www.nasa.gov/pdf/284273main_Radiation_HS_Mod1.pdf on 15.04.2017.

5) Biglan, A., Hayes, S.C, & Pistorello, J. (2008). Acceptance and commitment: Implications for prevention science. Prevention Science, 9, 139-152.

6) Bond, F. W., Hayes, S. C., & Barnes-Holmes, D. (2006). Psychological Flexibility, ACT and Organizational Behavior. In S. C. Hayes, F. W. Bond, D. Barnes-Holmes, & J. Austin (Eds.), Acceptance and Mindfulness at Work: Applying Acceptance and Commitment Therapy and Relational Frame Theory to Organizational Behavior Management (pp. 25-54). Binghamton, NY: The Haworth Press.

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1. International Academy of Astronautics: Cosmic Study on Space Traffic Management, 2006 https://iaaweb.org/iaa/Studies/spacetraffic.pdf
2. United Nations Treaties and Principles on Outer Space http://www.unoosa.org/pdf/publications/STSPACE11E.pdf

3. Disaster Charter (https://www.disasterscharter.org/web/guest/text-of-the-charter)

Space Accessibility Working Group

[1] Aliberti, M. & Tugnoli M. (2016) The European Launchers between Commerce and Geopolitics, European Space Policy Institute