FINAL REPORT

SPACE GENERATION FUSION FORUM 2019

SPACE FOUNDATION

https://spacegeneration.org/sgff2019

TABLE OF CONTENTS

SPACE GENERATION FUSION FORUM 2019 WAS MADE POSSIBLE BY

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Dear Reader,

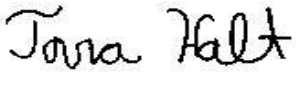
On behalf of the 2019 Organising Team, it is our great pleasure to present the official Report of the 8th Space Generation Fusion Forum (SGFF). SGFF 2019 was held in conjunction with the Space Foundation's 35th Space Symposium. So much time, creativity, and love for all things space went into crafting this programme behind the scenes. We were delighted to receive so much positive feedback from our delegates and industry guests. This report serves as a summary of the meaningful dialogue that took place at this year's event.

SGFF has been designed to provide a comprehensive and diverse programme that brings to the forefront pertinent topics across the current global space industry. SGFF 2019 proved to be dynamic, stimulating, and fun. We encouraged thoughtful conversations, lively debates, creative exchange of ideas, and, most importantly, connection with young space professionals from around the world. We were blown away by the quality of this year's delegate applicants.

We would like to take this opportunity to personally thank the Organising Team for their hard work and dedication in putting together an incredible programme. This is a huge year of growth for us as we have expanded SGFF from a 1.5 day event to 2.5 full days of programming. We couldn't have done it without many late nights, early mornings, and creative problem solving sessions with our fabulous team.

We would also like to extend a special thank you to the Space Foundation Team and all of our sponsors who have stepped up to show their support for the next generation and make the Space Generation Fusion Forum possible.

We hope that you enjoy reading through this report and remembering or learning anew from our incredible delegates and space industry leaders.



Lauren Smith
SGFF 2019 Manager

Tara Halt
SGFF 2019 Deputy Manager

SPACE GENERATION FUSION FORUM OVERVIEW

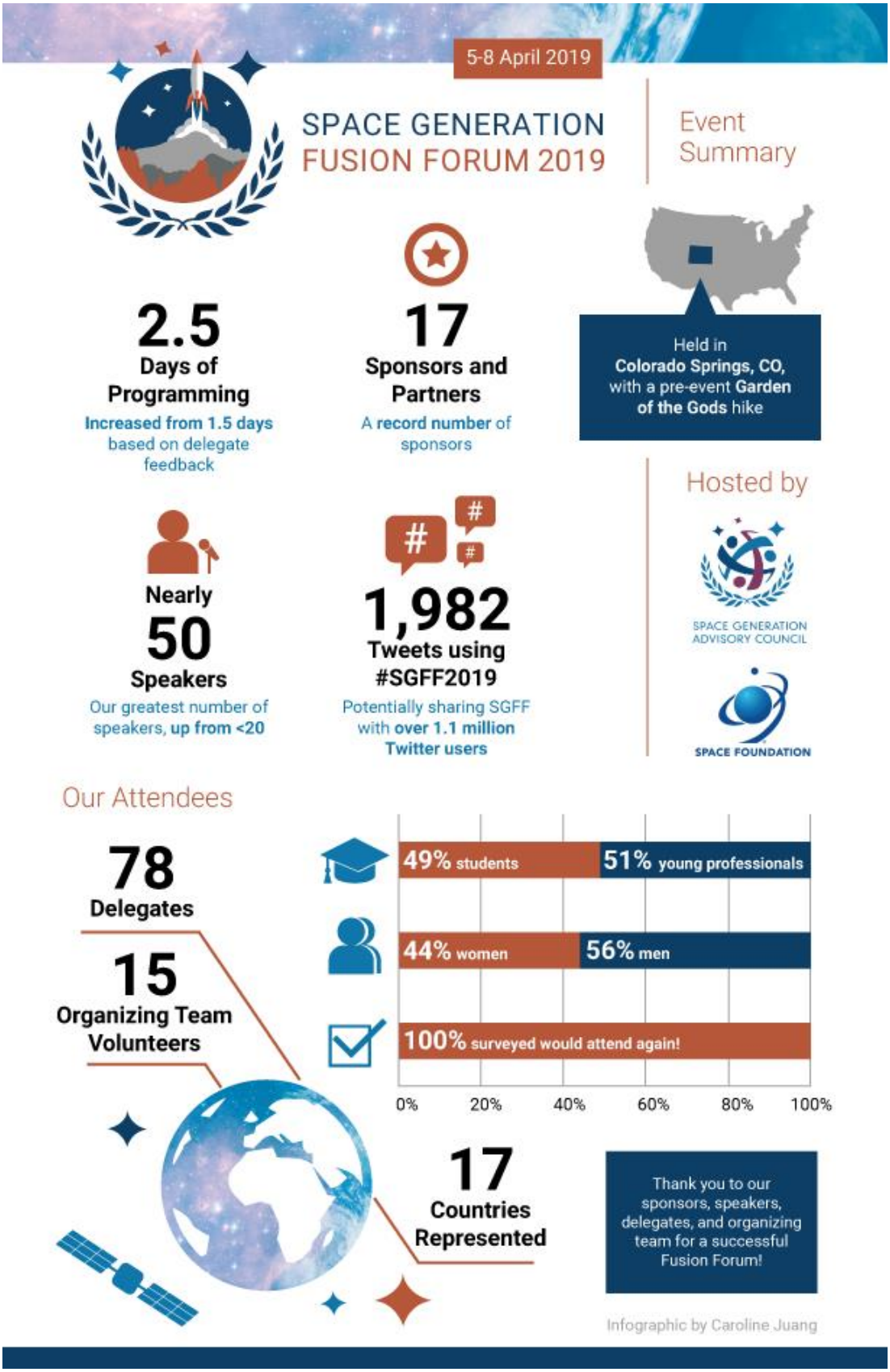
Overview of the Proceedings

Against the backdrop of the beautiful Colorado Rockies, the eighth Space Generation Fusion Forum was a global gathering of students and young professionals. Under the new 2.5 day expanded format, delegates were able to increase the time they spent with industry leaders, as well as time they got to spend with each other, future industry leaders. Our objectives for the Forum were to:

1. Strengthen the international network of the Space Generation Advisory Council. From the perspective of the individual delegates, many of whom come from developing countries, it is a chance to interact and engage with the incoming generation of space professionals from all over the world. From the perspective of the SGAC, it allows us to consolidate our international links in order to best represent and facilitate the voice of the next space generation.

2. Examine and consider key questions that face the space sector and international community at large as well as to provide input to international thinking from the next generation of space professionals. All output produced by SGFF is compiled into a report which is presented at the United Nations Committee on the Peaceful Uses of Outer Space, stakeholders within the space sector, and other conferences around the world.

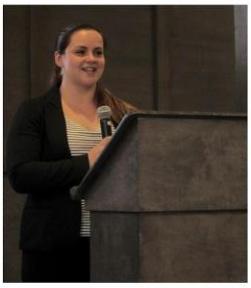
3. Allow tomorrow's space sector leaders to grow their network within their generation and to also have the opportunity to interact with today's space leaders by way of the Space Generation Fusion Forum high-level speakers.


5-8 April 2019
SPACE GENERATION FUSION FORUM 2019
Event Summary
2.5
Days of Programming
Increased from 1.5 days based on delegate feedback
17
Sponsors and Partners
A record number of sponsors
Held in Colorado Springs, CO, with a pre-event Garden of the Gods hike
Nearly 50
Speakers
Our greatest number of speakers, up from <20
1,982
Tweets using #SGFF2019
Potentially sharing SGFF with over 1.1 million Twitter users
Hosted by
SPACE GENERATION ADVISORY COUNCIL
SPACE FOUNDATION
Our Attendees
78
Delegates
15
Organizing Team Volunteers
49% students
51% young professionals
44% women
56% men
100% surveyed would attend again!
0%
20%
40%
60%
80%
100%
17
Countries Represented
Thank you to our sponsors, speakers, delegates, and organizing team for a successful Fusion Forum!
Infographic by Caroline Juang

SGFF 2019 DAY 1 HIGHLIGHTS

Breakout Sessions on Workforce Development

Keynote on Apollo History in Retrospect by Dr. John Logsdon, George Washington University



Emerging Space Dinner

SPACE GENERATION
FUSION FORUM 2019

LIGHTNING TALK: MANNY SHAR, BRYCE SPACE AND TECHNOLOGY

Global Space Economy Overview

Mr. Shar provided an overview of the global space economy, as well as a preview of the upcoming Bryce Space and Technology Start-Up Space Report 2019. Historically, nations have led the space age from Yuri Gagarin to the moon landings; they drove innovation and technology, evident from advancements such as microchips, the Shuttle, and the LEO economy. Today, however, commercial companies are doing more in space than ever, from launch services to data analytics, and are critically important to the space sector. Currently, the world's governments contribute a quarter of the global space economy and the commercial satellite industry contributes the rest (GNSS chips, satellite television, etc). Revenue from the global satellite industry has doubled in the last decade, even with slowing growth in recent years. In addition, many billionaires today are investing in space and building the market, hoping people will come, including using space tourism to encourage further engagement.

There is also investment going into smallsat launch and many smallsat launch vehicles are under development. These vehicles will launch new space entities: Satellite constellations like OneWeb, who recently raised 2.5 billion dollars, as well as companies working on asteroid mining. Companies are testing and developing technologies along the way.

Responses to Audience Questions

When asked about the future of new space businesses, Shar answered space business needs to be thought of any other business - it needs demand. There is a lack of demand in space infrastructure with demand not developing as expected. It's still an early research phase as of now, but there will be increasing levels of activity into the future. Space tourism is an unproven market but billionaires are taking on massive risks by investing in it, sensing a high reward.

PANEL: THE SPACE INDUSTRY'S NEXT BIG THING

Moderator: John Holst, Senior Analyst, Space Foundation
Thomas G. Roberts, Program Manager & Research Associate, CSIS Aerospace Security Project
Dr. Jamie Morin, Vice President, Defense Systems Operations, The Aerospace Corporation
Dr. Alice Bunn, International Director, UK Space Agency

Panelist Discussion

Dr. Jamie Morin: If I were in your shoes and I was trying to figure out what the next big thing in space was, I would visualize space topics as a venn diagram. First circle: what is technically feasible. Second circle: what is economically feasible? Do I have a sustainable business model, will a foundation fund me, will a government invest in it? Third circle: what works politically? Individual human beings cannot just go off and do things in space without working together.

We need to look at the intersection of these three bubbles and what can we do that is in the middle of them. Where do we see new business, economic, and political opportunities emerging and how can we take advantage of those? Who can take advantage of these? Startups, government agencies, existing companies, etc.

Dr. Alice Bunn: Next big thing? International cooperation. Currently working on deep space cooperation. How do we make sure this operating arena is safe? It is in all of our best interests to make sure that we're working together, sharing data, and making sure we can always keep working in this space. We understand that there are military sensitivities, but we need to ensure that the capability of safety is secured for our future. Civil programs like global communications, telemedicine, etc. are all about delivering benefits to society. All these activities, military and civil, are working to help society and maximizing the benefits of space for humanity.

Thomas Roberts: What would happen if we saw a Pearl Harbor event in space? The next big thing in space is sharing data of what's in Earth orbit. The US Air Force manages a catalog of the many items in orbit but they have sensitivities and priorities and therefore redact information on orbital parameters and objects. Therefore, we need an international agreement to share the data that we have. We need to frame space as a non-contested environment and we need to work together to maximize space as a peaceful domain.

Bunn: We have to acknowledge that we are already in a contested space arena. What are we trying to achieve with these military activities? How can we look at this in a new way so that we can all benefit from space? If we get it wrong, and have contested space, then we all suffer. We rely on UN frameworks and need these to be up to date. The UN process is not fast enough and we need these policies to be up to date so that we can have the political environment keep up with the economic and business arenas.

Morin: We see ships around the world registered in countries where there are less regulatory restrictions and therefore makes their operations cheaper. We need to not let this happen in space because space is hard to clean up. A lot of the power here relies on the investors because they need to be responsible. If a company is trying to license in a country that has lower regulatory barrier, ask why? Responsible companies should be registering in countries that are responsive to the industry, understand the ramifications of not working together in a peaceful manner, and will make sure that efforts are conducted in a responsible manner.

Roberts: We need to decrease our uncertainty bubbles of where things are in space. We need to share data about where active objects are and what their parameters are so we can better manage where things are in space. This does not account for space debris though. We could use transponders on smallsats to help the global community locate these and increase space situational awareness. Data sharing across national and corporate lines is essential for

decreasing the uncertainty of where objects actually are. Moving things in space is resource intense and we want to minimize the amount of times that we are using these resources.

Audience Questions

What kind of possible backlash can you get when you have to work these issues with lots of military folks?

Bunn: A lot of people in this field are from the Cold War era and do not want to compromise. We need more voices here to work together. When you get challenged, you need to refer back to our mutual priority of working together for all of humanity. We absolutely need fresh eyes here, working together to figure out how we can do better as humanity.

What do you think of on orbit service and manufacturing as the next big thing?

Bunn: We need to find the sweet spot of enabling these technologies while making sure that they are safe and internationally responsible. For an application that might be normally deemed risky, the technology needs to be assessed so that it can be less threatening and perhaps not be in an unsafe area for long.

Holst: When we do these activities, we need to make sure that everyone is aware of what is being done and aware that we are conducting activities for peaceful purposes rather than in a malicious manner.

If you think back 20 years, what did people think was the next big thing at that time and how has that proceeded?

Morin: Back then, the ISS was the next big thing. This has been a very visible indicator of international cooperation and the possibilities of what is capable when we work together. Have we achieved what we expected out of these efforts? How might the ISS transition to a commercial effort? If we have a current big thing, our ability to pivot to a new big thing is limited financially.

Bunn: Back then the next big thing was having satellite constellations, and they didn't succeed. So why are we doing this again? The business model has changed and therefore new things are now viable. We've also increased our awareness of why we need these sorts of capabilities and what's possible for them. If we lost satellite navigation capabilities, just for the UK, this would cost 1 billion per day.

Roberts: 20 years ago people talked about how the cost of launch was decreasing. If you look at all the history of what has made it to space, we thought that air launch systems would be huge but really this has only been like 70 of 5000 launches. Therefore, while the next big thing was more affordable access to space, so we want to minimize the frequency that we need to use these resources.

I would like to see more international cooperation with business opportunities. We get more diversity in thought when we work together. How do you think we might be able to work together more and build more opportunities to work outside of ITAR?

Bunn: We're not going to fix it in one go. We need to figure out how to address this chunk by chunk. We would typically look to a collection of like-minded states, and to work together to knock down some barriers with a goal of opening up these opportunities.

Morin: I'm going to pushback on this a bit. While ITAR is antiquated, we need to assess why it is there. If you come to a fence in the middle of the road, you can't just take it down, you need to look at it and assess why it is there. Almost all of the initial space technologies were developed for war fighting purposes. We cannot just move towards a transparent industry when there are military capabilities at stake that we don't want to transfer to people who might use them in a malicious manner. These are not invalid concerns, but we need to look at how we can consider these and balance them with concerns that ITAR is antiquated. We do still have nation-states and we need to balance security concerns.

KEYNOTE: ADMIRAL JAMES O. ELLIS, JR. USN (RET), NATIONAL SPACE COUNCIL

Admiral Ellis gave Delegates an update on the National Space Council (NSpC) and their Users' Advisory Group (UAG). The National Space Council exists because there is no entity within the US Government that has sole responsibility for space, and so the White House wanted to coordinate a broad interagency approach to strengthen US leadership in space. It is chaired by the Vice President of the United States with several key cabinet secretaries as members.

Due to the work of NSpC, the President has signed four Space Policy Directives (SPD), which are currently in the process of working out the details:

- SPD 1: Goal of going back to the moon
- SPD 2: Regulatory reforms to facilitate commercial launch activities
- SPD 3: Involved development of a Space Traffic Management policy
- SPD 4: Establishment of the US Space Force

The UAG is a Federal Advisory Committee for industry and other non-federal stakeholders to advise the NSpC. Meetings are held in the public domain and experts from diverse areas to contribute. The group is not looking for only for answers, but also wants to know what are the problems, issues and topics that need to be addressed. Admire Ellis invited all Delegates to submit short white papers to contribute to the discussion within the Users' Advisory Group.

