SPACE GENERATION
ADVISORY COUNCIL

7th Space Generation Fusion Forum

April 15-16 2018

Held annually in scenic Colorado Springs in conjunction with the Space Symposium, the **Space Generation Fusion Forum** is a two-day, high-intensity, fast-paced professional development and networking event focused on the international and US space industry. Delegates are students and young professionals from around the world and various facets of the space sector including science, engineering, law/policy, business/commerce, medicine, media, military, and government. Through discussion tracks, expert panels, keynote presentations, and interactive activities, these selected delegates will "fuse" their perspectives.

By attending the Space Generation Fusion Forum, delegates will learn, share their knowledge, network with fellow students and young professionals in the space industry, and meet the industry's leaders and experts.

All output produced by the Space Generation Fusion Forum is compiled into a report to be presented at the United Nations Committee on the Peaceful Uses of Outer Space, as well as other conferences around the world.

Visit the SGFF 2018 website at spacegeneration.org/sgff2018

The **Space Generation Advisory Council** in Support of the United Nations Programme on Space Applications is a global non-governmental, non-profit (US 501(c)3) organisation and network which aims to represent university students and young space professionals to the United Nations, space agencies, industry, and academia.

Cover Image: Каспий (Caspian Sea)
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Contents

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Letter from the SGAC Chairs

It is our great pleasure to present you the report of the seventh Space Generation Fusion Forum (SGFF), held in Colorado Springs, USA on 15th and 16th, April 2018. The event gathered 75 students and young professionals from 17 countries to discuss and explore a diverse range of topics relevant to the space generation. In order to enhance the discussions, five focused tracks were organised, and experts in this field were invited to moderate and guide the attendees' discussions.

We are also pleased to have the opportunity to invite selected SGAC members to join us at the Space Generation Fusion Forum through the Global Grant Programme. The winners were selected based on their experience, dedication, and contributions to the SGAC.

We would also like to thank our team of highly dedicated volunteers whose work is the reason for the ongoing success of the Space Generation Fusion Forum, and of course Chantelle Dubois (Canada), Space Generation Fusion Forum 2018 Manager, who lead this year's team. This event would also not have been possible without the coordination, planning, and motivation of these 15 students and young professionals from around the world.

A very special thank you also goes to the Space Foundation, host of the Space Generation Fusion Forum. We greatly appreciate the relationship between Space Foundation and the Space Generation Advisory Council, which has been invaluable throughout this endeavour.

Last but not least, SGAC would like to extend a thank you to all of the event's sponsors who helped make the Space Generation Fusion Forum a reality. We are proud of the outcome of the seventh Space Generation Fusion Forum and look forward to building on its success and momentum.

Sincerely,

Alexander Gibson (USA)
SGAC Chair

Matteo Emanuelli (Italy)
SGAC Co-Chair

Letter from the SGAC Executive Director and the SGFF 2018 Manager

The Space Generation Fusion Forum was born out of the idea that the next generation of space leaders need to be collaborative and informed about the global space industry. This year our goal was to create a programme that not only informed our attendees about the range of activities happening around the world in the space sector, but also empower them through shared knowledge and insight exchanged with peers and mentors—a "fusion" of perspectives and ideas.

To that end, 75 delegates from 17 countries were invited to join us in Colorado Springs, USA for a day-and-a-half of keynote presentations, panel discussions, discussion track sessions, networking, and professional development. The organising team consisted of 15 volunteers who were located anywhere in-between East Coast USA, to East Coast Australia. A broad range of professional and academic disciplines were represented, ranging from government, policy/strategy/law, medicine, engineering, and science, all the way from undergraduate students to young professionals in their early careers.

We'd like to thank our host, the Space Foundation, as well as our generous sponsors and partners. We'd also like to thank the speakers, moderators, and panellists who took time out of their busy schedules to join us this year.

Without further ado, we are pleased to present the Space Generation Fusion Forum 2018 Report.

Sincerely,

Clémentine Decoopman (France)
SGAC Executive Director

Chantelle Dubois (Canada)
SGFF 2018 Manager

SGFF 2018 Overview

Space: Into the Mainstream

As space begins to enter the mainstream in our daily culture, the next generation will have to tackle problems ranging from regular launches interfering with air traffic patterns and increasingly congested orbits requiring space traffic management, to the lack of public excitement and therefore funding as trips to the Moon and Mars become more regular. Simultaneously, the International Space Station, which has served as an anchor for space exploration, international collaboration, and commercial opportunities for the last 20 years, is reaching the end of its support cycle with increasing rhetoric of moving on to other projects. Once space becomes an even more obvious and ubiquitous part of our everyday lives, can we step beyond the engineering driven space exploration towards a more diverse group of occupations and nationalities in order to maintain a high level of sustainability in space.

SGFF 2018 Logo

This year the Space Generation Fusion Forum team has curated a logo to better represent the mission and purpose of the event. The logo utilizes the same logo system as both the Space Generation Advisory Council and the United Nations, featuring two olive branches crossed to symbolize peace–in this context, we intend for it to represent the peaceful uses of outer space. This is also a nod to our relationship with the United Nations, and in particular the UN Committee on Peaceful Uses of Outer Space, to whom the SGFF's outcomes are reported to at the committee's General Assembly meeting.

In the foreground, the outline of Pike's Peak in Colorado Springs can be seen, representing the location of the Space Generation Fusion Forum, using a burnt-orange hue from the region's mountains. The colour can also be seen as representing Mars, and the background's grey representing the Moon. Both of these destinations are of particular interest to today's space explorers, as the international space community prepares for deep space missions to these locations. At the Space Generation Fusion Forum delegates "fuse" their perspectives and provide input that will hopefully influence the future of the space industry, being part of its lift off.

Schedule

Sunday, April 15

AM Master of Ceremonies: Mr. McClain Goggin (SGFF 2018 Program Coordinator)

08:00 - 08:15 | Shuttle from Hotel Elegante to Cheyenne Lodge
08:15 - 09:00 | Delegate Registration & Breakfast
09:00 - 09:30 | Opening Remarks: Ms. Clementine Decoopman (Executive Director, SGAC) & Ms. Chantelle Dubois (SGFF 2018 Manager, SGAC)
09:30 - 09:45 | Host Keynote: Mr. Steve Eisenhart (Senior VP, Strategic & International Affairs, Space Foundation)
09:45 - 10:45 | Interactive Session: Navigating Your Career with Confidence & Joy, Ms. Debra D. Facktor (VP and General Manager, Strategic Operations and Commercial Aerospace, Ball Aerospace)
10:45 - 11:00 | Coffee Break
11:00 - 11:15 | Discussion Track: Subject Matter Expert Introductions

- DT1: Innovative Influences of Space on Earth - Mr. Rodrigo da Costa (Galileo Services Programme Manager, European GNSS Agency)
- DT2: Entrepreneurship in the Space Industry - Ms. Taryn Tomlinson (Senior Engineer, Chief of Staff, Canadian Space Agency)
- DT3: Space Tech and Innovation - Mr. Steve Jurczyk (Associate Administrator, NASA Space Technology Mission Directorate)
- DT4: Humans in Space - Mr. Richard Hieb (Astronaut (retired), NASA)
- DT5: Space Science - Dr. Jonathan Arenberg (Space Science Missions Chief Engineer, Space Center of Excellence, Northrop Grumman Aerospace Systems)
- DT6: National Security in International Space - Dr. Peter Hays (Adjunct Professor, George Washington Space Policy Institute and Senior Analyst, Falcon Research)