The key subcommittees of the UAG include:

- Exploration and Discovery

- National Security Space
- Economic Development / Industrial Base
- Technology and Innovation
- Outreach and Education
- Space Policy and International Engagement

The UAG meets directly with the Vice President to report on the findings from the UAG. Some of the discussions from the most recent meeting included:

- Discuss with NASA the architecture for going to the Moon
- Organisational structure of the future US Space Force
- How to advance US national interests in space and respond to growing Chinese space capabilities?
- Spectrum management
- Observe the 50th anniversary of Apollo 11

BREAKOUT SESSIONS: WORKFORCE DEVELOPMENT

Engaging Young Professionals at Conferences and Events

Dr. Melissa Sampson, AIAA

Dr. Sampson led a subgroup of Delegates in a discussion of how to engage young professionals at events. The American Institute for Aeronautics and Astronautics (AIAA) is running IAC this year and then will revamp the annual SPACE conference starting in 2020. She wanted to know how to get more young professionals involved, and the main insight from the discussion was to show companies the value of sending young professionals to these types of events like SGFF.

Dr. Sampson also talked about AIAA, an engineering organization with over 30,000 members. Most activity is US-based, but there are members in 85 countries with chapters all over the world. AIAA has technical committees, peer reviews, individual conferences, some advocacy and lobbying in the US. Delegates were surprised to learn that most members were from industry, not academia, and that only 20% of the membership is young professionals. When delegates discussed their participation in AIAA and other organizations, they found that the cost of membership is a barrier and that one of the key collateral in exchange is a magazine: a form factor not relevant for millenials. When asked, delegates said they would like to see AIAA add an online job board and more opportunities to publish more broadly.

Delegates next tackled how to engage young professionals at conferences. Delegates came up with several ideas of the issues they see at conferences:

- Panels of companies pitching without questions and answers. “I want to be part of the conversation. If I wanted a lecture, I would watch YouTube."
- Sessions are not well articulated, so attendees have to guess at the value case

- Young professionals are given different badges and are left out of the conversation
- Too often panels consist of the same group of older men talking to each other year after year

Delegates think that features of an engaging conference include:

- Communicate the value proposition of the host organization. AIAA facilitates a passion for people and space along with technical expertise
- Provide a very clear object, so expectations are met
- Provide opportunities to break into smaller groups for engaging conversation
- Provide networking events along with a handbook of who will be attending
    - Provide standing tables, free food and drinks
- Suggestion box that is not a black hole (maybe comment on it the following year) - like improved breakfast and food at SGAC this year based on comments from last year.
- Guidance on what types of sessions/events to go to (like a help desk)
- Encourage mid-career professionals to mentor young professionals and provide something fun for them. Encourage continuity in workforce without a gap between young professionals and older professionals.
- Broaden the speaker base across experience level and gender.

Employee Recruitment and Retention

Kimberley Stover, Harris Corporation

Ms. Stover represented Harris Corporation, a $6.2B space systems company. With the United States at its lowest unemployment rate in 10 years and a general shortage of engineers, she is facing higher attrition, especially amongst employees under age 35. Delegates were challenged to consider how companies can attract and retain employees, and what attracts a person to one company over another.

What young professionals look for:

- Compensation - seen as representative of respect
    - This is a struggle for most space companies with many engineers headed to Silicon Valley/Wall Street because of compensation
    - Many students graduating with higher debt levels than in previous generations
- Work/life balance
    - Also a struggle for many space companies
    - Most young professionals will sacrifice this initially for higher pay to pay off debt
    - Flexibility benefits can help a lot: Work from home; 9/80 schedules; flex time
    - Getting culture right: breaking down the barrier a bit can be helpful
- Interesting work (allowing control over project life and development)
    - Companies that exhibit a passion for space have a leg up
- Career Growth
    - Flexibility around type of work
    - Space industry has a reputation for slow career growth
    - Fear of being pigeonholed

    - Clearances slow the process further
- Job Security (90% of startups fail)
- Location/ability to experience specific things

How might a company show young professionals the above aspects?

- Peer interviews (referrals from friends etc.)
    - Traditional interview/application process doesn't show company culture
- Internships
- Alumni mentors in universities
- Opportunities to attend professional networking events
    - Ambassadors for company can also help with diversity

What makes people want to stay (retention)?

- Feeling valued and being rewarded for tenure. Millenials are more likely to job hop. Advised not to stay at a company for too long.
- Dynamic workplace environment
- Interesting work both in terms of topic of the work and knowing your work is going to contribute to the program/objectives
- Good leaders. A leader creates an open environment and open doors. Leaders provide trust and autonomy to pursue passion and do good work
- Transparency: Informal programmes / discussions often help groups work through a lot of the common frustrations. Half the time there's a good reason for something.
- Build a young cohort. Having a network and community is incredibly important
- Constructive criticism
- Professional development: opportunities to publish papers and attend conferences
- Diversity of backgrounds/perspectives/class/experience. Hiring for idiosyncrasies.
- Building Inclusion
    - build an open inquiry culture where it's okay to ask questions and to be wrong
    - Have crucial conversations where both sides identify disagreements and points where they agree
    - Inclusive culture must be genuine and fully endorsed
    - Structure meetings to enable open conversations

Knowledge Transfer

Rachel Davis, Lockheed Martin

A comparison of the aerospace workforce future needs and its current demographic distribution shows a gap in the current mid-career group (e.g. 35 to 45 year olds). As a result of retirement and general attrition, there is a near term need for the current young professionals to fill these roles at an earlier age. Hence, this discussion focused around the best practices for the necessary knowledge transfer from the generation about to retire and current subject matter experts to the next generation.

Delegates were first asked to self-reflect on strategies for knowledge transfer. Knowledge transfer was described by two broad categories:

- Tangibles – knowledge of:
    - Technical aspects
    - Processes
    - Tools
- Intangibles (i.e. soft skills or 'tribal knowledge'):
    - Customer/all relationships
    - Leadership presence and skills
    - Diplomacy/negotiation skills and navigation of inherent politics
    - Emotional intelligence

To facilitate in depth discussion on strategies for knowledge transfer in these two aspects, the group split into three smaller groups, followed by a final discussion. The key discussion points across the groups were:

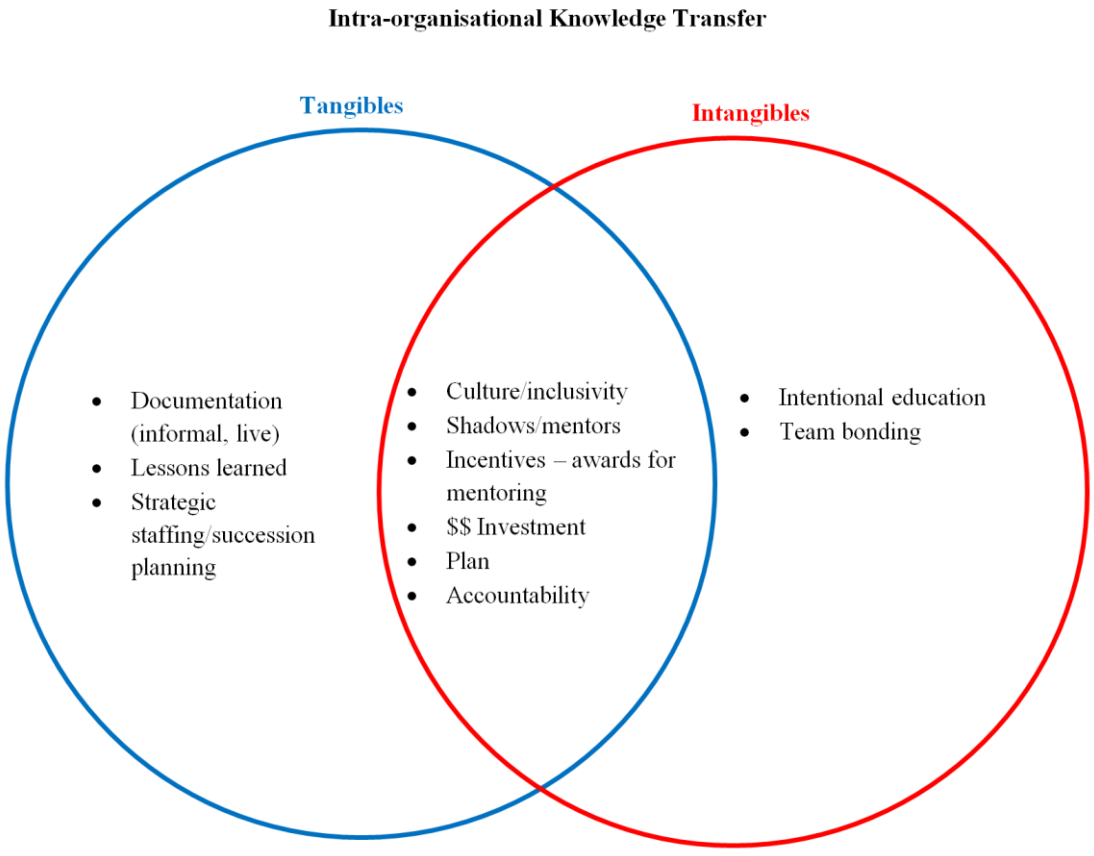
Tangibles:

- Documentation
    - Creating a Wiki type central source of information which contains decisions as well as the reasoning behind them
    - But also noted that too much documentation can also be an issue
- Review boards – provides the capacity to capture and learn from failures
- Sink or swim approach
    - Being thrown in the deep end can lead to the greatest learning
    - gives new employees the opportunity to make mistakes and be challenged
- Rotation programs
- Changes in corporate culture are needed:
    - Ability to tolerate risk by successional/strategic staffing
    - Less experienced staff take on a more consultant type role to maximise learning/decision making ability
    - It should be okay to ask the 'stupid' questions
- Strategic hiring: Hire for culture (e.g. agility, ability to think on feet, cultural fit)
- Mentoring is an important aspect:
    - create a culture that mentoring is expected
    - requires a degree of facilitation
- Strategic job shadowing
- Attending professional conferences – noted that not all organisations can and/or want to invest in employees (hence focus on high-performing employee development programs)

Intangibles:

- Company culture of feedback and open discussion to learn from failures
    - Build trust amongst teams to break down barriers (team building)
- Diversity training
- Better integration of HR offered programs
- Change agents
- Overhead budgets for professional development
- Mentorship
- Expectation management
- Job shadowing for building customer relationships

The best practices which emerged from the discussion are summarised in the image below. Note that a number of strategies overlap the tangible and intangible aspects of knowledge transfer.



Inspiring the Next Generation to Pursue Space Careers

Bryan DeBates, Space Foundation

Space Foundation is the host of the Space Symposium and the anchor partner for SGFF. A significant portion of their work is focused on educational activities, including programs such as the Center for Innovation in Education, which provides professional development for teachers to help them inspire their students; the Junior Space Entrepreneurship; and the Space Commerce Program, which recently won a grant to help minority business owners break into the space industry. The educational programs reach 75,000 people annually.

The Space Foundation breakout session was all about inspiring the next generation. Something happens in middle school after dinosaurs and space are popular - there's a cliff. Interest in areas like space wanes, and this only gets worse in high school. Space Foundation wanted delegates to think of what young people can do as influencers to help inspire the next generation.

Why are we talking about this? Delegates shared the following:

- There's a gap between the supply and demand of STEM talent - and we need to fill the gap but do it with the right people.
- The wrong people are trying to solve this problem - we need new ideas and we need to bring in experts outside of the engineers already in the space sector.
- Targeting parents is also important. Parents need to know their kids will get jobs that don't exist today

Why is it important to inspire the next gen of space professionals?

"Because we don't live forever!" There will always be a need to replace your skill set and knowledge. A good example here is the Apollo program - a bunch of people in their 20s that couldn't transfer their knowledge to the next generation. The knowledge was just lost. It's not even waiting until we die - if people do something in their 20s and you wait until your 60s, you probably won't remember what you did in the 20s. One delegate pointed out that they "can't even do the math from a few years ago." We should be thinking about contemporary knowledge transfer and inspiration - we should be inspiring kids with what we are doing today. A delegate shared the example of the automotive program at the University of Michigan. The engineering program there heavily draws upon real-world engineering problems in the auto industry for their curriculum, which has led a significant number of students choosing to take jobs in the auto industry.

How would you articulate the challenge we're facing?

One delegate said that the challenge is that space is important and transformative and we, as a sector, need continuity of progress, and that's at risk. The moderator agreed and added statistics to the argument: 10-15% of jobs at STEM employers can't be filled because the US doesn't have enough qualified graduates. Space is a $350B industry today and it is projected to reach $1T within 10-15 years (BofA). We will have a shortage of 11% of engineering jobs and >30% of math-based jobs. >25% of high school students are ill-equipped to meet the entry requirements of engineering-based college courses. The statistics today show that the industry is technologically evolving at a rapid pace, but we have a workforce that isn't educated to the level to meet the demands of that evolution.

A delegate pointed out that if we want the industry to change, we can't do the same things we always have done. We have to try new things. e.g., software engineers don't usually go into space - they go into traditional tech jobs / firms. If you want to attract software engineers to the space sector, it's not a single pipeline that you're working with. You need to inspire them in a multitude of ways so that even if they don't join the space sector right after school, they might be interested in launching a space start up later in their career.

One delegate pointed out that It's important to recognize that there are people who are non-technical who eventually move into technical fields. You can teach complex concepts with very basic tools (e.g., teaching satellite operations with Lego). Just because the problems in our industry are very technical doesn't mean the answers and training needs to be super technical.

Another delegate asked "Is there a trend to the STEM skills gap?" The moderator provided more data: Since the 1980s, the numbers have been getting worse. The generation that was inspired by Apollo and SciFi were leaving the sector in the 80s and there was nothing to inspire the next generation. There was a bit of a rebound when the space shuttle was first launched. However, since the 1960s, the number of kids getting into STEM has basically been declining. NASA, for example, has an aging workforce - they have this dilemma where a significant number of their employees will be retiring in the coming years and those roles need to be backfilled to meet mission requirements.

One delegate pointed out that there is a generational issue here as well. Newer generations have different criteria / priorities and they can't be engaged in the same way - they are often more focused on satisfying more immediate needs. Failure, for example, is becoming a taboo word in research / teaching. As a result, young people aren't able to work through failure by focusing on a long term goal - they typically just move to easier areas to get immediate satisfaction.

What experiences inspired delegates to get into space? What experiences worked and what didn't?

- Education
    - One delegate didn't decide to be an engineer until the last year of high school. They always wanted to be a writer until the delegate went to a magnet high school where they were exposed to science every day - the teachers there normalized the concept of research. The delegate pointed out that science is often taught poorly these days - e.g., we should stop forcing people to learn through memorization.
    - A delegate educated in the UK shared her experience of having a passionate teacher who taught their class about the solar system through a compelling story of the creation of the universe. The delegate said that inspiration can sometimes start in classes.
    - A delegate pointed out that everything starts in school when it comes to STEM careers. Teachers are often the first people you interact with on scientific topics and school serves as a common denominator across the world
- Media
    - One delegate pivoted by identifying the media as important. The delegate's roommate commented that the SpaceX Falcon Launch from 2018 video would have inspired them to be an engineer had he seen it earlier in his career.
- Science Fiction
    - Another delegate had a relative who was interested in science fiction that incorporates two components: (1) a vision of the future and (2) a philosophical question for you to ponder. Seeing visions of the future outside of action movies (that also prompted questions about potential future societies) inspired him to be involved. Those visions can help people push through the difficult math classes in university.

So how do we reach out to a wider / broader audience?

- Delegates indicated that both the media and teachers are important. Star Trek and Star Wars can be inspirational in setting kids on the right trajectory.
- Role modelling was also highlighted by multiple delegates as very important
- Delegates also shared the view that engineering is not seen as "cool". There's no Mad Men-like TV show portraying cool engineers in their everyday offices. Furthermore, role models in STEM are often authority figures. Students don't typically respond well to authority figures (e.g., DARE). We need role models who are non-traditional.
- What kept one delegate into space was seeing a role model that looked like her - you need people to be visible to the younger generation (esp. for underrepresented groups, such as women)

- Delegates mentioned the need for incentives for STEM professionals to go into schools and promote the space sector.

What are the solutions?

- The media is a huge influence. Apollo was inspirational - the SpaceX Falcon was somewhat like that, but we need much more in the way of inspirational media.
    - One delegate said that the media has been concentrated into bubbles - people are only exposed to media that reflects their world view. We need to reach out to people in non-space bubbles.
    - One delegate suggested we incentivize the showcasing of diversity and opportunities for trade careers in the media
- At an individual level, persistence is very important. We need to encourage the next generation (and their parents) to be persistent in pursuing a STEM degree / career. We need to tell people "it's ok to fail".
- For schools, reforming curriculum / instruction in teaching science is important. Science teachers need to reignite their love for science and need to to support high quality teachers better. STEM topics also need to relate to real world exciting things - you need to provide real world implications for why you should learn algebra, for example.
    - Delegates also suggested creating safety nets for STEM courses (e.g., if you fail a STEM course, you may not have to pay full tuition to retake it, to de-risk taking the course in the first place - Lambda School was shared as an interesting example of a model somewhat like this).
    - A delegate also pointed out that there are organizations that run programs to allow kids to work on something that will actually go into space - this is a very powerful tool
    - Delegates also flagged that scale is a huge challenge - how do you reach every public school in the country?
    - Delegates also discussed the important of trade schools for the space industry. They're devalued today, but we need to incentivize people to go to trade schools.
- Delegates also shared the need for incentives for people in the industry to go out in society and promote the space industry. People need to be proactive.
- We should also push companies to think about more than just profit when considering return on projects - we can ask them to measure projects in terms of inspiration / exposure

Young Professionals' Ability to Influence Corporate Goals

Clementine Decoopman, SGAC

Are young professionals stuck with already-established organizational vision/culture/mission?

Young professionals are attracted to organizations where they value the organization's vision, mission, and culture, and are more likely to stay with organizations that include young professionals in the feedback loop for evolving these. If young professionals are not satisfied with the established organizational vision, mission, and culture, and are unable to have an impact in changing them, then they will find a better environment. Young professionals value cultures that are transparent, positive, inclusive, and empowering.

Can young professionals play a role in changing an organization's vision/culture/mission?

Young professionals have valuable experiences and fresh perspectives that can benefit organizations, and they value being able to have an impact on their organization's vision, culture, and mission. An organizational culture that is open and receptive to having young professionals have influence will be more successful in attracting and retaining young professionals. Therefore, organizations need to seek honest impact from young professionals to understand their objectives so they can retain them better.

What tools would we like organizations to use to enable young professionals?

- Education (talks, short seminars, classes, and support for advanced degrees to improve in areas including technical skills, communications, and leadership)
- Mobility and changing positions within their own organization
- Mentoring programs
- Advocacy working groups
- Learn how to represent their own organization
- Organization-wide communication (e.g. Slack)
- Surveys and suggestion boxes to solicit feedback and measure employee satisfaction
- Gathering with other young professionals and diverse groups of coworkers in structured and casual/unstructured formats
- Mutually beneficial relationships between the organization and employees such as incentive programs for training and service exchanges
- Workplace collaboration and geographical mixing of employees

Barriers to making changes and implementing tools like these that young professionals see their organizations encountering include a lack of awareness, reluctance to change, and not enough prioritization.

10 Pieces of Advice for Young Professionals

1. Find mentors, champions/advocates, and coaches
    a. Reach out to people and take advantage of established networking opportunities
    b. Mentor: Provides mentee with advice, exposure, and inspiration through sharing

   c. Advocate/Champion: Active and vocal supporter of your career
   d. Coaches: Dedicates time and effort to help you improve
   e. These people might all be different, you might have different ones at different times, and that's all good!
2. Believe in yourself, seek data, find consensus, and stand up for what you think
   a. Survey, idea box, chats, meetings, etc.
3. Be honest with Performance Reviews
   a. Seek constructive criticism and seek opportunities to review your superiors like in 360 review programs
4. Be honest with your expectations and initiatives
5. Create community/support groups
6. Seek out ways to be the face of your organization
7. Pay attention to your organization's direction and look for opportunities to showcase your skills
8. Seek funding/resource opportunities to work on your ideas
9. Failure IS an option.
10. Bring a good attitude, have fun, and love what you do!

KEYNOTE: PROF. JOHN LOGSDON, GEORGE WASHINGTON UNIVERSITY

Professor John Logsdon has spent his entire career studying the policy and historical aspects of U.S. and international space activities. This has included the publication of numerous books, including *John F. Kennedy and the Race to the Moon (2010) and After Apollo?* We could think of no better person to provide delegates with a historical perspective on why we decided to go to the Moon, how we achieved it, and how we can learn from the past to enable our future exploration back to the Moon and beyond.

John explained the historical lack of interest in space exploration by the Eisenhower and initially the Kennedy administrations. He then discussed in detail the political motives which shaped Kennedy's pitch to Congress and perhaps his better known call to action “we choose to go to the moon" speech at Rice University. Due to the perceived political threat of the Soviet Union, the Kennedy administration had a newfound drive to achieve this lofty goal for the nation.

Unknown to most, Kennedy worked hard to try and cooperate with the Russians on a joint mission to the Moon. Although Nikita Khrushchev initially rebuffed the idea, negotiations remained open on the topic until Kennedy's untimely death in late 1963. Although the Apollo program suffered from a lot of criticism from Congress and the public during the early 60s, Kennedy's death put an end to it all, as the program continued almost as a memorial to his legacy.

Following the Apollo 1 fire, a rather risky decision was made for the Apollo 8 crew to orbit the Moon and return to Earth as opposed to the planned Earth orbit. Following the success of this mission, Apollo 11 placed the first humans on the Moon in 1969. Following this success, Kennedy's dream had been fulfilled, and Nixon stated that "space expenditures must take their proper place within a rigorous system of national priorities", which has remained the space policy until modern times.

John shared his belief that the political conditions which led to the funding of Apollo are unlikely to be seen again, however perhaps surprisingly we are seeing a similar scenario with this current administration. Time will tell if they achieve similar successes.

Audience Questions

Speaker has given that time period a realistic context. Is there a lesson we can learn from that period, to take into the next 50 years? Great things can happen for not great reasons (space race due to Cold War). These things can have a lasting positive impact on society, despite the reasons for doing so.

Based on the trends of the current administration, will the new effort to the Moon be at risk if there is a change in 2020? The guiding goal that the US space program should be human exploration beyond LEO has been consistent since 2004. But it's been fits and starts for 15 years and there is always a risk. He hopes there is enough consensus to sustain interest even during a transition.

Similarities between Apollo and new US proclamation to return to the Moon. What were Apollo's mistakes in policy and are there lessons learned? Apollo was not sustainable. The Saturn V was designed for one application, which had no other future use. Hopefully we don't repeat that mistake.

EMERGING SPACE DINNER: JIM MORHARD, NASA

NASA Deputy Administrator Jim Morhard shared his vision for the US role in space - to be global leaders. The US was built on the idea of freedom and has led the world in building a civilization of free nations - this is the freedom that took the US to the moon. As we celebrate the 50th anniversary of the moon landing, Jim remembers when he was 12, camping with his dad and listening to the moon landing on the radio - an act which claimed the Sea of Tranquility for all humankind. He also shared the story of a woman who was a young girl in India for the moon landing. Her father took her to a forest clearing, where they could clearly see the moon, and he narrated the landing to her - this was one of her favourite memories. She eventually grew up to attend MIT and work on space policy in the US.

Jim shared the advice that our paths are not straight, but challenged the delegates on what is our measure of what will make us a legend - like Glenn, Stennis, Armstrong, and Goddard. Jim's message was that our measure should be creating the greatest good for the greatest number of people - this is what NASA is trying to do. NASA is working on amazing projects - in aeronautics, they're developing the X59, which will travel at 1.4 Mach. In Earth Sciences, they're focused on applications in farming (e.g., increasing crop yields, using less nitrates, increasing irrigation efficiency), navigation, banking, and more. The OSIRIS-REx mission is another terrific effort from NASA - but also a story about being adaptable.

The Trump Administration has created a new story - a single campaign with 3 domains:

- Low-Earth Orbit: A space lane of commercialization - we will choose to commercialize not for US but for the world. We shouldn't view the US government as a landlord, but as a customer in a commercial marketplace. NASA is going to be in the market to buy services
- Moon: By 2024, we choose to land again astronauts on the moon - and it will be a woman first this time. Jim shared that we are going for different reasons this time. We want to prove out technologies to make future crewed missions to Mars possible. The intent is to unify free nations, create economic opportunities, and inspire people.
- Mars: Whoever goes to Mars first will lead Mars in the future. The Opportunity mission just ended - it was supposed to last 90 days and lasted almost 15 years. Curiosity found building blocks of life on Mars. The Mars 2020 mission will fly a helicopter off the surface of Mars. The US is leading the way, but must continue to do so.

Jim shared that he hopes we will not choose to give up and offered his advice for success:

- Be thankful. Have courage, and humble wisdom.
- Exude grit, wisdom and determination
- Maximize time spent at conferences like Fusion Forum
- Practice honesty, loyalty, integrity, and being a good leader
- Disagree without being disagreeable
- Compromise without compromising values
- Win the big ones: Focus on the big pieces and do not get caught in the small stuff
- Ultimately he asked us to be legends - and that we should join with other free countries to go to strive to better the human condition and to make every day matter. We can build a better life for all

EMERGING SPACE DINNER: ANDREW RUSH, MADE IN SPACE

Andrew Rush, the CEO of Made in Space, kicked off his speech by declaring how truly great the economy of space is. In particular, the space economy has been able to bring together a

diverse group of industries - launch, defense, remote sensing, exploration, telecommunications and more - united by a vision for something more.

Made In Space wants to create the tools to allow people to sustainably live and work in space - and they are making real progress, starting with commercialization of their LEO efforts. A lot of energy and effort across the industry is going into space-enabled manufacturing. The goal is not to just use space as an open high ground, but to use it for an industrial purpose - to have factories in space. For example, in-space manufacturing of satellites has great potential. Currently, satellites are built, folded, sent up to space, then unfurled. This is a process that has worked well historically, but it requires satellite designers to focus on how to survive launch instead of optimizing for the space operating environment. Made In Space is developing the technology to allow the manufacturing and assembly of satellites on orbit.

Made In Space is also spending energy in manufacturing for exploration efforts - i.e. manufacturing equipment that can go with astronauts to make missions more resilient and reliable. Ideally, they want to make the next "Apollo 13"-style movie quite boring, since the astronauts could just have a manufacturing plant next to them in space to solve the problem.

Ultimately, Andrew pointed out that space is a team sport. Made in Space has worked with NASA, DARPA, Northrop Grumman and many others - and he is excited to see to the contributions of those in the room on whatever team they join.

EMERGING SPACE DINNER: COURTNEY SCHMITT, BROOKE OWENS FELLOWSHIP

Courtney Schmitt presented her perspective on women leaders in space as a Brooke Owens Fellow of the class of 2018. Her host institution was Virgin Galactic, and her mentor is Dr. Ellen Stofan, John and Adrienne Mars Director of the Smithsonian National Air and Space Museum.

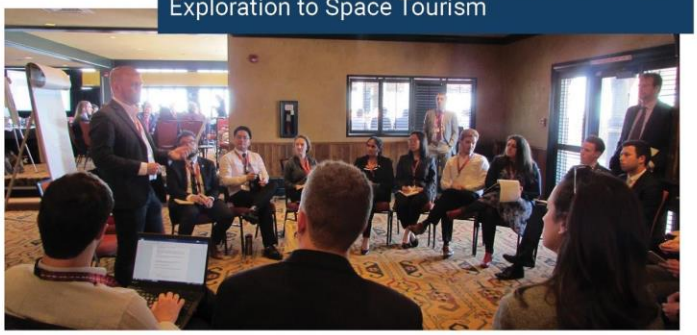
Emerging leaders are those who work hard and think differently; they aren't afraid to challenge the status quo. One of the biggest changes in space technology and policy are the people. The new emerging leaders will be from diverse backgrounds and insights. The Brooke Owens Fellowship is about encouraging women who were originally sidelined; it gives you the tools and network to drive right in and gain confidence to lead. Brooke Owens Fellows and their mentors are founders of startups, talented researchers and engineers, organizers of space symposiums, and savvy communicators. They inspire and lift others up along with them because they want to give back.

EMERGING SPACE DINNER: SHAYNA HUME, MATTHEW ISAKOWITZ FELLOWSHIP PROGRAM

Ms. Hume wanted to focus on the commercial space industry but encountered difficulties finding productive internships. She is now at University of Colorado at Boulder and is pursuing a master's degree in entry, descent, and landing. It was there she found out about the Matthew Isakowitz fellowship. She became part of a group of people with discordant ideas of the future wanting to take on challenges that were barely in existence. “The Fellowship proved to me that no matter what my background is, I can be a player," said Hume. Today people are finding ways to widen access to space, starting with high school students launching cubesats, and on through to innovative commercial businesses. As we continue onward, the young people of SGAC will be in higher positions in the workforce. Our differences become will become our strengths, which will open the door to a different vision of the space industry. There is a communal desire to improve space around us: Venture capitalists, technologies, space junkies, all around astropreneurs. These people have insane dreams but put in the work to make the dream real, and representative of the greater generation coming to the scene now.

SGFF 2019 DAY 2 HIGHLIGHTS

Panel on Humans in Space: From Government Exploration to Space Tourism



Lunch keynote by Larry Price, Lockheed Martin Space

Breakout Sessions on Space Topics

SGAC Pin Ceremony

SPACE GENERATION
FUSION FORUM 2019

LIGHTNING TALK: KYLE ACIERNO, iSPACE

The "moon rush." The moon is back on the table, it's been 50 years since Apollo. Nationalism, lunar resources, and the rise of the private industry is showing the new race to the moon: India's first scheduled launch to the moon, China's sample return, the US' plans to put a woman on the moon, and Europe's moon village. Everyone wants to associate their nation with lunar exploration. Originally we thought it was this bland, dry place, but remote sensing missions have shown us it is full of resources. Iron and thorium means you can find a lot of rare earth elements. Hydrogen and oxygen – there is a focus to get to the lunar poles to discover more about the water ice that exists. If water is on the moon, it could serve as propellant to get to near earth asteroids. There is an increase in venture capital investment. Investment last year was more than 2017, and 2019 will have more investment than every other year combined. The outlook in 2040 is a trillion dollar market. We will be leaders of this new massive industry.

New companies have come up and iSpace is one of them. We went from four to five employees to 80 with one dream - to expand the social and economic sphere to include the moon. iSpace has a "Moon Valley" vision, the staging ground for your next business. As for the Google Lunar XPRIZE – iSpace focused on the rover, put almost 10 years into developing this rover. In 2013, they won the Terrestrial Milestone Prize. People started to believe in iSpace, private sponsors wanted to invest. The Google Lunar XPRIZE canceled, but iSpace was determined to make the product come to the market. They've raised $95 million dollars to develop their own lander, receiving funding from Suzuki and other businesses who wanted to expand their business to the moon.

Next generation rovers need to be able to access difficult places like craters for initial prospecting activities. iSpace will work with another company to put its payload into geotransfer orbit which weighs one ton and will deliver 30 kilograms to the surface. It can host scientific payloads and deliver our rover to the moon. They want to go into shallow craters in southern and northern pole. iSpace is planning 10 missions thus far, finding customers who want to participate. Payload delivery, data collection, and advertising.