11:15 - 12:00 | Discussion Track: Session 1
12:00 - 13:00 | Lunch and Lunch Keynote: Ms. Lisa B. Callahan (VP and General Manager, Commercial Civil Space, Lockheed Martin Space Systems Company)

PM Master of Ceremonies: Ms. Tara Halt (SGFF 2018 Program Coordinator)

13:00 - 13:25 | Astronaut Keynote: Mr. Richard Hieb (Astronaut (Retired), NASA)
13:25 - 13:35 | Speaker: Mr. Kyle Acierno (Managing Director, Europe, iSpace)
13:35 - 14:20 | Interactive Panel: Cooperation in Deep Space Exploration moderated by Mr. Anthony Yuen (SGFF 2018 Delegate Coordinator)

- Mr. Robert Chambers (Director, Human Spaceflight Strategy and Business Development, Lockheed Martin)
- Dr. Pascale Ehrenfreund (Chair of the Executive Board, DLR)
- Mr. Clay Mowry (Vice President for Global Sales, Marketing, and Customer Experience, Blue Origin)
- Mr. Steve Jurczyk (Associate Administrator, NASA Space Technology Mission Directorate)

14:20 - 14:35 | Coffee Break
14:35 - 15:00 | Speaker: Mr. Eric Choi (Senior Business Development Manager, Magellan Aerospace & Award-Winning Author and Editor)
15:00 - 16:05 | Discussion Track: Session 2
16:05 - 16:15 | Speaker: Ms. Karen Kuhlman and Ms. Karen Rucker (Brooke Owen Fellowship Program)
16:15 - 16:35 | Closing Keynote: Mr. Robbie Schingler (Co-Founder & Chief Strategy Officer, Planet)
16:35 - 16:40 | End of Remarks: Ms. Chantelle Dubois (SGFF 2018 Manager, SGAC)
16:40 - 17:00 | Group Photos
17:00 - 17:15 | Shuttle from Cheyenne Lodge to Hotel Elegante
17:30 - 19:30 | Delegate Dinner

- 18:00-18:30 awards and pin ceremony
- 18:30-19:30 "Into the Unknown" Documentary Screening followed by JWST panel

- Dr. Jonathan Arenberg (Space Science Missions Chief Engineer, Space Center of Excellence, Northrop Grumman Aerospace Systems)
- Ms. Allison Barto (Program Manager, James Webb Space Telescope, Ball Aerospace)
- Ms. Carleen R. Beste (Director, Global Corporate Citizenship and Manager, Northrop Grumman Foundation)
- Mr. Martin Frederick (Corporate Director, Civil Space Programs, Northrop Grumman Corporation)

19:30 - 19:45 | Shuttle from Hotel Elegante to Space Foundation HQ
19:45 - 21:00 | Yuri's Night at the Space Foundation HQ
21:00 - 21:15 | Shuttle from Space Foundation HQ to Hotel Elegante

Monday, April 16

Master of Ceremonies: Mr. Tobias Niederwieser (SGFF 2018 Program Coordinator)

07:45 - 08:00 | Shuttle from Hotel Elegante to Cheyenne Lodge
08:00 - 08:15 | Breakfast
08:15 - 08:20 | Opening Remarks: Ms. Chantelle Dubois (SGFF 2018 Manager, SGAC)
08:20 - 08:50 | Opening Keynote: Ms. Victoria Samson (Washington Office Director, Secure World Foundation)
08:50 - 09:50 | Discussion Groups: Presentations
09:45 - 10:25 | Interactive Session - "New Race to Space": Dr. Jan Woerner (Director General, European Space Agency)
10:25 - 10:40 | Coffee Break with Smores
10:40 - 11:10 | Closing Keynote: Mr. Carlo des Dorides (Executive Director, European Global Navigation Satellite Systems Agency)
11:10 - 11:20 | Opportunities with SGAC: Ms. Clementine Decoopman (Executive Director, SGAC)
11:20 - 11:30 | Closing Remarks: Ms.Chantelle Dubois (SGFF 2018 Manager, SGAC) & Ms. Lauren Smith (SGFF 2018 Deputy Manager, SGAC)
11:30 - 11:45 | Shuttle from Cheyenne Lodge to Broadmoor Hotel for the Space Symposium

Space Symposium, New Generation Space Leaders Activities

All SGFF 2018 Delegates will have access to the Space Symposium/NewGen Activities on Monday

12:00 - 13:00 | Vice President Presentation (limited seating available/will be streamed)
13:00 - 14:30 | New Generation Space Leaders: Mission Overview and Welcome Luncheon
15:00 - 17:00 | New Generation Space Leaders: Speed Mentoring
17:00 - 18:00 | New Generation Space Leaders: Networking Reception with Mentors
18:30 - 19:30 | 34th Space Symposium Opening Ceremony
19:30 - 21:00 | Grand Opening of the Ball Aerospace Exhibit Center and Pavilion

Speakers and Moderators

Kyle Acierno
Managing Director
iSpace Europe

Jonathan Arenberg
Space Science Missions
Chief Engineer, Space
Center of Excellence
Northrop Grumman
Aerospace Systems

Allison Barto
Program Manager, James
Webb Space Telescope
Ball Aerospace

Carleen R. Beste
Director, Global Corporate
Citizenship and Manager,
Northrop Grumman
Foundation
Northrop Grumman
Corporation

Lisa B. Callahan
Vice President and
General Manager,
Commercial Civil Space
Lockheed Martin Space
Systems Company

Robert Chambers
Director, Human
Spaceflight Strategy and
Business Development
Lockheed Martin

Rodrigo da Costa
Galileo Services
Programme Manager
European Global
Navigation Satellite
Systems Agency (GSA)

Carlo des Dorides
Executive Director
European Global
Navigation Satellite
Systems Agency (GSA)

Steve Eisenhart
Senior Vice President, Strategic & International Affairs
Space Foundation

Pascale Ehrenfreund
Chair
DLR Executive Board

Debra D. Facktor
Vice President and General Manager, Strategic Operations
Ball Aerospace

Martin Frederick
Corporate Director, Civil Space Programs
Northrop Grumman Corporation

Richard J. Hieb (Rick)
Astronaut (Retired)
NASA

Peter Hays
Adjunct Professor, George Washington University
Space Policy Institute
Senior Space Policy Analyst, Falcon Research

Stephen Jurczyk
Associate Administrator
NASA Space Technology Mission Directorate

Clay Mowry
Vice President for Global Sales, Marketing and Customer Experience
Blue Origin