- Payload delivery
- Data collection
- Advertising

iSpace will put solid state battery on its rover, and other company will put insurance on the rover to learn how to insure space objects. Space agencies are serving as anchor customers, Luxembourg, Draper team, JAXA. They need help, and will be posting 40 jobs in the coming months. If you are someone who believes the sky is not the limit, if you want to work in an interracial, interdisciplinary, intercultural environment, work for iSpace. Help us get to the moon!

Challenge is surviving the lunar night; iSpace is partnering with NHK for the solid state batteries to survive the lunar night. Since RTGs are not an option, because there are not many companies willing to sell a private company nuclear material. This is really complicated and expensive. Batteries only last a few weeks, so you have to do things fast. Abigail Gonzales does studies on where to land that astronauts haven't been to yet. Most expensive real estate exists on peaks of light on North and South Pole, always have access to sunshine and permanent access to a power source. All countries and companies will be trying to get to those areas.

KEYNOTE: DEBRA D. FACKTOR, BALL AEROSPACE

Building Your Future - Navigating the Inflection Points of Life along the Way

Dr. Facktor spoke to Delegates about how to navigate a career with confidence and joy. Dr. Facktor is now a Vice President at Ball Aerospace, headquartered in Boulder/Broomfield, Colorado, but several years ago she was looking for something new so she wrote down everything that was important to her in a dream job. She asked Delegates to do this same exercise, listing things that were important to them in a new job (salary, window office, who you're working with, location) as well as passions and dreams. Debra was at a Space Symposium a few years ago and made a deal to become president of AirLaunch based on her sheet of paper.

Debra gave the Delegates ten pieces of advice to help them with their careers:

1. Be an expert where there is none - know your stuff, find what you do best, learn. Share. Be engaged - get involved in professional associations, community. Build and establish your expertise, value and role.
2. Don't abandon your post - when times are tough, don't just quit. Change how you react, behave, see things. See what else you can change. Others are relying on you. Do what's right for you and others
3. Look out and up from where you are - explore other opportunities outside of your world. Seek perspectives that are not your own. Meet new people, try new things. Stretch, grow.
4. You can't buy experience, it takes time. Experience is the result of hard work, commitment and time. Learn it and earn it. Struggles can give you energy to transform. You and others will know when you're ready. Once you're there - own it, embrace it, "be".
5. Create connections - teamwork (collaborate and partner for success), look for synergy across departments, markets, technology, teams. Diversity of ideas/people results in better products. Invite new ideas
6. Understand your impact on others - think about what you say/do and how it lands. Own up to mistakes. Be accountable. Be gracious and kind to those around you. Recognize,

respect and thank those who contribute. Think about who else that person is responsible to direct reports, supervisor, family. Think about how do you say it, what you do, and how it's going to land others. Have to be conscious of how you interface with your co-workers. Be mindful. ALWAYS thank people.

7. Seek joy! Finding your guiding principle. Discover and make time to do what makes you happy. Find the right fit, so you can be yourself. Manage your energy. Prioritize, focus. Be present. (spin class picture)
8. It's OK to ask for help - it's okay to be vulnerable. Seek out mentors/advice - talk to someone with a different perspective, shared experience. You are strong, but that doesn't mean you have to do it alone.
9. How do you navigate the inflection points of life?
10. Pass it On - being here is a responsibility, not a privilege - share what you learn. Be a mentor - take on the responsibility to help someone else navigate their career. Be an advocate, sponsor, champion for others. Be the person that makes a difference in someone's career, someone's life

PANEL: SATELLITE INNOVATION: ENABLING THE NEXT PARADIGM SHIFT

Moderator: Charity Weeden, U.S. Senior Advisor, Policy and Strategy, Astroscale
Barry Matsumori, CEO, Bridgesat
Joseph Anderson, Vice President, Operations and Business Development, Northrop Grumman
Therese Jones, Senior Director of Policy, Satellite Industry Association (SIA)
Collin Mitchell, General Manager, Space Systems & Ranges, Harris Corporation

Panelist Discussion

Charity Weeden opened things up with a discussion on what "innovation" means. To some it means breakthrough technologies, while for others it means taking a diversity of technologies and policy ideas and doing something unique with them. Her company Astroscale is applying a diversity of technologies to the new reality of space debris and helping satellite operators deal with it. In this panel she wanted to talk about both definitions and also the core of satellite innovation: our industry's diversity of technologies, business cases, regulations, and people.

What are the biggest developments leading up in this age of innovations?

Joseph Anderson: A big change is the industry adopting the attitude of Silicon Valley technologists, the way you develop things, intersection of diverse things, including development of smallsats. Launch is key as you have to get to space, and there are many new launch access companies. Competition, and figuring out how to manage failure will lead to increased innovation.

Therese Jones: Access to space is cheaper than it has ever been, and that is leading to a proliferation of constellations and more specialized satellites. Charity noted that faster and cheaper smallsat construction will help drive affordable launch.

Colin Mitchell: A good goal is for the satellite market to become self-sufficient. To do that, we need to reach economies of scale by mass producing satellite components and buses, and we need to work on bringing on-orbit servicing to market. Eventually this could lead to more on-orbit services that would provide not just mission extension, but augmentation of satellites as well. These augmented technologies and capabilities will bring transformative innovations.

Barry Matsumori: It's worth considering why we're going to space. There are markets we can affect in telecom, earth observation, exploration and science, and manufacturing. The key limitation to our industry's role in all of this is the launch cost per kilogram. We have to work to increase access to space.

Therese Jones: There's also a space debris concern - how do we ensure that each is a responsible actor in space? We've started with new regulation reforms from the FCC. Colin pointed out that companies are helping to shape those policies as well.

Charity asked how we can develop the best practices to enable innovation in the future? How are regulations helping shape innovations? What do we have to change? Joseph stated that SSA policies can be good if it favorable to all in the domain. Colin stated that NASA technology transfer policies are a good example in that they help innovations. Therese stated that no matter what the regulations are, getting regularity certainty as soon as possible helps the industry. Barry stated that national attention to space is a good sign that the industry is innovating.

Charity asked how satellite innovations support other industries. Therese listed the transformative effects of internet access around the world, as well as the wide-reaching effects of remote sensing with data analytics. Colin talked about some spin-off applications for space manufacturing.

Charity asked about the most interesting satellite products that will come about in fifty years' time. She stated space products powering sustainable and efficient use of resources to counter climate change. Colin stated that by then we'll have satellites being manufactured from space. Barry thought that people will go to Mars and utilize VR.

To finish the panel, Charity asked what non-space related jobs helped the panelists get to their jobs in space. Joseph said the Army gave him a critical capability for making decisions. Colin said that his masters in engineering and MBA gave him the ability to look at the big picture including the regulatory, legal, and business aspects. Barry stated his experience with computer chip design allows him in his current company to change the design of a chip on the

fly. Therese stated that her diverse education in astronomy, science, history and policy gives her a holistic picture.

Audience Questions

What difficulties are there in selling new technologies? How do you make sure that there is a customer for it?

Joseph said that if you build, launch, and demonstrate technology, you can determine the customer base as you go. Collin agreed that demonstrating was very important because we're a very risk-averse industry commercially. Barry recommended that companies go to Bryce and get market data. Charity stated that you have to clearly lay out the value of your service and communicate that properly to your customers.

PANEL: HUMANS IN SPACE: FROM GOVERNMENT EXPLORATION TO SPACE TOURISM

Moderator: Dr. George Nield, President, Commercial Space Technologies
Ariane Cornell, Director of Astronaut and Orbital Sales, Blue Origin
Michael "Sooch" Masucci, Astronaut, Test Pilot, Virgin Galactic
Dr. Pascale Ehrenfreund, Chair, Executive Board, DLR
Marshall Smith, Director, Human Lunar Exploration Programs, NASA

Panelist Discussion

George Nield introduced the panelists after which each member gave introductory remarks touching on the dynamics related to the future of humans in space. Marshall focused on NASA's plans to send humans to the moon by 2024 and the challenge it represents. Pascale gave a European perspective and plans for future human exploration. Ariane gave a shoutout to SGAC highlighting her prior role as Executive Director and then focused on Blue Origin's mission of "millions of people living and working in space". Michael "Sooch" Massuci talked about the various aspects of ensuring sustainable human transportation from the regulatory to the technical and market challenges.

Sooch - SpaceShip Two is designed for a purpose. Have a lot of technology in both airplanes, flight technology on display + avionics to be smart about what the crewmembers need. We are trying to to run Virgin Galactic flights as part of the National Aerospace System without additional regulations. We're trying to make it operate like a plane to simplify the regulation.

George asked Ariane - what is the market for space tourism? Ariane: There is a good market out there, we have seen a of interest already but when we start flying, that's when we see the demand grow. There are a group of internationals who are going to want to explore and it's not

a country specific thing. There is a lot of interest in it already and it has the opportunity to last for many years to come.

George asked Marshall - Society seems more risk averse these days. Do you agree? Marshall: Our society has become more risk averse but we sell ourselves a bit short. At NASA we push the envelope to do exploration. We need to look at what are reasonable risks and evaluate the culture of risk.

George asked P Ehrenfreund - ISS has been tremendously successful. Can you think of DLR/international community that can support NASA's accelerated lunar exploration plans? Pascale: We have to go to deep space but we shouldn't abandon LEO. ESA has the exploration program (E3P), this is how we can cooperate and will be determined during upcoming ministerial. DLR has been a brilliant anchor and it's interesting to see how we transition from ISS to Lunar exploration. There is lots of expertise in Germany in robots and autonomy.

George asked Ariane - In the wake of the 737 incidents, how do we think about ensuring safety in space and avoiding space-related accidents? What can we do to prepare? Ariane: It's Important that industry and government work together hand in hand so that government is not too constraining while ensuring we have safeguards in place. From industry/Blue perspective we take safety very seriously. We do lots of safety tests and ensure they work under edge cases (e.g. landing safely with 1 parachute). We are partnering with the government and ensuring we are doing it right.

George asked Sooch - Two more spacecraft are under construction; will they be operating from Spaceport America or others too? Sooch: Right now we have licenses to operate out of Mojave, going to increase. Lots of international interest (Scotland, UAE) so we are looking at adding options for spaceport launch. Need to establish regulatory and process by doing it locally first and then doing it combined with whatever vehicle being used.

George asked Marshall - What are some of the differences between going to the moon to stay and Apollo? Marshall: We're really looking at reusability and ensure we have capability. Need to be fiscal responsible and ensure sustainability. We will be on the moon less than 5 years from now. Reusability is about being responsible - Gateway is a key part of that. Reusable command module can change orbits reshape architecturally and prototype for Mars exploration.

Audience Questions

You talk about cooperation. This morning we heard from ispace. How is the future settlement on the moon going to work, and how will it be integrated?

Marshall: We Need to learn about the resources and minerals, water ice etc. We may want to lean on vulnerability. How we work together from industry to industry and with international partners. Working together as a team to make sure the systems we build are cooperative.

Pascal: it will be a multi-stakeholder effort. Multi-stakeholder purpose and ensure emerging nations can contribute what they are able to contribute. It must be a step by step approach.

The Silicon Valley approach is to move fast. Do you imagine regulatory environment being able to adapt to it?

George Nield: All aspects of the challenge need to be considered. Just because we've always done it one way, doesn't mean we need to continue that way. Need to innovate if we want to operate at the speed of balance. Delicate balance with ensuring safety.

Sooch: Having worked with FAA on space side. There's a point when you see a path/avenue safely. Experience is with FAA have been able to make the case. Problem is if we have the time to do that and need to.

Pascale: Should we proactive? Yes. Takes a long, long time and lots of stakeholders. Space law is critical subject where you can engage for future lunar exploration. Need regulatory framework for exploration.

Ariane: We have to work together on these activities. Looking at larger long term issues at the UN and working on more short term with New Shepherd, we really have to work together.

How do you balance legacy and flight proven with innovation?

Sooch: lack of computer software on spaceship two? Make decision on autonomous route versus none. Look at historical decision points and what led to that. Always build on what's already been done. Always do that smartly.

Marshall: Have to evaluate risk management process. Don't have to go through the process from the start. What we do from 2024 has to be using evolved technologies and capabilities.

KEYNOTE: LAURENCE A. PRICE, LOCKHEED MARTIN SPACE

To the Moon! Orion's Great Leap into Deep Space

Engineers solve hard problems, the impossible just takes a little bit longer. The Orion program is a remarkable opportunity, building on the capability that Lockheed Martin has been fostering since Apollo. The Constellation program was canceled, so it was very exciting to see NASA and the Congress excited in human spaceflight again. In order to fly the complex systems we want it will take everyone working together: robots and humans; NASA, ESA, JAXA, and others, as well as Congress and the current administration.

Orion crew module and service module are the result of a thousand trade studies. They are built as an international vehicle with a complex relationship: ESA does the service module, while NASA does the crew module. Lockheed Martin is working through the ITAR issues. The first service module was delivered in November and cycle testing is finishing in April. Next the capsule will go to Ohio for full-scale vacuum chamber testing.

Orion first flew on Exploration Flight Test 1 a few years ago. EFT-1 flew to almost 40,000 miles, higher than any human-occupied spacecraft since Apollo. EFT-1 helped Lockheed Martin gain confidence in the vehicle, and also showed some problems, such as 2 airbags deflated that should have rolled the capsule back upright upon landing.

This spring, Lockheed will towards the Max-Q jettison separation test. The real key is to get EM-2, the crewed flight, in a year or so after that. All the groundwork is in place to do great things. When the program was designed, it was moon, Mars, and beyond. After Constellation was cancelled, it was briefly an ISS rescue mission, and now it's back to a deep space vehicle. Either way, the Orion vehicle program has stayed on track for over a decade.

Laurence showed delegates lots of interesting pictures and videos, such as Orion undergoing acoustic testing with rock concert speakers, Orion visiting the White House lawn, and Orion's ascent abort system. The ascent abort system was selected because it was the cheapest way to provide escape (separate quickly from the launch vehicle) and still meet spacecraft weight to orbit. It accelerates the capsule to almost 50,000 miles per hour!

With EM-2, Lockheed is trying to reuse much of the vehicle as they can as they learn to fly it. Lockheed is currently outfitting five Orion vehicles at once, working collaboratively with Germany and Airbus. Lockheed is also working on the inside of the vehicle as well, helping astronauts train at the Neutral Buoyancy Lab in the Johnson Space Center. Extremely exciting times today, there's not a better time to be involved in this business than where you are today.

Lockheed is exciting about NASA's Lunar surface missions: want to learn where the moon came from, how craters are formed, there's so much interest in what data is coming back from this capability.

Audience Questions

Exploration Upper Stage: We desperately need the SLS and EUS capabilities, working with Boeing to build. We need the capability to fly anything and not be in a corner. As Robert Lightfoot said, we have to do all this together.

What's next after Orion: Laurence doesn't even try to dream of the future, because capabilities will be much different then. All Lockheed Martin can do is build really cool machines that are sustainable and will enable the future.

How do you collaborate with others: helping collaborators with the paperwork so they can focus on the engineering. Constantly working in a business risk analysis sense, we need to look at different business cases (what if ESA decided not to fund?). We are going to fly as fast as we can to demonstrate capabilities. All about risk, NASA is about returning astronauts safely home.

BREAKOUT SESSIONS: SPACE TOPICS

Government, Commercial and International Space: Which Way Is Up?

Dr. Mary Lynne Dittmar, Coalition for Deep Space Exploration

Delegates started the session with discussing why they wanted to participate in this discussion (over other breakout groups). The answers were varied but hit on the intersection of politics, economics, technology, and infrastructure and how that applies to the commercial space industry of today and the deep space industry of tomorrow. Delegates agreed that the economics of commercial space today lie chiefly in being able to provide value back to Earth for work done in space, but in the future this may change.

Delegates discussed the objectives of commercial space today, including making profits, having non-governmental customers to provide additional income streams, keeping regulations free enough to allow creativity in the market, and creating an entire end-to-end value chain. This led to a conversation on regulations which today at the national level provide operational guidance and provide validity and legal infrastructure that helps give certainty to the industry. We don't know the answer today, but it's important to keep working on this though and not wait until something bad happens and too many protections get put into place. As we look towards creating global regulatory frameworks, we need to work to provide stabilization and predictability in a way that at least provides guidance for governments globally, so a one-size-fits-all full solution might not work. The industry is at a multi-entity place with different countries and different levels of space development. Would intergovernmental agreements like the ones for International Space Station work? What about an institute that drives the vision and creates a set of standards that countries can voluntarily subscribe to or not? That could potentially avoid stifling development of less-established countries, but some countries would then choose not to respect those standards, so some sort of accountability entity might still be required to step in. George Nield, formerly of FAA AST, provided delegates with a caution: the FAA was given a dual mandate for commercial space: facilitate expansion but also require safety. George advised that any government authorities need to have a primary mandate to enable industry to succeed. This led to a discussion on what regulations for commercial space actually include and encourage (safety/protection vs business success) as well as licensing. A point was made that regulation should be based on

risk posture, and the delegates discussed the roles of government regulations vs. ISO standards and insurance companies.

Delegate Takeaways:

- Flexibility of industry, only certain regulations will apply based on what you would do
- Symbiotic relationship must be established between commercial and government and other interested parties (create ecosystem)
- Private vs Public Relationship (also involve general public)
- International vs National Regulations, Proactive vs Reactive regulations
- Define what we need to look for, what is driving the commercial industry? Insurance, profit, etc
- What they can, want or should do (soft vs hard law)
- Case Studies: NGO, ISO, airline industry growth scale
- Competition of Countries for Launch Regimes

Building a Sustainable Economy in Low Earth Orbit

Justin Kugler, Made in Space

Justin Kugler, Vice President of Advanced Programs & Concepts at Made in Space, began by giving us an introduction of himself and his work at Made in Space. The company has garnered a lot of attention lately due to their work on 3D printing at the International Space Station and a proposal for the economic manufacture of ZBLAN fiber on orbit. This attention motivated a lot of questions from the breakout session delegates. Justin shared that for now, Made in Space will rely on sourcing material from Earth, however they are interested in developing a closed cycle of manufacturing for on-orbit use, such that materials can be repurposed. He believes that water will be the first material sourced on-orbit. He also discussed how one of the major challenges for their business is regulatory uncertainty for on-orbit operations, and how working with organizations which aim to progress regulations (such as CONFERS) helps them to attract investors. Justin specifically discussed how many regulations apply to vehicles depending on where they launched from, so this leaves a gap in legislation for things manufactured in space.

Delegate discussions then turned to more general ideas of how to build a sustainable economy in low earth orbit. Made in Space has targeted what they see as one of the most promising areas for making an economic case to develop a service on orbit, and that other companies will need to do the same. On-orbit manufacturing seems to have unlimited potential growth, but what should be made in space? The first question for a product is, why does it need to be done in space? Some ideas which were discussed included:

- Does the product gain an advantage from having a higher ground, such as telecommunications or Earth observation?

- Does it benefit from a microgravity environment, such as ZBLAN fiber-optic material?
- Might it need to be constructed on orbit if it can't survive the launch environment?
- Might it need to be constructed on orbit because it is too large for a standard fairing?
- Could services on orbit provide better time sensitivity? Such as a medical stint or cast for astronauts.
- Finally, it's important not to forget that there is some added value to products because "space is cool", although it's important not to place to overvalue this statement.

Delegates ended the conversation with Justin by discussing how to make things affordable in space, discussing how removing humans-in-the-loop currently required by the Made In Space business model is a critical first step. This quickly turned back to a conversation on policy and regulations, and how removing a lot of the uncertainty would enable businesses to thrive in space. Talking with Justin gave delegates a better perspective on what it will take to see the emergence of a new low Earth orbit economy.

The Future of Space Communications and Navigation

Jim Schier, NASA Space Communications and Navigation Office (SCaN)

Introduction: State of Satellite Comm and Nav

Communication and navigation are crucial elements of every mission and they require international organization. This is already happening today between governments, but the push is to make this a reality in the commercial market as well. The satellite communications market is valued at $120B in annual revenue, and in order to maintain the business case the market needs to consistently maintain profit. This had led to a new goal to introduce innovations to reduce the cost of satellite navigation.

NASA SCaN runs all communication and navigation for NASA with just 3 percent of NASA's total budget. There are 3 main elements to NASA ScAN: Near Earth Network (NEN), Deep Space Network (DSN), and Space Network (SN). NEN has ground stations positioned globally to track all orbits around the Earth. DSN has 3 ground stations with 70-meter antennas spaced apart 120 degrees around the world to provide maintain 100% tracking of spacecraft far away, like Viking at 23 billion kilometers away. SN provides communications from satellites to other satellites and to the ground through the tracking data relay satellite system (TDRSS). TDRSS started commercially, but NASA had to take over the system after some key partners such as Western Union pulled out.

At NASA they've seen missions become more and more international over time, and today almost all missions have an international component. It's a really international environment which is open and collaborative. The commercial market however is a different environment. The commercial satellite communication industry is a large and healthy industry that is

growing steadily but slowly with the top 10 biggest companies (8 European, 1 Canadian, 1 Japanese) having closed proprietary infrastructures.

Satellite communication has historically followed the bent-pipe approach, but miniaturization of technology allows for the development of smart satellites with onboard processing and intersatellite link. Goal: satellite communications for $1 million per unit. Current cost about $300 million per unit.

Discussion Summary

- New companies using open source platforms and finding success by doing so. NASA is adapting this approach as well, for example by adapting IP protocol, with the caveat that it has to be adapted for new environments such as long-distance links to the moon. There was a group discussion about a standardized international protocol that might be beneficial for commercial companies but suspected there would be hesitation in the military market. However, current proposals are discussed within the military to incorporate a standardized approach despite security and export control hurdles.
  If you are doing this standardized approach, does net neutrality from Earth extend into space?
- Communication also includes positioning and timing systems. NASA is researching with laser communications system using cubesats as technology demonstration. 3 currently in planning: 2 in low earth orbit and one in deep space with potentially others in the future. Laser is beneficial as there is no spectrum management to deal with. Optical communications with 1515nm wavelength is not foreseen to have any beam interference issues due to small beamwidth. Additionally, miniaturization from mass producing terrestrial telecommunication industry can now be used in space to build power, laser, antenna interfaces at a reduced cost and size/weight.
- United States made the mistake of 2 different agencies managing spectrum: NTIA for government spectrum and FCC for non-government spectrum. They have to agree for one vote in the worldwide commission. All other countries did not split up their spectrum management.
- NASA has released a broad agency announcement to award contracts to the industry to study how to establish private public partnerships and how they are useful to NASA. Near Earth Network today is already a 50:50 split between commercial and government owned. Downside is that 2 out of 3 commercial companies today are foreig-owned.
- International space agencies are working together and are unified to develop a standard called the lunar communication architecture that is applicable to other bodies such as Mars as well. This would allow building up an interoperable system from scratch on interplanetary systems before it is available on Earth.
- Currently no integrated system is available, only components from about 15 different companies.

- Currently kilobits on the uplink and gigabits on the downlink (100000:1 ratio) which is a very undistributed ratio. The only exception is the ISS with 25 megabits uplink.

Main takeaways presented by delegate Karen Rucker

- Commercialization/Standardization: Closed architecture is state of the art. Startups using open source platforms might lead the way to interoperability as was the case with the terrestrial cell phone network industry
- Regulation: Combine NTIA with FCC to achieve synergies and achieve a powerful but lean regulation against spectrum interference.
- Optical and laser communication with lower beamwidth, but higher technical standards and higher costs are promising technology for higher throughput and lower interference.
- First laser communication systems already not interoperable with each other due to the use of different wavelength standards. Great opportunity for synergies available with the technology used in mass produced terrestrial fibre optics market.
- Deep space systems are currently being proposed to be more interoperable than near earth systems to date as they are built up by scratch with interoperability in mind.

High Speed Space: Industrializing an Industry

Dave Fischer, Director of Business Development, RUAG Space

RUAG is a leading supplier of space products in Europe and has a rapidly growing presence in the United States. Their capability spans advanced manufacturing of composite and metallic components, including additive manufacturing. Based on this operational domain, RUAG facilitated discussion on the organisation and market-level changes required to meet space economy demands in the next ten years on the technology, process and people fronts.

To kick-off the discussion, the group undertook a keyword brainstorm of connotations associated with segments of the space industry:

1. Government space: exclusionary, far-reaching, policy is a necessity, outdated, bureaucracy
2. NewSpace: agile, AI, fast, rapid growth
3. Commercial space: bland, agile, lower access barrier

When Dave asked the group to point out the similarities between all three domains, delegates came to the conclusion that all are enablers of space ecosystem growth. Dave then did another keyword brainstorm to describe the interaction between Government and NewSpace. Delegates came up with words such as volume, friction, collaboration, complementary, partnerships, service provider.

The discussion group then split into three groups. Each group addressed one of the following topics: What changes to company, market etc are required to meet space market demands in the next ten years on the: (1) technology; (2) process; and (3) people fronts?

The following major points were raised by the group:

Technology

- Automation and reliability – AI which is both a tech and cultural issue
- Key Growth Areas: Space debris, software control while in flight, additive manufacturing
- Revolutionary vs evolutionary technology (look around and adopt from other industries)

People

- Automation and AI – training to use tech effectively and teaching employees so that attrition is not an issue. Portray AI as a complementary to human performance.
- Reward/incentivise for continued learning and innovation

Process

- Digital supply chain to augment satellites, digital twin, digitisation and MBSE
- Whilst transitioning; data security and accountability and proprietary info

The group noted that AI and culture change were central themes across the three facets discussed.

A delegate asked Mr. Fischer about the challenges of readying COTS products for space, and how they could be addressed. Mr. Fischer said that from a technical perspective, there is a demand for the development of radiation hardened, high-quality products. Culturally and from a business perspective, first adopters (i.e. a customer) are essential to qualifying space-grade products.

Mr. Fischer ended the discussion by asking delegates how young professionals at an individual level can impact paradigm shift in the space industry. Delegates provided several ideas:

- fail-fast and encourage emerging nations
- grow personal ability to sell a story and approach ideas with an understanding of the history
- promote diversity (i.e. geographical, gender and generation, as well as different educational backgrounds) since these are critical to cross-functional teams and breaking down barriers collaboration and inclusion should be an inherent part of work processes
- acquire expertise in a given field, but also,
- develop breadth in ability both technically and in other domains to understand the “bigger picture”
- be agile in regards to interpersonal relationships and in terms of self-awareness.

Sustainability and Security

Dr. Peter Martinez, Secure World Foundation

At Secure World Foundation, Peter and others are focused on space security, so this breakout group focused a little more on military aspects of space than other groups. Peter asked delegates to think through and discuss the difference between militarization and weaponization of space. This brought about discussions on the definition of a weapon and if there was anything inherently wrong or not about having weapons in orbit. After this initial discussion delegates discussed the current counter-space capabilities available to militaries:

- Anti-satellite missiles
- Malicious satellite servicing – disassembling
- Jamming / spoofing
- Lasers on the ground and in space
- Cyber security capability
- Causing irreversible vs reversible harm

Delegates then discussed these capabilities relative to the Outer Space Treaty, which prohibits the deployment of weapons of mass destruction in orbit, but does not prohibit military actions in space. Instead, groups of experts are looking at the laws of warfare here on Earth and seeing how they apply to conflict in space, including what is allowed and where the gaps are. Delegates first discussed the United Nations Group of Government Experts (GGE) and the continuing work on the proposed Prevention of an Arms Race in Outer Space (PAROS) Treaty. There are currently diverging viewpoints on whether the treaty should be fundamentally addressing technologies or addressing behaviors. The EU has been working on a multinational International Code of Conduct while Russia and China have proposed the Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects (PPWT). This and other treaties look at traditional disarmament perspectives without considering NewSpace realities and norms of behaviors. The UN GGE is also working on more short term voluntary actions known as transparency and confidence building measures (TCBMs).

Dr. Martinez then turned the discussion to the Space Force, which has been debated for over twenty years in the United States, so it's not a new idea. The idea has been driven by the notion that the balancing of space capabilities between the Intelligence Community and the Air Force (and to some extent the Army and Navy) has its place, but it leaves the US without an ability to quickly react to space threats. Dr. Martinez gave an update on the current position of Space Force and Space Corps concepts in the House and Senate and then delegates discussed whether or not the Space Force will be beneficial for the space industry.

Delegates finished the session with a discussion of the elements that threaten the sustainability of space security and highlight the fragile space environment

1. Current state of policy / norms of behavior and trust / rule of verification / problem of lack of regulation of liability for space debris
2. Technological capability to remediate / remove space debris
3. Economical viability / commercial feasibility of removing space debris

SGFF 2019 DAY 3 HIGHLIGHTS

Astronaut Closing Keynote by Dr. Sandy Magnus, AstroPlanetview, LLC

Thank you for a great Fusion Forum!

KEYNOTE: GENERAL JOHN HYTEN, US STRATEGIC COMMAND

"My perspective is from the past, but your perspective is towards the future."

General Hyten never thought he would become a 4-star general, but he found a place where people challenge him, where people were different from him, and it helped shape his path.

Hyten's passion has always been space, and it is so important to have something in life that is about your passion. When he was young, his family moved to Huntsville, Alabama for the Apollo program. He met Von Braun when he was 10, one month after the moon landing. He really wanted to be an astronaut, so he studied to be an engineer. That was his dream, but the dream you end with might not be the dream with which you started.

Hyten had a vision issue, so he joined the Air Force. H wanted to go to Harvard University and was admitted in 1977. It was challenging to be in the military at that time in Cambridge. He became a communications specialist. Before he planned to leave Air Force, he was asked what was one thing he wanted to do, and he answered that he wanted to be in the space business. Space is important on the battlefield. Space was brought into the battlefield. It's used to defend the country and defend the environment.

General Hyten highlighted that there are two things no one can take away from you: Integrity and attitude. The truth will come out in the end. Be able to control your attitude, and keep your attitude positive. He also reflected on how it's amazing how your dreams can change.

Audience Questions

Approach to space debris?

Take a leadership role but also work with the international community. A lot of leadership thinks it ties our hands, but it actually does not, because it helps us work smarter. Debris is a significant problem for the future.

What is the biggest challenge to your organization?

US Strategic Command has to reorganize itself to a warfighting command. When Strategic Command is called functional capabilities, then it become something that it isn't. If you want to change it, you better change it straight way. It takes time for change to happen, that's the challenge of changing culture at Strategic Command. The change has to come from a vision, it has to come from leadership, you can't just talk about change. The vision becomes embraced by those who work with you. Talking about change is one of the most popular things to do, but not the most productive.

What is your vision for the future of space or space force?

I am not doing this for the glory or the money. If I can feel that I can make a difference to my country and a difference to the world. If the job meets that, then the answer is yes. “Why are you doing what you are doing? I think I love it and I feel I can make a difference."

We need to reestablish a Space Command for the Space Force. Within the Air Force, we don't need to establish another bureaucracy. Need to have a place on the joint chiefs.

How to deter other nations from ASAT as a demonstration of power?

We need an international agreement of norms of behavior. India did it at a low orbit and all the debris will fall down to Earth. Need to work with other nations to go down that path.

How to create a positive environment in an institution that has a reputation?

The core motivation is the most important. Your organization should always keep focused on that core motivation.

What do you hope for the commercial space industry and what is the government's role?

The government in general hasn't done a great job. Someone out in the commercial world might change the world, and the government better has a relationship with them. We need to be more aggressive and push them, and make it easier for them to do business with the US Air Force or US Military.

Use of nuclear devices in space for planetary defences?

Right now we are prohibited from using nuclear propulsion or nuclear weapon in space. We need to discuss nuclear power and capabilities in space without being worried about the technology. We have become afraid of nuclear capabilities. “For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of preeminence can we help decide whether this new ocean will be a sea of peace or a new terrifying theater of war."