Victoria Samson
Washington Office Director
Secure World Foundation

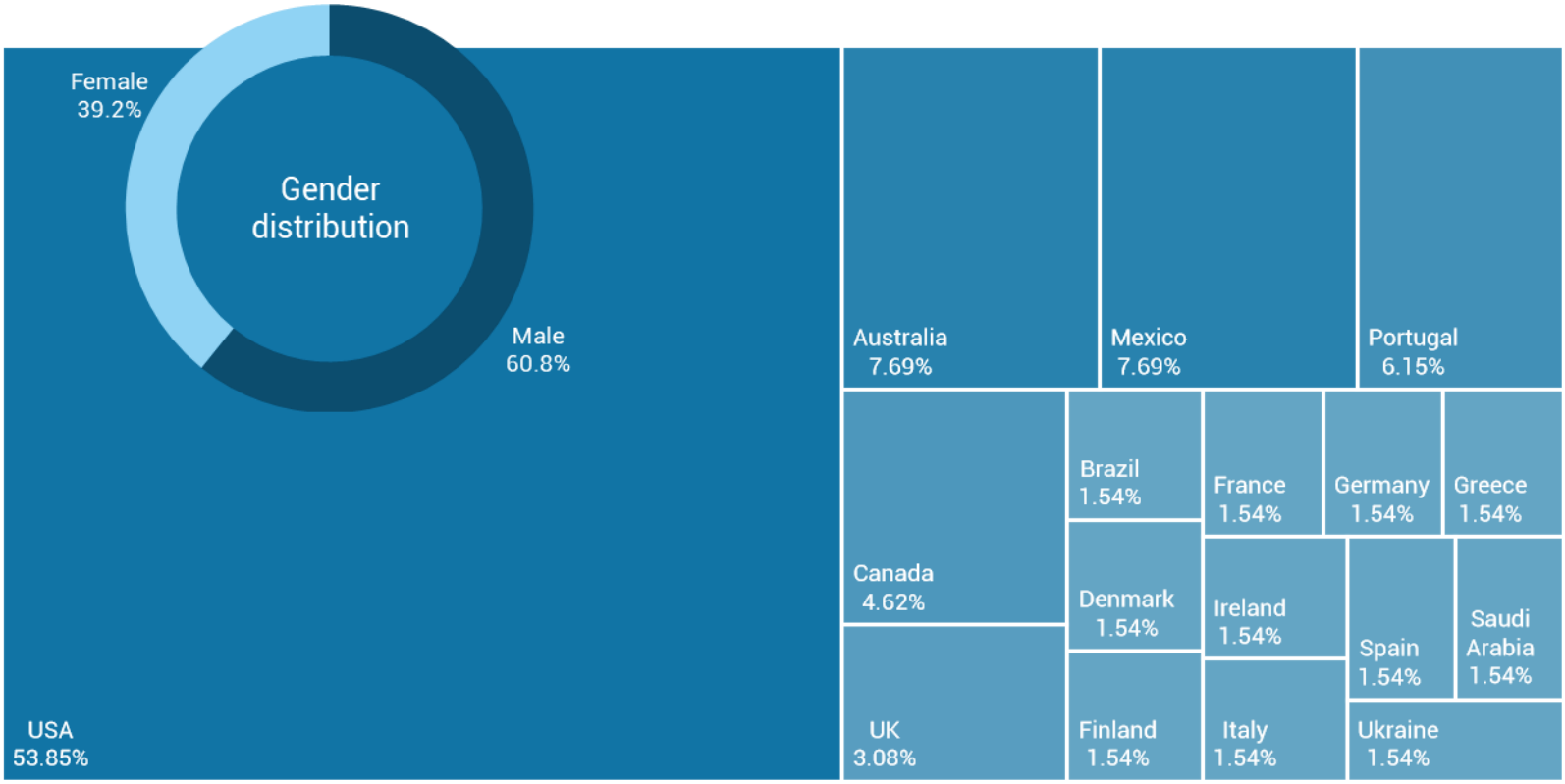
Robbie Schingler
Co-founder And Chief Strategy Officer
Planet

Taryn Tomlinson
Senior Engineer, Chief of Staff
Canadian Space Agency

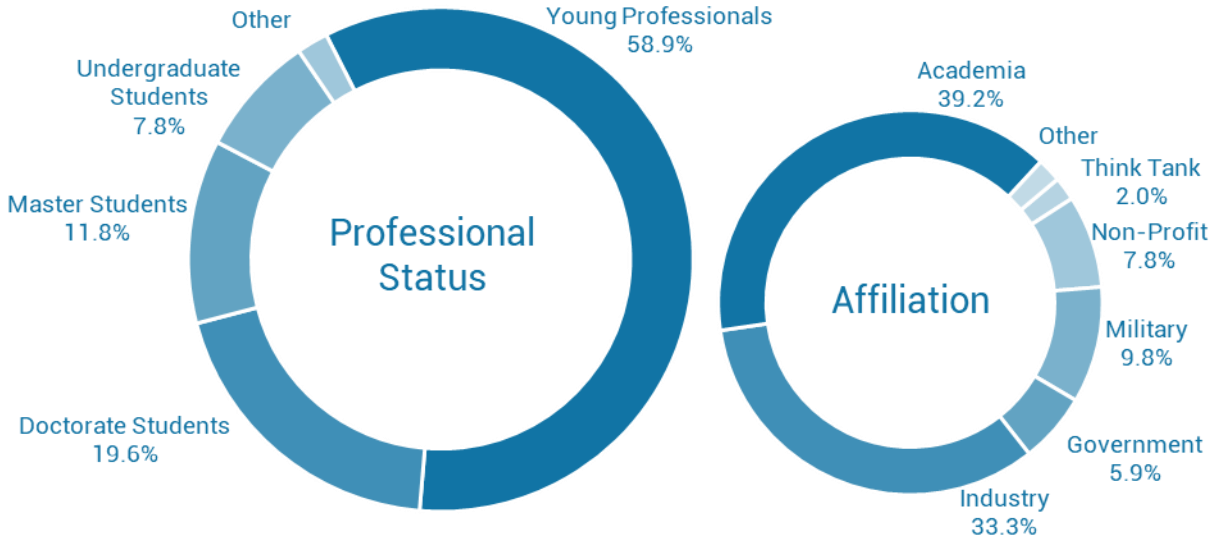
Dr. Jan Woerner
Director General
European Space Agency

Statistics for SGFF 2018

The 7th Space Generation Fusion Forum received 160 delegate applications, a record for the event. Of these applicants, 75 delegates from 17 countries around the world were accepted to attend. Of those delegates, 40% identified as female, and 60% as male. In addition to delegates, there were 15 members on the organising team, and 21 industry professionals that participated as either speakers, panellists, or discussion group moderators.



Among the delegates, young professionals were the largest represented group and made up almost 60% of the attendants. As for affiliations, the biggest chunk of delegates was affiliated to academia (39.2%), followed by industry (33.3%) and the military (9.8%).



Day 1 Highlights

The morning of April 15, 2018 75 delegates (students and young professionals) from 17 countries and from all across the space sector came together for the 7th Space Generation Fusion Forum in Colorado Springs, Colorado. Four of SGAC's recognised regions were represented, including: North, Central America and the Caribbean; South America; Europe; Asia-Pacific, and the Middle East. Our theme this year was "Into the Mainstream", and over the next day and a half our delegates would explore how the space landscape will change as space shifts into mainstream culture, becoming a normal part of our everyday lives. We had an amazing line-up of speakers from across the space industry, discussed topical space issues including humans in space to national security, and our delegates were able to meet and network with passionate young people from a variety of backgrounds and disciplines.

An early start saw our delegates quickly caffeinated, before kicking the day off with opening remarks from Steve Eisenhart, Senior Vice President of Strategic and International Affairs at our host, the Space Foundation. Throughout the day, we had an outstanding cross-section of speakers. Deborah D. Facktor (Vice President and General Manager of Strategic Operations at Ball Aerospace) gave our delegates 10 key tips for moving forward with their aerospace careers and invited attendees to share their advice for each other. Advice like "Take on the hard stuff" and "make sure to sit at the table and be involved" are tips the delegates quickly took to heart in the first round of Discussion Tracks, taking place for the rest of the morning.

Food was definitely in order after such a busy morning, and during our Lockheed Martin-sponsored lunch, Lisa Callahan (Vice President and General Manager of Commercial Civil Space, Lockheed Martin) inspired us all with Lockheed's vision for humanity's journey to Mars. The future does look exciting!

It was then time for a little career motivation, with former NASA Astronaut Rick Hieb highlighting the need for a career in space to be a continuous learning and self-improvement process. This nicely segued into our next speaker, Kyle Acierno, a current SGAC member and managing director of iSpace Europe. Kyle demonstrated what is possible as a young professional in the space industry, speaking about iSpace's journey from a start-up competing in the Lunar X Prize to the development of its own lunar rover to their vision for lunar mining missions.

Keeping the focus on pushing the boundaries of space exploration, our Deep Space Exploration panel, moderated by SGFF Delegates Team Member Anthony Yuen, brought together some big names in Human Spaceflight: Clay Mowry (Vice President of Global Sales, Blue Origin), Rob Chambers (Director of Human Spaceflight Strategy and Business Development, Lockheed Martin), Pascale Ehrenfreund (Chair of the DLR Executive Board) and Stephen Jurczyk (Associate Administrator, NASA) to discuss the future of deep space exploration, the need for collaboration between public and private, between governments and between academia and industry, and crucially that future space endeavours need to embody agility and flexibility in their design.

Shifting gears slightly, Eric Choi, Senior Business Development Manager for Magellan Aerospace and a Science Fiction writer in his spare time, spoke about the incredible influence popular culture and science fiction have had on modern space travel. Such influences are becoming increasingly important ways of exposing and inspiring the public, shifting space into the

mainstream. Eric Choi provided a fantastic opportunity for delegates to hear a different perspective on the space industry than they would otherwise be exposed to.

An exciting addition to our program this year was the Brooke Owens Fellowship Presentation, a fellowship created to provide industry support and mentor female undergraduates in the aerospace sector. Karen Kuhlman and Karen Rucker, both recipients of the fellowship this year, spoke to the Forum about the importance supporting women in the industry and the amazing opportunities the fellowship presents.

After a packed day, it was then time to hear the closing keynote from Planet Co-Founder and Chief Strategy Officer Robbie Schingler, discussing Planet's growth from a garage start-up to a company of over 500 employees and three offices around the world. Robbie's message to the delegates included his top 10 tips to solve problems and progress your career, like "do it with the right people", "start small and iterate" and "be a market maker".

We ended our day with a Northrup Grumman sponsored dinner at the Hotel Elegante, the presentation of our scholarship winners, and the newly created SGAC Pioneer Award, awarded to our SGFF Manager Chantelle Dubois and Delegates Team Member Anthony Yuen for extraordinary commitment to SGAC and its mission. After a fascinating documentary on the James Webb Space Telescope (JWST), Northrop Grumman hosted a JWST panel with Allison Barto (Program Managers for the JWST at Ball Aerospace) and John Arenberg (Space Science Missions Chief Engineer, Northrup Grumman). Both had some good advice for our delegates including "don't wait until the end of projects for lessons learned, record them as you go" and that "generalists with deep technical specialities are highly valuable". The evening was concluded in style, celebrating the Yuri's night taking place at the Space Foundation HQ.

Day 2 Highlights

Fusion Forum delegates returned for the second and last day at the Cheyenne Lodge. The day started off with opening remarks from Victoria Samson, Washington Office Director of the Secure World Foundation.

After Victoria's thought-provoking speech on the secure, sustainable and peaceful uses of outer space, the discussion track group presentations began, with each discussion track nominating one person to present their findings to the rest of the Fusion Forum delegates. The first discussion track was 'Innovative Influences of Space on Earth' and was presented by Danny Bednar of the University of Western Ontario's Department of Geography. Danny spoke about solving problems outside of the space sector by spinning out space technologies. Next up was the 'Entrepreneurship in the space industry', co-presented by Colin Nugen of Lockheed Martin and Mike Provenzano of Carnegie Mellon University's MBA programme in Pittsburgh. Colin and Mike examined the opportunities in the industry in the coming years, particularly with Earth Observation data and how only 10% of that data is used today. The 'Space Tech and Innovation' track was presented by Global Grants Programme recipient, Genaro Grajeda of Eutelsat who discussed how technology will advance as a necessity, rather than as a trend, as humans travel to deep space. Saul Reza Arcelus of AeroMexico presented the results of the 'Humans in Space' track. Saul highlighted the importance of learning from the past to build a sustainable path forward for human exploration in deep space. The 'Space Science' track considered the roles for both humans and robots in future space science missions and was presented by Claire Wilhelm of the George Washington University Space Policy Institute. The final track, 'National Security in International Space, was represented by Brian Kester of the U.S. Air Force. Brian and his group deliberated on what causes instability on the space sector's national security areas and what we can do to improve stability.

It was then time for delegates to participate in one of the European Space Agency's Director General Jan Woerner's 'Jams with Jan' sessions on the moon village and his perspective on the new race to space. Dr. Woerner's position as ESA DG provided delegates with a unique opportunity to interact with the person responsible for bringing 22 member states to collaborate with each other to achieve space objectives that benefit a vast community.

After Dr. Woerner's interactive session, delegates went outside for a well-deserved s'more break by the firepit on the Cheyenne Lodge porch, with the fantastic weather and beautiful views of the Rocky Mountains making the break all the *s'more* worthwhile.

Mr. Carlo des Dorides, the Executive Director of the European Global Navigation Satellite Systems Agency gave the closing keynote speech and provided an overview of the Galileo program initiated by ESA. Carlos went on to discuss the advancements in technology and improvements in consumer experience through the use of the global navigation satellite system program.

We ended our half-day, final session with a heartfelt speech by the Fusion Forum manager for 2018, Chantelle Dubois. Chantelle thanked her team that made the Fusion Forum possible, the sponsors involved in getting this event off the ground, and her Deputy Manager, Lauren Smith who will be leading the Fusion Forum team in 2019. Our delegates then headed to the Broadmoor Hotel to attend day 1 of the Space Symposium, impatient to attend SGFF2019.