PANEL: FORWARD TO THE MOON: REFLECTING ON APOLLO 11 AND LOOKING FORWARD TO THE NEXT 50 YEARS

Moderator: Jan Woerner, Director General, ESA
Dr. Thomas Zurbuchen, Associate Administrator for the Science Mission Directorate, NASA

Jennifer Jensen, Vice President, National Security & Space Programs, Draper
Joe Landon, Vice President, Advanced Programs Development, Commercial Civil Space, Lockheed Martin
Dan Hendrickson, Vice President, Business Development, Astrobotic
Mika Ochiai, Associate Senior Administrator, Lunar Exploration Program Preparatory Office, JAXA

Panelist Discussion

Moderator Jan Woerner opened with a discussion of Apollo's history and expressed the view that competition is a major driver of human progress. "For me it's clear the Apollo space race is the past. We should value the past and prepare for the future. We should go back to the Moon together in cooperation. Competition is a driver, but cooperation is an enabler." The series of questions that followed begin to explore what we can we learn from Apollo:

How does the memory of Apollo affect current operations? Panelists said Apollo is the picture of human ambition and focus. Exploration unites the world; even Iranian religious leaders put it in their newspaper. We also can't move forward to Mars in a vacuum; we need international cooperation. We believe in partnership as a big part going forward.

Jan - In Pence's recent speech, ESA heard different words that didn't sound like international cooperation. Zurbuchen: SPD-1 directs to go back to the Moon/Mars with international collaboration. We are trying to rattle the cages, accelerate schedule, very deliberate audience - speech was not directed to an international audience.

Jan - Thomas was speaking about speeding up on the commercial side. We have 2 quite different commercial entities. Question to Joe (Lockheed) - what for you, as a young person, what is Apollo for you? Joe - my perspective first. I was not born when the Apollo landings happened. What I see in the eyes of people who saw it, I recognize! How many people here saw when SpaceShipOne won the X-Prize? I was in Mojave when that happened, and that's my Apollo moment. At Lockheed Martin, we're very excited about VPOTUS's announcement. We're excited to use our expertise to go after this common goal.

Jan - is the Apollo effect of the future done by astrobotic? Dan - of course. Apollo is more than just an inspiration, it's a challenge. It can't simply be replicated because it doesn't really fit the time right now. Today we need to do it differently. We look forward to the Moon - we're working with commercial and international partners in a much more elevated way. The Moon itself is a much different destination as we understand it better now than we did in the 60s. Then, we didn't know about water ice, lunar caves, etc. Now there are new opportunities.

Jan - Thomas, back to you, what about the future of moon exploration? Is it private, commercial, public, either or? Is there a difference between private and commercial? Thomas - we hope it's private, but we don't know how the market will evolve. Before I decided to do our

robotic program entirely commercially, we did research. The natural thing would have been to make our own landers, but we flipped it on its head. We're buying services for lunar landers. Some programmatic risk is "is the market going to pan out?" Our goal - just like we want to commercialize LEO, we want to commercialize the Moon. NASA is about going beyond. We don't want to be in the same business 20 years from now - we want to have the industry behind us so we can lean forward.

Mika - one key thing we're looking at in Japan is sustainability. Our budget is quite limited, but we want to go to the Moon and then Mars. it's the natural thing to do. We want to maximize our experiences for future generations.

Thomas - Apollo affected how people choose their educations - engineers, scientists, STEM…

Jan - was it just because of the money? Thomas - I think it was really because of the inspiration. It's not for the money; it's a job where I can make an impact. It helps to have money, but if you see a human on another celestial body, to know you had a part of that is incredible - not just in the US, but around the world. It creates opportunities in careers we would have never expected. I agree with Mika on sustainability being so important. We're currently at less than 0.5 percent of the US gross national product… Apollo was over 4%

Jan - similar experience with ATV. Thought it was sustainable, but it's not at the end.

Audience Questions:

I love the Moon Village. When that was first introduced, we didn't have the same momentum as we have now. How can we take concrete action to have this happen in an international way?

Joe - Apollo was a competition. We should focus on collaboration instead of competition. Instead of exploration, we can focus on economic development. How do countries encourage development? They build roads and powerlines. That's how we should think about this with the moon. What NASA has done with the commercial lunar services contract is the exact right thing to do. Government won't know what the big business will be, but they can put the hooks in to make that possible.

Dan - bilateral and multilateral agreements between agencies are great. Our company is already making agreements with international space agencies, like Mexico. International partners can buy into a US company. We hope to create access for the entire world through our service.

Jennifer - contracting already with iSpace from Japan. We were going there commercially regardless of what NASA was doing. Previously, commercial was moving faster than the

government side. I think that's why NASA is now open to more commercial opportunities. The more connected we are, the more united we are, and the more we'll work together as a world.

Thomas - before I went to NASA, I was a professor and part of a venture fund. It's obvious we want to fly payloads to the surface of the moon. Landing is important, but we want to do science there. We want to learn how to build that capability. Our (NASA) entire procurement of space instruments ran faster than we normally do. We'll have the payloads by the end of this calendar year. We don't want commercial companies to wait for us - we want them to go at speed. I said "we're ready to go to the surface of the moon this calendar year" so that the commercials are motivated to go fast - don't want them to behave like NASA. The likelihood of success is 50%, because we don't know.

Thomas - later today I am meeting with my international colleagues. They're on my phone, we work together all the time. We asked all the space agencies what do you want to do. Out of these inputs, we'll stitch the framework to do the work they want us to do. Don't want to do regulations in a vacuum (Jan - but there is vacuum on moon haha).

Jan - NASA totally owned Apollo. The Moon Village is completely opposite. It's not one master and the others are following.

What are your thoughts on the Moon Village Jan?

Jan - I'm just moderator! Up until 2 weeks ago it was crystal clear what we would propose. It's not as clear now. We'll know more after today. We were going to go to lunar gateway then on from there. If this story is now in danger, than I cannot ask ESA member states to pay a big amount of money to guarantee this. My meeting is on the 17th of April, so I will be able to approach the member states then.

If we conquer space, will do it as humanity, not individual countries? Jan translates question - is today a totally different part of this competition?

Dan - we're partnering with Ecuador and Colombia as we develop their first payload to open up a lunar campaign in the future. In the US, there are Commercial Lunar Payload Service Providers. We'll need more than just transportation - power plants, ISRU, infrastructure… a great opportunity for different agencies, countries or companies to provide that infrastructure specialization (which is what you want to see in an emerging market).

Jan - Some competition is good to avoid monopolies

Dan - Astrobotic doesn't have a robotic arm on the lander, so we'll have a competition for that specialization.

Joe - When you do difficult things, you'll have to have a leader. Whoever is the most capable or whoever writes the biggest check is generally the leader. It's a mistake to think you don't have someone to lead.

Jan - Do we have just one leader in Antarctica?

Joe - The first expedition did.

Jan - But this isn't the first expedition to the moon…

Times are different, priorities, partners, etc. How do you foresee us maintaining focus on Moon to Mars? How do you see us in this room being able to help be a part of that?

Thomas - I run science, not human exploration. But it is in our scientific interest to have a human exploration program. The international space station is one of the big big victories of space. We need to move forward, out of low earth orbit. We need to learn how to live for a longer time far from security, from the protected magnetic field. I want the next generation leaders to have a role and a voice in that. If you're Americans, vote. There are people that you vote for, talk to them.

Jan - never be silent. There is no stupid idea. I gave a talk last week to normal people (which I try to do, not only to the converted ones). My baker had an excellent idea on how to go to the moon. I listened - who knows. He wanted to use a laser to go to the moon. Not as propulsion, he thinks it should be possible to climb up on the laser beam. Is this quantum entanglement? Nobody can explain it. Maybe dark matter for communication? Listen always. Be excellent. Try to be leaders. To listen to listen to listen!

Jennifer - the railroad provided transportation, and people didn't have to reinvent the wheel every single time. It needs to be open for everyone. Keep the right mindset and architecture to make it affordable.

Is it the accepted opinion (with respect to medical capabilities) that we're prepared to go back to the moon and stay?

Jan - UK is not leaving ESA! Just so you know. The moon village is not a colony on the moon. In our solar system, there is no planet as beautiful as the earth.

Thomas - if we go in 5 years, we won't be able to go to stay based on that program. We need a more sustainable rate. The medical aspects of the journey worry us. Also aspects of innovation. So medical is not as important in the short term, but certainly as we go for the longer term.

What's next? We're excited about going forward. Not just in the next 5 years with things that have been announced. What are you most excited about with respect to the next 50 years?

Mika - 2040s/2050s, we hope to have some base or village on the surface of the moon. We'll need fuel and a variety of supporting capabilities on the surface of the moon.

Jan to Mika - do you see fences and flags of different nations in the village? Will there be borders where you need a visa?

Mika - we don't need that. But we want to have something common.

Jennifer - we have diminishing resources, so there could be some good discoveries. We like potential fuel stations to get us further into space. We don't know what we don't know, but we're excited for the opportunities.

Jan to Jennifer - can we get resources from the moon both for use on the moon and for use on the earth?

Jennifer - all of the above.

Joe - very little value currently being created in space for space.

Dan - we want to see missions twice a year or faster. Want to use lunar water ice to get around in the solar system. We're most excited long-term for ISRU.

Thomas - we will have really screwed up if we end up on the moon with a whole bunch of fences. Most humans will still be on earth. We'll be on Mars and other bodies. We will have launched or will soon be ready to launch the first mission to the next star. Not with humans, but we'll have figured out the propulsion problem to do it. It'll help us get around the solar system too in our own neighborhood.

What are you looking for out of academia (other than STEM students)?

Mika - industry academia cooperation in the future

Thomas - academia are some of the most stable organizations on earth. It's about the future - to take us further, beyond where we are.

ASTRONAUT KEYNOTE: DR. SANDY MAGNUS, ASTROPLANETVIEW, LLC

"Everything I need to be successful I learned in kindergarten." - Sandy Magnus

Sandy's talk focused on going back to basics with simple principles that can often be forgotten but are critical to team success. She shared the following nuggets of wisdom on various topics with the Fusion Forum delegates:

- **Teamwork***:* Playing with friends nicely is important. Building an effective team and being an effective team member is important. In order to get the required strengths in a team you have to first understand what your own strengths and weaknesses are
- **Leading From any Position:** I learned this from playing soccer. There is a difference between being in charge and leading. Understand that you can be a leader from a different position at different times depending on what the situation is and what your strengths are.
- **Being a Good Follower:** The astronaut corps is organized very horizontally. I had to understand when leadership was needed and when I had to hang back based on the team dynamics.
- **Academics** - Love of Learning: Don't limit yourself of learning something new just because it seems too much effort to learn!
- **Passion** - Or How to Have Fun: Never have a job that you are not passionate about. This does not mean that every moment is fun, but you are passionate about the overall goal.
- **Balance** - Work and Play: We are all so passionate about space it is easy to let space consume you. You should have a counterbalance outside of space!
- **Service** - Helping People: The key behind everything we do is to bring humanity forward, and it is important to help out people.

Audience Questions

How did seeing Earth from Space change your perspective?

As human beings we take things for granted (which can be compared to famous sightseeing spots in your hometown that you haven't visited!). Seeing the thin atmosphere and the planet as a whole makes you realize how fragile it is and that we have to take care of it.

How do we solve problems that seem like they are being discussed forever?

Take it on yourself to make that decision; get the data and make a decision so that you are able to move on. There will never be a point when you can achieve consensus in large groups of people. Don't be afraid of being wrong. If you are learning from it, it is better than not making a decision. You will never have enough data to make a completely certain decision

Can you tell us about a time that you have failed?

On the Space Station you are always under surveillance and there is no way to hide anything stupid you made. For me one example was a stripping a screw to open the door for a science experiment which made the science experiment fail.

How will the psychological astronaut selection process change when going to the Moon and Mars?

The goal of the selection is really just to understand who you are. Astronauts get mentally prepared for their mission so they know upfront what their mission is. The second important point is to be doing something productive especially during idle time on Mars transit for example.

With broadening space to everyone, do you think it is possible for "normal" people to fly with less training?

Training will always evolve to match the mission.

What are the top 3 things that need to be incorporated in future human habitats?

Think about how people use the space. On the ISS the Galley, Toilet, and Treadmill are in one space which does not make sense. Lighting in the ISS is only on the ceiling but it prevents you from using the space three dimensionally as there are no lights on the floor.

What is the worst and best advice you have received as a woman?

I personally have never differentiated between female and male advice. The best advice always is follow your passion. Be yourself. Don't react to people by their behavior because it is easier. Be true to who you are or let their behavior influence your behavior. You cannot change who they are, but you can change who you are.

What is your personal experience working internationally in space?

We don't differentiate between nationalities but define people on their performance. Astronauts have unifying passion about space which bonds people together.

SGFF Scholarship Winners

Global Grants Programme Award

ispace Scholarship

Malisetti Foundation Scholarship

University of Colorado Boulder Scholarship

SPACE GENERATION
FUSION FORUM 2019

SGFF Organizing Team

SPACE GENERATION
FUSION FORUM 2019

APPENDIX A: SGFF 2019 SPEAKERS AND PANELISTS

In order by organisation name

Dr. Jamie M. Morin
Vice President, Defense Systems Operations
Aerospace Corporation

Jamie Morin is vice president of Defense Systems Operations, Defense Systems Group at The Aerospace Corporation. He assumed this position on March 29, 2017. In this role, Morin serves as executive director of the Center for Space Policy and Strategy, which provides objective analysis and comprehensive research to ensure well-informed, technically defensible, and forward-looking space policy.

Jamie most recently served as director of Cost Assessment and Program Evaluation (CAPE) for the Department of Defense, where he led the organization responsible for analyzing and evaluating the department's plans, programs and budgets in relation to U.S. defense objectives, threats, estimated costs, and resource constraints. Prior to his role as director of CAPE, Morin served for five years as the assistant secretary of the Air Force (Financial Management and Comptroller). Jamie also served for a year as acting undersecretary of the Air Force, where he led the Air Force Space Board and Air Force Council.

Previously, Morin was a member of the professional staff of the U.S. Senate Committee on the Budget, and served as the committee's lead analyst for the defense, intelligence, and foreign affairs budgets. Morin graduated from Georgetown University with a bachelor's degree in foreign service. He earned a master's degree in public administration and public policy from the London School of Economics, and a Ph.D. in political science from Yale University. He has also completed the Harvard Kennedy School's Global Leadership and Public Policy Executive Program.

Dan Hendrickson
Vice President, Business Development
Astrobotic

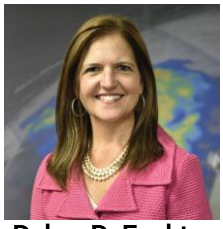
Dan Hendrickson leads Astrobotic's business development efforts and payload sales. Prior to Astrobotic, Hendrickson served as the Director of Civil and Commercial Space Systems at the Aerospace Industries Association (AIA). During his time at AIA, Hendrickson was a consensus builder among a council of 50 U.S. space companies to provide the U.S. Government guidance on key space industry interests. Before transitioning to AIA, Hendrickson served as a civilian mission assurance engineer at Cape Canaveral Air Force Station on five successful Atlas V launch campaigns.

Dr. Sandra H. Magnus
(@Astro_Sandy)
Principal
AstroPlanetview, LLC

Dr. Sandra Magnus is a former NASA Astronaut and veteran of three spaceflights, including a 4.5 month stay on the International Space Station and as a crew member of the last shuttle mission, STS-135. While at NASA Dr. Magnus worked extensively with the international partners to address ongoing operational issues. Following her 16 year career at NASA she became the Executive Director of the American Institute of Aeronautics and Astronautics where she served for 5.5 years. During her tenure as ED, Dr. Magnus led the organization through governance, organizational and cultural change to align it to meet the future challenges in Aerospace. She currently is the Principal at AstroPlanetview, LLC, continuing to serve the industry as a consultant.