Discussion Track 1: Innovative Influences of Space on Earth

Sponsored by the European GNSS Agency (GSA)

Moderator: Mr. Rodrigo da Costa, Galileo Services Programme Manager, GSA

What do we make of the Apollo moment?

The successful landing of Apollo 11 on the Moon generated great public interest in the space programme, and it is said to be responsible for the growth of advanced degrees in engineering and related fields throughout the second half of the 20th century. The question around this debate was thus about whether there would ever be a new Apollo moment, and if so, what will this be.

Delegates noted the historical idiosyncrasies of the Apollo programme and the first crewed mission to the Moon. While another Apollo moment is possible, the historical and political circumstances that allowed for the successful Apollo missions are probably unique to their time.

One discussant noted that slower processes such as global climate change and increasing global inequality might be pushing our generation to solutions provided by space-based technologies. In this sense there may not be Apollo moments, but longer-term processes providing inspiration.

Other discussants provided the example of the launch of the Falcon Heavy Rocket in 2018 as an inspirational moment within the space community as well as beyond. This reflection notes the potential for activities by non-state actors to provide inspirational moments that turn public attention towards the space sector. It was then discussed as to how much nationalism and the conditions of the Soviet-American rivalry were necessary for much of the cultural impact of the Apollo missions. Discussants questioned whether private actors' accomplishments would be as inspiring as those of national governments.

Another example provided was the one-year orbital flight of Scott Kelly: that was agreed to be an inspiring moment in space, but delegates debated as to as to whether that truly had significant cultural impact beyond the space sector.

Ultimately, discussants agreed that outreach and communication from within the space community was needed to reiterate the value of space technology and exploration to their lives. Group members also promoted the value of the inspirational nature of space accomplishments, as both cultural moments of pride as well as drivers of technological and political progress.

The roles of public and private actors

Discussion then moved to the roles of public (government) and private (for profit) actors in outer space and the future of space.

Discussants noted that a unique component of the private sector was the innovation and risk-taking capacity of profit seeking firms. This was contrasted with the slower speed of government processes. Nevertheless, it was also suggested that some space assets are perhaps best thought of as crucial public infrastructure akin to highways and sewer systems. In this sense there is a role for government in providing basic public good from space-based infrastructure, such as navigation systems, communication and Earth observation processes as part of national infrastructure for all citizens.

Conversely, discussants were unsure whether there was value in, or an ethical claim for, ever privatising certain aspects of public space infrastructure.

The topic was archived by the common view that private interests have always benefited from initial public investment, and that a powerful role for government in outer space was to provide the pathway for private actors to experiment and innovate.

Promoting the Value of Space on Earth

Discussants moved to explore common issues surrounding space advocacy and the challenges of promoting the value of space-based technology on Earth. Particular attention was placed on communicating space benefits in accessible language to both the public and interdisciplinary audiences. Group members felt that many in the space community have a difficult time sharing their work and insights across disciplines such as astronomy, engineering, and business.

In order for space advocates to develop stronger communication skills, the value of interdisciplinary learning and networking opportunities was stressed as key to allowing members of the space sector to bring space to the mainstream. Participants noted that functions such as the SGFF help people become familiar with and sort out the cultural and language differences between disciplines.

The ability to show the impact of space technology for business, education, science, and people's daily lives was noted as a useful strategy in making connections between the space sector (or space bubble) and other sectors of society yet to integrate space into their practices. Promotion of space education to young people was also identified as a key goal for mainstreaming space awareness.

Finding New Places where Space can Innovate

The last discussion focused on how people within the space sector can identify societal problems outside of those which we are already familiar.

Ultimately group members discussed the value of listening to the insights from people in other fields with an open mind towards what we know that might be able to help them. The notion of promoting solutions, as well as listening to problems was seen as crucial for linking space applications to societal issues. The value of cross-disciplinary learning was highlighted, such as attending conferences outside of the space sector to identify academic, scientific or business problems that may benefit from the introduction of space applications.

Discussion Track 2: Entrepreneurship in the Space Industry

Moderator: Ms. Taryn Tomlinson, Chief of Staff, Canadian Space Agency

What policies would be most beneficial to future space entrepreneurs as space becomes more mainstream?

The delegates of the DT2 started by acknowledging that policies and regulations can be both positive and negative. Some regulations, as Trade Agreements and free trade, COTS, CATALYST, stimulate entrepreneurial activities. Similarly, some regulations instead hinder entrepreneurs: ITAR, for instance, remain a speedbump for many companies, both within and outside the US.

Delegates agreed on the need to focus on the opportunities that do provide a stimulus to businesses and leverage them to collaborate internationally. If it takes too long for the government to act, then companies could be creative. Delegates brought Virgin Orbit's Vox Space subsidiary as example of creative solution.

Some examples discussed that hamper innovation and entrepreneurship were restrictions in rendezvous, proximity operations and docking in space; the too wide range of actors and agencies to be consulted in order to receive authorizations to launch and operate in space.

Delegates agreed on the need for advocacy of entrepreneurial-friendly programmes in policy, remembering to not advocate for programs that deter entrepreneurs, such as government contracts that require shared intellectual property and data rights between the government and company.

Similarly, delegates discussed on the need to clarify the Outer Space Treaty in regard to the utilization of outer space resources, as well as the profiting from them. Currently the Treaty requests that any resources taken from space is equally shared between all countries on Earth. Luxembourg and US have taken progressive stances on this, but all countries need to be involved in this decision. Not to hinder entrepreneurial activities, this treaty could be changed to be more like Maritime law, where international waters are not owned by countries, but resources in them (e.g. fish) are still available to be owned and exploited.

Finally, a last discussed item under this topic was the possibility to leverage public/private partnerships to create a wider availability of financial instruments, such as equity-based transactions, convertible notes, contracts, loans.

What can NewSpace and traditional aerospace companies learn from each other?

Moving on the following discussion item, delegates agreed on the relevance of employee retention to enable innovative mindsets, as employees are a company's most important assets, and it is very important to keep top talent. From the more experienced traditional organizations, New Space companies can learn to not overwork their employee base and encourage mentorship programmes.

Discussant agreed on the need for New Space companies not to imitate the large traditional aerospace corporations, avoiding the creation of bureaucratic organizational charts that prevent interaction and sharing of knowledge. Instead, New Space companies should make cross-functional, agile teams.

Similarly, large organizations can and must learn from New Space companies, thus remain on the pulse of what's occurring in the industry. It is true that they can benefit from bootstrapping and the new space scrappiness, but large companies also risk becoming complacent with cost plus development contracts, losing eventually to innovative start-ups that compete with fixed prices contracts and leverage every opportunity available to create revenue.

Large aerospace company are nevertheless learning from new space ventures by setting up infrastructure to mimic agile development processes. Delegates brought Boeing HorizonX and LM Ventures as examples.

Similarly, large aerospace companies need to fund R&D projects commercially when possible, thus limiting a business' risk profile to policy changes (e.g. new administration, international relations, etc.).

What are the opportunities for future innovation? Which markets are oversaturated?

Discussant started acknowledging that there's a widespread focus on the benefits of space products, while it's easier to sell the benefits of space when these are tied in to other industries, like explaining how imaging data or greenhouse gas emission monitoring can benefit an industry like, for instance, Agriculture.

From this, delegates discussed on a wide range of opportunities. Firstly, they agreed on the fact that Earth observation data is underutilized, and that there are numerous low-cost start-up opportunities available downstream of the satellite market. Earth observation data, despite being oversaturated, still is rich in opportunities, provided for instance by Artificial Intelligence.

A monetizable model for remote sensing would be creating a centralized data hub made with layers of different sensor technology, potentially using open source data, while continuing to find new ways to combine sensors to create new data and new insights.

Among other opportunities discussed there were:

- Artificial Intelligence and Machine Learning;
- Manufacturing in space for use on Earth, with examples being Pharmaceuticals, microelectronics;
- Enabling technology such as in-space servicing/logistics to manage debris, inactive satellites, space stations, lunar equipment, etc.;
- Emerging markets to fuel third world development and opportunity to shape policies within new space agencies, as it may be easier for developing countries to adopt ground breaking technologies and make an infrastructural leap before developed countries.

The delegates also discussed current oversaturated markets, with a clear focus on Rocket Launch market. This market will likely see consolidations in the near future, reaching a 4-5 major launch companies, similarly to what happened to the airline industry in the past decade. Delegates agreed on the need to be disruptive and very differentiated to be successful now.

Similarly, and as discussed earlier, delegates agreed on the potential saturation of the earth imaging market. Nevertheless, entrepreneurial mindset could find ways to fully fill the gap in EO Data utilization, as currently we only use about ~10% of the data we get from space.

Discussion Track 3: Space Technology & Innovation

Moderator: Mr. Steve Jurczyk, Associate Administrator, NASA Space Technology Mission Directorate

How do you view innovation on the Space Sector?

Delegates discussed the ongoing acceleration and expansion of products and services enabled by space systems and technology, and in particular remote sensing, communications, debris mitigation, satellite servicing, space tourism, space manufacturing, space resources, and the reduction of cost of access to space.

New Space, in particular, was agreed to be a main driver promoting innovation in the sector more than ever. New business models, approaches and opportunities are enabling innovation in applications and private investment. With a relevant factor being the overcoming of the more traditional risk-adverse mentality and approach.

Delegates noted that small satellites are leveraging a broader range of technologies, lowering the cost of access to space and making space more accessible for all actors.

How will it change as technologies on Earth develop?

Delegates discussed about the evolution of space tech, touching the topic of innovative solutions as algorithm-based design and other physics-based tools, the intensive use of 3D printing, rapid prototyping and agile development, the advent of Space Medicine, the development of better training tools as result of VR and AR applications, the integration of new materials for every part of the value chain of the space industry, the introduction of more optimized structures, and advances and upgrades on Systems Engineering.

Delegates agreed on the fact that it is up to this generation of young professionals to define the challenges and expected outcomes that will drive future technological changes.

How will it change as more humans journey into space?

Delegates debated about how technology and innovation will be impacted as human spaceflight becomes routine. Granted that technology will have to evolve by necessity, an ever-increasingly spacefaring civilization will drive projects that are more long-term, high-risk, and with high-pay offs. Technologies will need to be scalable, consequently allowing for lower cost missions and the need to develop even more innovative and creative solutions

Ideally, as more humans fly to space, there will be more stand alone, self-sufficient and sustainable technologies, and innovation in sciences related to the human factor will be considered ever more relevant.

Overall, more space travel will require, and enable large scale in-space infrastructure and in-space sustainability

Which technology will be pushed from the government to the private sector? Will agencies adapt innovations from private industry?

Discussant agreed on the fact that technology in the space sector will be driven by the private industry rather than the government, and that there is a perception of slow timelines for innovation in the space industry. A suggestion is for Governments to establish initiatives promoting certain space technologies or standards widening private actors' room for action.

Delegates also raised the need for awareness on the fact that governmental regulations and international governing bodies will be challenged to keep up with innovation trends.

Thus, the delegates came up with steps that UN OOSA and other international governing bodies would need to prepare for. Firstly, there will be the need to update a common set of regulations for emerging space capabilities and activities, integrating property rights, resources and behavioural norms for the space industry. Secondly, to keep up with innovation, international organizations will need to consider more flexible and scalable mechanisms other than treaties, for instance establish voluntary standards to encourage international partnering, considering the development of certification standards and establishing and developing a governing body similar to the International Telecommunications Union.

Critical Tech or Policy areas needed to be addressed before Space can truly enter the mainstream?

While discussing the final item of the Track, delegates agreed that for Space to truly become mainstream there's a need to address – and solve – Humans' physical limitations. In fact, many issues are still related to how humans could cope with the exposure to radiation (or how to avoid such exposure), the absence of gravity for long term, and how would they deal with medical emergencies when Earth (and gravity) are not an option. Issues to be addressed are also related to enabling space crews to be healthy and productive despite being subject to different life conditions, to study life spans and mortality of crews, to the lack of real-time communications. Finally, challenges to be addressed are those related to social and psychological aspects of space travel, as well as those concerning life sustainability and the needs of astronauts in long-term missions.

Possible solutions to address these issues and challenges will be a stronger partnership between Humans and Robots, the integration of Artificial Intelligence with space activities, automation and ergonomics. More efficient and higher thrust in space transportation will be needed to shorten in-space time (while traveling to other Planets, for instance). An additional solution discussed was the utilization of exoskeletons, both for mitigation and human enhancement.

Discussion Track 4: Humans in Space

Moderator: Mr. Richard Hieb, Astronaut (Retired), NASA

As plans for the ISS come to an end, what will be the next human destination? Is it the Moon, Mars, a commercial microgravity platform, a deep space habitat or is it even a distributed network of destinations?

The discussion group advocated mostly for a cis-lunar/on-lunar surface "next step". In fact, such next step would see more arguments in its favour, namely: geopolitics and a new "space race" ignited by China; the Moon being more easily defendable or weaponizable than Mars, with countries being more interested in the former than the latter; the possibility to use the moon as testbed for both technology and health science before venturing to Mars; and the possibility to leverage resources to colonize the Moon and push forward to Mars in a more sustainable manner.

Nevertheless, some arguments were also in favour of moving toward Mars instead. There's in fact a risk to "get stuck" on/at the Moon, as investing resources for the Moon clearly prevents those resources from being invested to reach the red Planet. Moreover, a journey to Mars would be more inspirational – thus getting more public support – than going back to the Moon. A final point in favour of Mars would be that Mars is more Earth-like, thus exploration and life on the celestial body should be easier in some extent.

How can we learn from the past and explore in a more sustainable way? How much risk are we willing to take for humans in space?

Delegates moved to this discussion item by first agreeing that it is hard to eliminate risk without taking risks first. This can be done by learning from simulations such as analogue missions.

Additionally, accidents and disasters should be reinterpreted as critical milestones to learn from, sacrifices to achieve a "greater good", rather than simply disasters. This philosophy should be assimilated by general public and decision makers alike.

How can we organize a large number of private space tourist or workers in space? What needs to be put in place so that it doesn't become a lawless land?