Charity Weeden
(@cweeden)
U.S. Senior Advisor, Policy and Strategy
Astroscale

Charity is focused on helping to foster international space partnerships, supporting solutions for space sustainability, and resolving hard policy problems. She started her career in the Royal Canadian Air Force tracking submarines then switched to tracking satellites in Cheyenne Mountain Air Force Station as part of the 1st Space Control Squadron. Her final military assignment was as Assistant Attache of Air and Space Operations, helping to bolster the Canada-US space relationship. Charity has also been Senior Director of Policy at the Satellite Industry Association, representing over 40 members' interests to the US government and public. Among the several hats she wears, she is also currently President of SSPI- Mid Atlantic Chapter, a fellow of the Canadian Global Affairs Institute, industry representative of the Commercial Space Transportation Advisory Committee (COMSTAC), a recurring lecturer at George Washington University, and a mentor for the Brooke Owens Fellowship.



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

Debra D. Facktor is the vice president and general manager of Strategic Operations for Ball Aerospace, where she is responsible for increasing Ball Aerospace's profile in the market and facilitating collaboration across the company. Facktor is the company's senior executive in the Washington, DC area and leads Washington Operations, Marketing & Communications, and Strategic Development.

Most recently, Facktor took on the additional responsibility of leading the Commercial Aerospace business unit where she created and executed an integrated company-wide commercial strategy that leverages Ball's heritage of capabilities in areas such as remote sensing, transformational communications and data analytics. She has since returned her focus to Strategic Operations and Ball's commitment to deepen its presence and engagement at all levels in the Washington, DC metro area.

Facktor brings over 30 years of experience in the aerospace industry to her current role. Prior to joining Ball in January 2013, she served as the president of DFL Space LLC, an aerospace consulting firm focused on developing innovative business strategies for a wide range of clients. As an industry professor at Stevens Institute of Technology in Hoboken, NJ, she led its Masters of Engineering in Technical Leadership program and served as Director of Strategic Programs for the Systems Engineering Research Center (SERC). She was Principal Investigator on the SERC research project "Expedited Systems Engineering for Rapid Capability and Urgent Needs," sponsored by the U.S. Air Force.

Facktor has extensive business experience including serving as president and an owner of AirLaunch LLC, a small business which won funding from the Defense Advanced Research Projects Agency (DARPA) and the U.S. Air Force to develop an operationally responsive small launch vehicle. She previously served as vice president of Business Development and Strategic Planning for Kistler Aerospace Corporation.

Among other distinctions, Facktor was honored with the University of Michigan 2014 Alumni Merit Award for Aerospace Engineering and as the Women in Aerospace (WIA) "Most Outstanding Member" for 2012. She is the former chair of the board of WIA and founding president of the WIA Foundation. Facktor serves on the board of the American Astronautical Society (AAS), the Future Space Leaders Foundation, and the industry advisory boards of the University of Michigan Aerospace Engineering Department and the Johns Hopkins University Space Systems Engineering program. She is also an appointed member of the FAA's Commercial Space Transportation Advisory Committee (COMSTAC). Facktor is a fellow of the American Institute of Aeronautics and Astronautics (AIAA), a fellow of the AAS and an Academician of the International Academy of Astronautics (IAA). She holds both a B.S. and M.S. in Aerospace Engineering from the University of Michigan, and is an alumna of the International Space University summer session program in space

policy and law.

Dr. Melissa Sampson
(@DrSampson)
Sr. Manager Advanced Systems, Commercial Aerospace and Strategic Technology
Ball Aerospace, AIAA Associate Fellow

Melissa Sampson is a Senior Manager, Advanced Development, at Ball Aerospace, supporting the company's Commercial Aerospace and Strategic Technology business. Sampson is responsible for new business and technology development within the commercial marketplace, with a focus on emerging markets.

Prior to joining Ball, Sampson worked at United Launch Alliance (ULA), where most recently she worked as a program manager for cislunar technologies. Her experience gained at ULA spans business development, advanced programs, engineering, contracts and government affairs. Additionally, Sampson is a frequent speaker on topics related to the cislunar economy; next-generation technologies; and science, technology, engineering and math (STEM).

Outside of the office, Sampson dedicates her time to developing the next-generation of aerospace leaders, and was a founding Director for the Girls in STEM Board of Directors, an organization empowering and inspiring middle school and high school girls to pursue careers in STEM.

Sampson is an American Institute of Aeronautics and Astronautics (AIAA) Associate Fellow, International Coaching Federation (ICF) Accredited Coach, Society of Women Engineers (SWE) member and a Lean & Six Sigma Black Belt. She holds a B.S. in Chemistry from the College of William & Mary and an M.S. and Ph.D. in Aerospace Engineering from the University of Colorado, Boulder.

Ariane Cornell
(@arianecornell)
Director of Astronaut and Orbital Sales
Blue Origin

At Blue Origin, Ariane Cornell is the Director of Astronaut and Orbital Sales.

Ariane was formerly based in Vienna, Austria as the Executive Director of the Space Generation Advisory Council in Support of the United Nations Programme on Space Applications (SGAC).

Previously, Ariane worked in international management consulting, first with Accenture based in San Francisco as an analyst and then with Booz Allen Hamilton in Washington, DC as a senior consultant.

Ariane earned an MBA from Harvard University and a Bachelor of Science degree with honors from Stanford University.

Barry A. Matsumori
(@AZBammer)
Chief Executive Officer
BridgeSat

Barry was appointed as CEO of BridgeSat in 2017 and he brings over 30 years of experience in telecom and space technology as well as broad business insight.

Prior to BridgeSat, Barry joined Virgin Galactic in 2015 as a senior vice president and managed large segments of the company including business development, advanced designs and operations. He was recruited to SpaceX in 2011 as SVP and was responsible for all sales and business development. During he tenure, Barry's team developed the large backlog of rocket launch that drove momentum of SpaceX's presence in the space marketplace.

Prior to SpaceX, Matsumori worked for several telecom companies, primarily at Qualcomm, in developing mobile communications technologies and products lines from 1994 through 2010. Matsumori had also worked in several early stage technology companies in development and management roles, including an IPO on the Frankfurt Stock Exchange.

He is named in 16 patents. Barry holds a BS in business from Arizona State University and

an MS in electrical engineering from the University of Arizona.

Courtney Schmitt (@CourtMSchmitt) Master's student, Johns Hopkins University, **Brooke Owens Fellowship**

Courtney Schmitt is a Master's student at Johns Hopkins University pursuing a degree in Robotics. She will be graduating in May this year and moving to Seattle to work as an Avionics Engineer for Blue Origin.

Courtney graduated from Johns Hopkins in 2018 with a degree in Mechanical Engineering. As an undergraduate, she focused her studies on Aerospace. She participated in a variety of research including working with a cosmologist to map the locations of black holes in the universe, which she was recently published as a co-author for her contributions. The summer after her junior year, she had an internship at a start-up company manufacturing autonomous underwater vehicles. She currently continues work with autonomous vehicles researching in the Autonomous Systems, Control and Optimization Lab at Hopkins. For her senior capstone project, Courtney worked on a team to design an enclosure for a high-precision optics table. The design will assist NASA funded researchers at the Space Telescope Science Institute search for life on habitable extrasolar planets around other stars.

Courtney is an active member of her school's rocketry team, the AstroJays, developing avionics for the hybrid rocket motor they are building and is also the President and co-founder of the Johns Hopkins Chapter of the Students for the Exploration and Development of Space (SEDS).

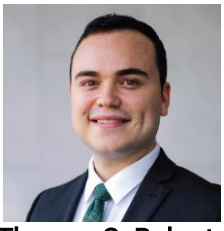
As a Brooke Owens Fellow, Courtney worked for Virgin Galactic the summer of 2018.

Manny Shar (@mannyshar) Head of Analytics **Bryce Space & Technology**

Manny Shar is the Head of Analytics at Bryce Space & Technology, leading consulting engagements for government and commercial clients, and having supported Bryce's international expansion over the past year. He has worked across the board on innovative projects from early stage investment to commercial model development in the satellite communications sector, previously managing a multi-billion-dollar portfolio of assets and carrying out cross-functional strategic business development activities.

Manny is actively involved with the Space Generation Advisory Council (SGAC), having helped organise multiple prior events, such as SGFF and SGC. Manny also advises numerous space start-ups, providing strategic business and technical advice. He is a member of numerous working groups and committees, including the IAF Entrepreneurship and Investment Committee.

Manny holds a master's degree in space studies from the International Space University and a bachelor's degree in computer science from the University of Kent.



Thomas G. Roberts (@ThomasGzRoberts), Program Manager and Research Associate, Aerospace Security

Thomas G. Roberts is a research associate and program manager of the CSIS Aerospace Security Project. His research interests include satellite system architecture analysis, civil and commercial space operations, and international collaboration in science research. Previously, Mr. Roberts has written on space-based missile defense, threats against space-based assets, and human spaceflight programs. His work has appeared in The Atlantic, War on the Rocks, The Bulletin of the Atomic Scientists, and other publications. Mr. Roberts is the host and executive producer of Moonstruck, a podcast about the history of human spaceflight. He holds a B.A. in astrophysical sciences with honors and an undergraduate certificate in Russian studies from Princeton University. In 2015, he was named a Harry S. Truman Scholar.

Project,
Center for Strategic and International Studies (CSIS)

Dr. Mary Lynne Dittmar (@DittmarML), President and CEO, **Coalition for Deep Space Exploration**

Dr. Mary Lynne Dittmar is President and CEO of the Coalition for Deep Space Exploration, a diverse industry trade group of more than 65 companies engaged in human exploration, science, and commerce in deep space. Her previous experience includes managing Flight Operations for The Boeing Company on the International Space Station Program where she later served as Boeing Chief Scientist for Commercial Payloads. She returned to the ISS many years later as Senior Advisor for the International Space Station National Lab.

Mary Lynne is a Fellow of the Sigma Xi National Research Society and an Associate Fellow of the American Institute for Astronautics and Aeronautics. From 2012-2014 she was a member of the National Research Council Committee on Human Spaceflight, and is currently in her second term on the Space Studies Board (SSB) of the National Academies of Sciences, Engineering and Medicine. In June of 2018 she was appointed by NASA Administrator Jim Bridenstine to the Users' Advisory Group of the National Space Council (UAG) and was then appointed by Department of Transportation Secretary Elaine Chao to the DoT Commercial Space Transportation Advisory Committee (COMSTAC). She resides in Washington, D.C.

Dr. George C. Nield, President **Commercial Space Technologies, LLC**

Dr. George C. Nield is the President of Commercial Space Technologies, LLC, which was established to encourage, facilitate, and promote commercial space activities. He served as the Associate Administrator for Commercial Space Transportation at the Federal Aviation Administration (FAA) from 2008-2018. Dr. Nield has over 30 years of aerospace experience with the Air Force, at NASA, and in private industry. A graduate of the United States Air Force Academy, he holds an M.S. and Ph.D. in Aeronautics and Astronautics from Stanford University, and an MBA from George Washington University. He is also a Flight Test Engineering graduate of the USAF Test Pilot School.

Dr. Pascale Ehrenfreund Chair of Executive Board **DLR**

Pascale Ehrenfreund is the Chair of the Executive Board of the German Aerospace Center (DLR). The German Aerospace Center is among the largest centers for aerospace, energy and transportation research in Europe with more than 8600 employees at 40 institutes and 20 locations in Germany. Since three decades she contributed as Principal Investigator, Co-Investigator and Team leader to ESA and NASA astronomy and planetary missions as well as experiments in low Earth orbit and on the International Space Station. Pascale Ehrenfreund is Research Professor of Space Policy and International Affairs at the Space Policy Institute/George Washington University in Washington DC, Chancellor of the International Space University ISU and incoming President of the International Astronautical Federation IAF. Pascale Ehrenfreund holds a Master degree in Molecular Biology, a PhD in Astrophysics, and a Master degree in Management & Leadership. The asteroid "Ehrenfreund 2114 T-3" bears her name.

Jennifer Jensen
Vice President of National Security and Space
Draper

Jennifer Jensen is Vice President of National Security & Space Programs (NS&S) at Draper. As part of an independent, not-for-profit research institution, NS&S provides innovative solutions to U.S. national security, global defense and commercial space markets. Ms. Jensen joined Draper in 2018 from Sierra Nevada Corporation where she served as Vice President of Business Development for Communications, Navigation and Surveillance Systems since 2011. In that role, she built and sustained relationships across the DoD as well as commercial markets. Ms. Jensen began her career in the U.S. Army in 1989, where she was the first woman distinguished honor graduate of flight school and one of the first women to transition to combat aircraft. She rose through the ranks rapidly and left active duty in 2011 as a Colonel. During her final position in the military, as Program Manager at the Army's Redstone Arsenal, she was responsible for the acquisition, implementation and interoperability of state-of-the-art aviation technology into existing and future Army aviation manned and unmanned aircraft. Ms. Jensen holds a B.S. in Aviation Management/Flight Technology from the Florida Institute of Technology, an M.B.A. from New Mexico State University, and a Master of Military Operational Art and Science from Air Command and Staff College (ACSC), Montgomery, AL. Jennifer is also a fixed and rotary-wing commercial/instrument multi-engine rated pilot.

Johann-Dietrich "Jan" Woerner
(@janwoerner)
Director General
ESA

Johann-Dietrich 'Jan' Wörner became the ESA Director General on 1 July 2015.

Previously, from March 2007 to June 2015, he served as Chairman of the Executive Board of the German Aerospace Center (DLR).

Jan Wörner was born in Kassel, Germany, in 1954. He studied civil engineering at the Technical University (TU) Berlin and TU Darmstadt, from where he graduated in 1985. In 1982, as part of his studies, he spent one year in Japan, investigating earthquake safety of nuclear power plants. Until 1990, Mr Wörner worked for consulting civil engineers König und Heunisch.

In 1990 he returned to TU Darmstadt, where he was appointed as a professor of Civil Engineering and took over as Head of the Test and Research Institute. Before being elected as President of TU Darmstadt in 1995, he held the position of Dean of the newly established Civil Engineering Faculty. Jan Wörner headed the university from 1995 to 2007 and succeeded in making it the first autonomous university of the Federal Republic of Germany.

Jan Wörner has been awarded numerous prizes and positions, such as the Prize of the Organisation of Friends of Technical University Darmstadt for 'outstanding scientific performance'. He was also appointed to the Berlin Brandenburg Academy of Sciences and to the Convention for Technical Sciences (acatech) and is a representative of the Technical Sciences Section of the Leopoldina, the national academy of sciences of Germany.

Jan Wörner has received honorary doctorates from New York State University at Buffalo (USA), technical universities of Bucharest (Romania) and Mongolia, the Saint Petersburg University for Economics and Finance (Russia) and École Centrale de Lyon (France). He has received the Federal Cross of Merit (Officer's cross, 1st class) of the Federal Republic of Germany for his continuous efforts regarding the next generation of scientists and Germany as a location for Science, Technology and Engineering. He has furthermore been awarded the honours of Knight of the French Légion d'Honneur.

Before joining ESA as Director General, Jan Wörner was head of the German delegation to ESA from 2007 to 2015 and served as Chairman of the ESA Council from 2012 to 2014.

Colin G. Mitchell
General Manager, Space Systems and Ranges
Harris Corporation

Colin Mitchell is general manager of the Space Systems and Ranges (SSR) business area, managed from Harris' Colorado Springs, Colorado, location. SSR is part of Harris' Space and Intelligence Systems business segment, which offers complete Earth observation, weather, geospatial, space protection, and intelligence solutions from advanced sensors and payloads, ground processing, and information analytics. Mitchell provides strategic direction and leadership for Harris' SSR family of programs, including the U.S. Air Force Life Cycle Management Center's System Engineering and Sustainment Integrator (SENSOR) program, and the U.S. Army's Wideband Satellite Communications Operations and Technical Support (WSOTS) program. Previously he was business area leader for Special Programs in Harris' Intelligence, Surveillance, and Reconnaissance business segment. He also served as manager of sales operations for the Space and Intelligence Systems segment.

Mitchell joined Harris in 2015 with the company's acquisition of Exelis, where he started as an image scientist and progressed to positions of increasing responsibility in strategy, planning and analysis, and business development, Before joining Exelis (then ITT) in 2009, Mitchell served five years as an officer and paratrooper for the U.S. Army, holding positions such as platoon leader, aide-de-camp, and Corps operations officer. His military career included two combat deployments to Iraq.