Discussant approached this topic by focusing on legal and policy frameworks to keep stakeholders in check. A delegate proposed to ask manufacturers to be responsible for law enforcement and be liable otherwise.

A second suggestion was to establish an international framework, potentially with the UN governance. The framework could derive from industries that present similarities with space and space tourism, namely maritime and aviation industries. It could be reactionary and based on experience and on binding agreements whose violations could be punished.

How do we overcome the physical limitations for humans to explore space? To what degree will technology help us overcome biology?

This topical issue, common with other Discussion Tracks, was addressed by the delegates by pointing out potential solutions.

A delegate noted that medical requirements could be determined by the type of mission, thus changing spacecraft standards accordingly with crews and missions. It was conversely pointed

out that medical requirements currently used for today's astronauts seem to have worked throughout the history of human spaceflight. Surely, medical standards will be higher for professionals exposed to space for longer time, compared to once-in-a-while tourists. A more exotic option would be to adapt the human to the space environment, rather than the spacecraft to the human needs, with potential implications of gene-editing technologies.

Surely, as per technologies, virtual Reality will have to be utilized to a great extent in matter of both training and biological and psychological adaptation. Psychology will be relevant as, for instance, not being able to see the Earth will represent a great psychological challenge. The delegates agreed on the need to develop technologies still unexplored or underutilized, with a key reference to cryogenic sleep and artificial gravity, as both will be vital for the future of long-term human spaceflight.

Discussion Track 5: Space Science

Moderator: Dr. Jonathan Arenberg, Space Science Missions Chief Engineer, Space Center of Excellence, Northrop Grumman Aerospace Systems

Can we still afford extravagant flagship missions, or would our resources be better spent on smaller missions? Would this make the industry more risk adverse?

Delegates kickstarted the discussion track agreeing on the need to come together as an international community to develop a collaborative long-term vision for space science and implementation plan for how partners can and will work together. The Antarctic Treaty was identified as a good parallel for this, highlighting the need to revisit the Outer Space Treaty to help develop a legal framework.

Delegates moved discussing on the complementarity of large and small missions to achieve space science research. In fact, while large missions can surely contribute in ways not possible with small ones, the latter are vital as testbed, achieve minor objectives, and keeping costs down. Doubtlessly, large missions have to become more affordable.

The discussion group moved on the importance of public opinion, as this shapes policy and thus funding. Getting the public behind space science missions can really contribute in obtaining the right funding.

As for large flagship missions, the delegates proposed various solutions to mitigate risks. Long-term political commitment surely helps reducing uncertainty, while standardization can enable lower prices, increases reliability and sustainability.

The discussion group also analysed the relevance of international cooperation for flagship missions. Agreements and contracts with third parties grant more accountability, and space science missions could be envisioned with parallels to the ISS agreement, the Antarctic treaty, or even an international version of the US decadal survey.

Finally, a last point for this discussion item was the need for consistency and stable funding, as also connected to the importance of public support. With a particular focus on the US-side, space science would benefit from a consistent funding and policy across administrations. Delegates suggested the need for NASA budget to be moved out of the discretionary funding, as well as the need to forecast and plan ahead multiple consequent missions to allow economies of scales and bringing down expenses, by creating, for instance, multifunctional hardware.

What space science do we want to accomplish?

Delegates moved to list the achievements and goals that need to be addressed, among many, discussant debated: standardized missions to go through all large bodies of the solar system; a long-term, sustainable human living presence in space, with the need to address radiation- and psychology-related issues; the need to continuingly discover to understand the formation of our planet and the solar system.

Delegates listed also the search for life in our solar system, with a focus on the icy moons; the solar physics and the functioning of other stars and ours, also to understand nuclear fusion; Sample-return missions, having in mind asteroid mining, space resources and closed-loop resources utilization

Finally, discussant also brought to the table the study of long-term climate change, astrophysics, genetics and biology in outer space and absence of gravity, and planetary protection.

How should the human-robotic interactions be in these missions?

For this discussion item, delegates brainstormed on potential integration and iteration between humans, robots and artificial intelligence. Granted that some automation and robotics do improve human efficiency, the discussion pivoted to when it is better to have a human than a robot/probe/rover in space.

As per space science, in fact, it is still more cost-effective to use a probe – with a team of scientists behind it on the ground – than an astronaut and expensive life support systems. Even in the case of easy and cheap access to space for humans, rovers will be ideal for exploration, in particular for what concerns planetary protection. Humans will still remain the mind behind missions, in terms of planning and strategizing, and AI/machine learning and current modern and future manufacturing (as in-situ 3D printing) will just be an incredible Human augmentation, rather than a replacement.

Final Space Science Brainstorming

Delegates discussed on the potential lessons to be learnt from industries like semiconductors, in terms of rapid development, or from to the Antarctic Treaty, as per international collaboration.

In order to achieve a united long-term vision, plan, and implementation for the identified space science objectives, the delegates agreed on the need to engage the public and political systems through, among other things: an increase in education of the general public, focusing on STEM, space, and the impact of space science on society; the development of interdisciplinary education systems for space professionals; and the development, encouragement and support of space-enthusiastic students and professionals, enabling them to engage with their political systems and step up for political roles championing for space sciences.

Discussion Track 6: National Security in International Space

Sponsored by Secure World Foundation

Moderator: Dr. Peter Hays, Adjunct Professor of Space Policy and International Affairs, GWU Space Policy Institute; Senior Space Policy Analyst, Falcon Research

Our 'National Security in International Space' group examined the current causes of instability in space and how stability in the space domain can be improved through policy changes and increased collaboration.

Throughout the world, there is increased recognition of, and focus on, the ubiquitous contributions that space capabilities make to global prosperity and security. Space plays a critical and sometimes unknown role in our daily lives. With no borders in outer space, major space actors have to manage the inherently global nature of the space environment diplomatically while protecting their critical assets and capabilities. Commercial, civil, and military actors are competing for limited resources like spectrum and orbital slots; new nations are entering space; others are formally incorporating the domain into their militaries.

As space enters the mainstream, our generation will help determine the correct balance between diplomacy and national security.

Delegates discussed using these questions as guidelines:

- What strategies should countries employ when discussing space security internationally? Is it possible for policy and diplomacy alone to achieve space security - why or why not?
- In which ways would it be beneficial to national security for countries to be more transparent about their space activities? What are some of the inhibitors to this?
- What recommendations can the space generation make to governments regarding future actions to pursue national security in space?

Scholarships awarded

SGAC works hard to make sure its members are empowered and supported in attending its events worldwide. For the 7th SGFF, SGAC successfully supported four members with the Global Grants Programme, awarding the scholarship to recipients from Italy, Portugal, Mexico, and Australia. In addition to the Global Grant, SGAC was able to establish, with the support of generous partners, seven new scholarships to facilitate attendance the SGFF.

Global Grant Programme recipients

Chiara Cocchiara (Italy) – Chiara is a System Operations Engineer with over six years of work experience in space operations at EUMETSAT, where she coordinates the development of space operations for the next generation of Earth Observation satellites (EPS-SG). She is also a Visiting lecturer in several European Universities where she teaches a course of Space Operations. Chiara has designed new drone technology which uses navigation satellites to save lives, and was awarded the MIT Innovators Under 35 Prize, and has been listed by the Forbes Magazine in the 30Under30 Forbes List, Category Industry as one of the 30 emerging leaders in this field in 2017. Chiara has one bachelor and three master's degrees in aerospace engineering, and a Master of Business Administration (MBA). She has volunteered for SGAC for IAC and SpaceOps Conferences, and currently represents SGAC to the SpaceOps Committee for the Students and Young Professionals Activities, which she is leading. Chiara has also participated in a Mars Analogue Mission where she was the crew engineer and commander of the simulation covering both technical and psychological studies.

João Lousada (Portugal) – João graduated from Instituto Superior Técnico, in Portugal, with a master's in aerospace engineering that included studies at Universitat Politecnica de Catalunya, in Spain, and University of Victoria, in Canada. He has worked in space feasibility concepts at the German Aerospace Agency (DLR) and in satellite assembly, integration and testing at OHB System, for European Space Agency (ESA) projects. Today he is a Systems Flight Control Engineer (STRATOS) for the Columbus Module of the International Space Station. He is also an active member of multiple volunteer organizations related to the space sector, such as the Space Generation Advisory Council (SGAC), where he has been participating and leading several technical projects as well as acting as co-lead of the Space Safety and Sustainability project group and as National Point of Contact for Portugal. João has also been a part of the core organising teams of several SGAC events, including national, regional and global events; and recently he was elected SGAC regional coordinator for the European region. He is also an analogue astronaut and field commander at the Austrian Space Forum, having taken in multiple analogue missions with different space suit simulators.

Genaro Grajeda (Mexico) – Genaro is Presales Engineer for Eutelsat based off Mexico City. He formerly was a Project Manager for one of the largest growing teleports in the world for several consecutive years. Genaro has experience with several Social Connectivity projects involving the reduction of the digital divide as well as introducing cellular backhaul networks via satellite. He has been involved in several state-of-the-art projects to introduce Internet of Things space-based solutions as well as designing and implementing networks in where new technologies can make a difference for remote populations and remote outposts for several industries. Genaro has been involved with SGAC since 2015. He was part of SGAC's organising team during SGC in Mexico during 2016 as well as coordinator for the Satellite Communications Working

Group with the topic: "Spectrum and Operational Challenges with the Emergence of Small Satellites." He was part of the organising team for the first "SpaceUp Mexico" during 2017 with an attendance of 200+ participants. Finally, Genaro is an active public science outreach communicator with several publications on national and international magazines, as well as radio and podcasts in which he focuses on space issues and events.

Conor MacDonald (Australia/Ireland) – Conor is a PhD student in acoustics and vibration engineering at the University of Adelaide in South Australia. He is in his second year of a PhD program, where he has been awarded a scholarship to undertake research into acoustic metamaterials and their applications with rocket payload fairings. Conor holds a Bachelor of Mechanical Engineering from the University of Adelaide in addition to be an alumni of the International Space University's SH-SSP. Conor's first encounter with the SGAC was in 2015 where he was awarded the Young Australian Space Leadership award to travel to the 2015 SGC and IAC in Jerusalem. Impressed by the calibre of the delegates and inspired by the SGC, Conor aimed to become more involved with SGAC committee. In 2017, Conor was a part of the organising team for SGC Adelaide as local team leader, ensuring the congress ran as planned and made sure everybody was enjoying themselves in his hometown of Adelaide. Shortly after SGC, Conor applied to be on the SGFF organising team and was made part of the Communications Team. This is Conor's first SGFF and is hoping to be part of an excellent event and wholesome experience.

Other Scholarships and Awards

Awardee	Scholarship
Alexis Wall	CU Boulder Scholarship
Gautham Viswaroopan	Malisetti Foundation Scholarship
Sissi Enestam	Young GSA Space Systems Synergy Scholarship
Khalid Al Awadhi	Space Fundamentals Training Program Alumni Scholarship
Heyam Al Blooshi	Space Fundamentals Training Program Alumni Scholarship
Samar Julaidan	Space Fundamentals Training Program Alumni Scholarship
Paulo Cummings Pizzuto	Space Fundamentals Training Program Alumni Scholarship

SGFF Participation in the 34th Space Symposium

Partnering with the Space Foundation, SGFF Delegates had the possibility to attend the NewGen track at the 34th Space Symposium. Activities started from April 16, Monday. With the full SGFF delegates being allowed to attend a speech by US Vice President Mike Pence, followed by a New Generation Space Leaders Luncheon, a Speed Mentoring and a Networking Sessions and the 34th Space Symposium opening ceremony.

Delegates that attended the full Space Symposium had the chance to contribute to the discussion by joining the NewGen track.

Tuesday 17th delegates had the chance to attend the *Ignite the Night* start-up competition.

Wednesday 18th a Networking brunch and Coffee Talk was organized for the NewGen, with a discussion on *What's Next? The Future of LEO and the ISS*.

Finally, on Thursday 19th April, delegates had the possibility to attend the event *Propelling the New Generation Workforce*, followed by the *Report of the 7th Space Generation Fusion Forum* to the Symposium audience. As conclusion of both the NewGen track and the Symposium, a *Reception in Honour of the New Generation Space Leaders* was held during the evening.

SGFF 2018 Organising Team

The Fusion Forum would not have been possible without the support of the Fusion Forum team, responsible for organising the event.

Alexander Gibson (USA)	SGAC Chair
Matteo Emanuelli (Italy)	SGAC Co-Chair
Clementine Decoopman (France)	SGAC Executive Director
Chantelle Dubois (Canada)	SGFF 2018 Manager
Lauren Smith (USA)	SGFF 2018 Deputy Manager
Tara Halt (USA)	Programme Coordinator
Tobias Niederwieser (Austria/USA)	Programme Coordinator
McClain Goggin (USA)	Programme Coordinator
Conor MacDonald (Australia/Ireland)	Communications Coordinator
Barret Schlegelmilch (USA)	Delegates Coordinator
Anthony Yuen (Australia/USA)	Delegates Coordinator
Markus Geiss (Germany/USA)	Delegates Coordinator
Kristin Shahady (USA)	Logistics Coordinator
Daniel Brack (Israel/USA)	Logistics Coordinator
Mansoon Shar (UK)	Strategy & Finance Coordinator
Chris Nie (USA)	Strategy & Finance Coordinator

Additionally, SGAC would like to extend a special thanks to the Space Foundation team for their support in organizing the Fusion Forum.

We'd love to stay in touch!

spacegeneration.org

The Space Generation Advisory Council is a non-profit organization and professional network that represents university students and young professionals in the space sector. SGAC has permanent observer status at the United Nations Committee on Peaceful Uses of Outer Space (COPUOS) and is a member of the UN Economic and Social Council, and the International Astronautical Federation (IAF). Headquartered in Vienna, with full-time staff, the organization is supported by a volunteer network of over 15,000 members in more than 150 countries. SGAC is a registered 501(c)(3) in the United States.

SPACE GENERATION
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