Prior to his commissioning, Mitchell earned a Bachelor of Science degree in Geospatial Information Systems from the United States Military Academy at West Point.

Kimberley Stover
Director, Human Resources, Space and Intelligence Systems
Harris Corporation

Kimberley Stover is director of Human Resources (HR) for the Space and Intelligence Systems segment, aligned with the Space Superiority and Positioning, Navigation, and Timing business units within Harris Corporation.

Space and Intelligence Systems complete Earth observation, weather, geospatial, space protection, and intelligence solutions from advanced sensors and payloads, ground processing, and information analytics.

Stover assumed the position of director in 2015, reporting to the vice president of HR. Her responsibilities include providing strategic and tactical HR support to the senior-level management team composed of the business vice president/ general manager and his direct and indirect reports. She leads the team of HR business partners for both segments, and her focus areas include change management, talent management, employee relations, staffing, salary planning, and training.

Previously, she served as HR manager, where she led three HR business partners in supporting the division's Operations organization. She provided HR support to the senior level management team and focused on leadership coaching, performance management, employee relations, and supervisor training. She joined Harris in 2011 as an HR business partner.

Before joining Harris, Stover was an HR business partner for Bowe Bell and Howell, where she was the primary HR partner for the site Engineering and Manufacturing functions, the corporate Quality and Supply Chain functions, and the corporate Information Technology function. She also held positions at Harris Stratex Networks, Syngenta Corporation, and Bic Graphic USA.

Stover has a master's degree in business administration from Elon University and a bachelor's degree in management from the University of North Carolina at Greensboro.

Kyle Acierno
Vice President Global Sales & Strategy
ispace, inc.

Kyle Acierno is an international expert in commercial space and a specialist in lunar exploration. Over the past decade, he has developed broad knowledge extending into space science, engineering, law, policy, finance, and business development. He is the chairman of the technical panel of the Hague Space Resources Working Group and regularly contributes to legal debates surrounding space resources.

Currently, Kyle works as the Vice President of Global Sales and Strategy at ispace, inc. ispace is a lunar exploration and transportation company with its headquarters in Japan and regional offices in Luxembourg and at NASA AMES in California. ispace managed the front-running competitor in the Google Lunar XPRIZE, Team Hakuto and raised a record $95M in December of 2017 to build a commercial lunar lander.

With both Canadian and Italian citizenship and a passion for exploration, Kyle has visited over 90 countries. He speaks Chinese and has limited proficiency in Spanish. He received a Bachelors in International Security and a Masters of Science in Space Studies.

Mika Ochiai
Associate Senior Administrator, Lunar Exploration Program Preparatory Office
JAXA

Mika Ochiai is currently serving as a senior associate administrator of the International Relations and Research Department, Japan Aerospace Exploration Agency (JAXA), where she coordinates international affairs of JAXA's space projects, as well as promoting wide range of space cooperation with overseas entities. From 2011 thru 2014, she worked in the United Nations Office for Outer Space Affairs (UNOOSA), located in Vienna Austria, as an Expert to implement the UN Programme on Space Applications and its Human Space Technology Initiative.

Since she joined the National Space Development Agency of Japan (NASDA), a former body of JAXA, she has been working in space enterprise with experiences of different areas, including the space transportation office, satellite applications office, and the human spaceflight office. She was also serving as a secretariat of the Asia-Pacific Regional Agency Forum (APRSAF) and for her contribution, she received a JAXA Presidential Award in 2007. She led the work of APRSAF Secretariat as an acting Executive Secretary from 2015-2016.

Laurence A. Price
Orion Deputy Program Manager
Lockheed Martin Space

Laurence A. Price joined Lockheed Martin in 1982 and was appointed to his current position as Deputy Orion Program Manager in 2005. He is responsible for the development of NASA's Orion crew exploration vehicle.

Price previously served as Director of Space Transportation Strategic Development where he was responsible for Lockheed Martin Launch Systems' long-term direction addressing Department of Defense, NASA and commercial space transportation systems. In addition, Price led the Alternate Access to Space Station project, which developed a commercial logistics capability to autonomously deliver and return space station cargo.

As the Director of Small Launch Vehicles, Price was responsible for the Athena and Multi-Service Launch System launch vehicle programs. The program team successfully launched the first flights of the Athena I and Athena II space launch vehicles and developed launch complexes at Vandenberg Air Force Base, California; Cape Canaveral, Florida; and Kodiak Island, Alaska. During this assignment, he was responsible for the launch of five Athena I and II vehicles for NASA and commercial customers including Taiwan's first space launch, and 2 MSLS vehicles for the Air Force.

Price also served as Director, Titan II Space Launch Vehicle program, and was responsible for cost schedule and performance of the Air Force Titan II system. In addition, Price was a project engineer on the NASA Space Shuttle Air Force payload integration contract responsible for the design and qualification of a cargo bay contamination instrument

Ascent Particle Monitor which flew numerous times. He was also responsible for mission planning and integration of two Shuttle payloads, Storable Fluid Management Demonstration and Interim Operational Contamination Monitor.

Prior to joining Lockheed Martin in 1982, Price was a project manager at Los Alamos Technical Associates, New Mexico, responsible for analysis and testing of nuclear weapons effects on aerospace structures. He also worked as a project engineer at Hughes Helicopter Company, California, responsible for development and FAA certification of improvements to the OH-6A helicopter.

Rachel Davis
Senior Mechanical Engineer
Lockheed Martin Space

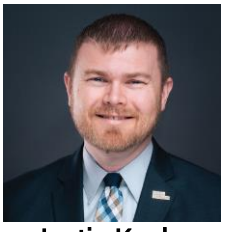
Rachel Davis is a senior mechanical engineer at Lockheed Martin Space, working as a control account manager and integrated product team integrator on the Orion program. She earned her BS in Mechanical Engineering at the University of Notre Dame, and continued her studies for a MS in Mechanical Engineering at Columbia University. Rachel worked at GE Energy retrofitting steam power plants before joining Lockheed Martin as a design engineer.

Joe Landon
(@joe_landon)
Vice President, Advanced Programs Development, Commercial Civil Space
Lockheed Martin

Joe Landon serves as Vice President of Advanced Programs Development for Lockheed Martin's Commercial Civil Space line of business. He leads an organization accountable for new business growth, strategy development and enterprise collaboration for human spaceflight, robotic deep space exploration, communication satellite solutions and weather and remote sensing markets.

Previously, Joe co-founded and served as Chairman of the Board of Space Angels, the leading source of capital for space startups. Joe also served as Chief Financial Officer of Planetary Resources where he built the company's finance team, and under his leadership, the company secured financing from some of the world's leading private and institutional investors before the company was acquired in 2018.

Joe graduated from Embry-Riddle Aeronautical University with a BS in Engineering Physics. He earned an MS in Aerospace Engineering from the University of Southern California and an MBA from Harvard Business School.



Justin Kugler
(@phalanx)
Vice President, Advanced Programs & Concepts
Made In Space

As Vice President for Advanced Programs and Concepts, Justin Kugler leads new business development initiatives for Made In Space, Inc. across the space-enabled products, exploration manufacturing, and on-orbit robotic manufacturing sectors. He has more than 15 years of industry experience and engineering degrees from Texas A&M and Rice University. Mr. Kugler previously developed the value proposition and numerous concepts for industrial R&D projects on the International Space Station National Laboratory. He also managed ISS National Lab pathfinder projects for the NASA ISS Payloads Office, developed crew training models for the Constellation Program, and served as an intelligence analyst for the Central Intelligence Agency. While earning his certificate from the University of Houston's Strategic Foresight program, Justin won the 2015 individual graduate student achievement award from the Association of Professional Futurists for his forecast of the future of industrial activity in space.

Shayna Hume
Ph.D. student, University of Colorado Boulder,
Matthew Isakowitz Program Fellow

Shayna is a first-year student in University of Colorado Boulder's astrodynamics Ph.D. program and is a recent graduate of the University of Miami with her B.S. in aerospace engineering. Her area of research is Martian Entry, Descent, and Landing, which she is currently creating models for at CU. In the past, she has had the opportunity to grow through internships at NASA and Lockheed Martin, and most recently worked at The Aerospace Corporation as an inaugural fellow for the Matthew Isakowitz Program. Shayna is committed to contributing to research, early STEM education, and creative commercial entrepreneurship in today's new space age.

James W. Morhard
Deputy Administrator
NASA

James Morhard was nominated by President Trump and confirmed to be NASA's 14th Deputy Administrator. He was sworn in on October 17th, 2018.

Jim helps provide overall leadership, planning, and policy direction. He performs duties and exercises powers delegated by the Administrator, assists him in making final agency decisions, and acts in his absence to govern NASA operations. Jim also is responsible for articulating and representing the agency's vision.

Prior to his tenure with NASA, Morhard was the U.S. Senate Deputy Sergeant at Arms. He began his career as an analyst for the Secretary of the Navy, where he reviewed procurement and research and development programs. Beginning in 1991, Jim served on the Senate Appropriations Committee, working on the Defense and Military Construction, and Commerce, Justice, State Subcommittees.

In 2003, he became Chief of Staff of the whole Senate Appropriations Committee, where he worked with House and Senate Leadership, the Office of Management and Budget, and the White House to pass the 2004 and 2005 Omnibus Appropriations bills.

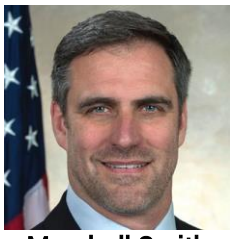
Jim earned his B.S. degree in accounting from St. Francis University, an M.B.A from George Washington University, and a Juris Doctor from Georgetown University.

Jim Schier
Chief Architect, Space Communications and Navigation (SCaN),
NASA

Jim Schier is the Chief Architect for NASA's Space Communications and Navigation Program at NASA Headquarters. He leads NASA and international studies on the evolution of NASA's space communications networks to meet the needs of future science and human exploration missions. He joined NASA in 2004 after 25 years in industry where he worked on civil, defense, intelligence, and commercial space systems. At Northrop Grumman, he supported re-architecting the National Reconnaissance Office's reconnaissance ground systems. He led system engineering subcontracts on commercial satellite systems including Iridium and Thuraya.

Mr. Schier was Avionics Manager and Chief System Engineer on the International Space Station at Grumman. At TRW, he managed flight software development on the MILSTAR Communications Satellite and led integration of materials processing experiments for the 1985 Shuttle Spacelab 3 mission. He received a Silver Snoopy award for his work on Spacelab 3 and a NASA Administrator's Group Award for the team that redesigned the Space Station. In 2015, he was awarded the NASA Exceptional Service Medal "for exceptional service and exemplary leadership in creating NASA's future Space Communications and Navigation Architecture." He holds degrees in Computer Science and

Electrical Engineering. In his spare time, Jim is a volunteer docent at the Smithsonian's National Air and Space Museum giving tours to the public.



Marshall Smith
Director, Human Lunar Exploration Programs
NASA

Marshall Smith directs the formulation and execution of NASA's human lunar exploration activities—the Gateway, which will be the first deep space outpost in cislunar space, and the human lunar lander initiative that will establish a sustainable, 21st century human presence on the Moon.

Most recently, Mr. Smith served as the Director of Cross-program System Integration (CSI) for the Exploration Systems Development (ESD) Division at NASA Headquarters. In this role, he was responsible for Systems Engineering and Integration (SE&I) of NASA's next deep-space transportation system—the agency's crew vehicle, next generation heavy-lift rocket, and supporting ground systems and operations. In parallel, Mr. Smith also served as SE&I lead for the Gateway, ensuring that the Gateway systems work seamlessly with the ESD systems while meeting agency objectives to foster both a sustainable presence on, and broad access to, the lunar vicinity through commercial and international partnerships.

Mr. Smith works closely with NASA's human and robotic lunar exploration personnel to identify requirements, concepts of operations, architectures, and to resolve technical issues associated with design, development, and operations of the integrated systems.

Mr. Smith has served NASA for more than 30 years, working in flight simulation, aircraft, robotic, and human spaceflight systems. For the past 10 years, he has focused on human spaceflight and served as the Langley Research Center lead for Ares activities, the Flight Test 2 Manager for the Constellation Program, the Ares I-X SE&I Chief and on the Space Launch System formulation team. Mr. Smith received his Bachelor of Science in Electrical and Computer Engineering from the University of Tennessee with a Master of Science in Electrical and Computer Engineering from Virginia Polytechnic Institute and State University.

Dr. Thomas Zurbuchen
(@Dr_ThomasZ)
Associate Administrator, Science Mission Directorate,
NASA

Dr. Thomas Zurbuchen is the Associate Administrator for NASA's Science Mission Directorate. On a daily basis, Zurbuchen works to ensure that NASA's science missions are part of a balanced portfolio that enable great science, help us unveil the unknown and facilitate a better understanding of our place in the cosmos. He brings a wealth of scientific research, engineering experience and hands-on knowledge to NASA's world-class team of scientists and engineers. Zurbuchen earned his Ph.D. in physics and master of science degree in physics from the University of Bern in Switzerland. He was previously a professor of space science and aerospace engineering at the University of Michigan in Ann Arbor.

Admiral James O. Ellis, Jr.
USN (Ret)
Chairman, Users' Advisory Group
National Space Council

James O. Ellis, Jr. retired as President and Chief Executive Officer of the Institute of Nuclear Power Operations (INPO), located in Atlanta, Georgia, on May 18, 2012.

INPO, sponsored by the commercial nuclear industry, is an independent, nonprofit organization whose mission is to promote the highest levels of safety and reliability -- to promote excellence -- in the operation of nuclear electric generating plants.

In 2004, Admiral Ellis completed a distinguished 39-year Navy career as Commander of the United States Strategic Command during a time of challenge and change. In this role, he was responsible for the global command and control of United States strategic and space forces, reporting directly to the Secretary of Defense.

A 1969 graduate of the U.S. Naval Academy, Admiral Ellis was designated a Naval aviator in 1971. His service as a Navy fighter pilot included tours with two fighter squadrons, and assignment as Commanding Officer of an F/A-18 strike/fighter squadron. In 1991, he assumed command of the USS Abraham Lincoln, a nuclear-powered aircraft carrier. After selection to Rear Admiral, in 1996 he served as a carrier battle group commander leading contingency response operations in the Taiwan Straits.

His shore assignments included numerous senior military staff tours including Commander in Chief, U.S. Naval Forces, Europe and Commander in Chief, Allied Forces, Southern Europe during a time of historic NATO expansion. He led United States and NATO forces in combat and humanitarian operations during the 1999 Kosovo crisis.

Mr. Ellis holds a master's degree in aerospace engineering from the Georgia Institute of Technology and, in 2005, was inducted into the school's Engineering Hall of Fame. He completed United States Navy Nuclear Power Training and was qualified in the operation and maintenance of naval nuclear propulsion plants. He is a graduate of the Navy Test Pilot School and the Navy Fighter Weapons School (Top Gun). In 2013, Mr. Ellis was elected to the National Academy of Engineering.

In 2009 he completed three years of service as a Presidential Appointee on the President's Intelligence Advisory Board and, in 2006, he was a member of the Military Advisory Panel to the Iraq Study Group.

Mr. Ellis currently serves as an Annenberg Distinguished Fellow at the Hoover Institution at Stanford University where he also holds an appointment as an Adjunct Professor in the Department of Management Science and Engineering. A former Chairman of the Board of the Space Foundation, in 2018 he was appointed Chairman of the User's Advisory Group to the Vice President's National Space Council. He is the former Chairman of the Board of Level 3 Communications and serves on the board of directors of the Lockheed Martin Corporation and Dominion Resources, Inc.

Joseph D. Anderson
Vice President, Operations and Business Development,
Northrop Grumman/Space Logistics LLC

Mr. Anderson has more than 30 years of satellite engineering, management and leadership experience. Mr. Anderson joined Northrop Grumman in 2012 following 20 years of service at Intelsat. Mr. Anderson is the Vice President of Operations and Business Development for Space Logistics LLC, a wholly owned subsidiary of Northrop Grumman. In this role, Mr. Anderson is responsible for managing the technical, operational, licensing and insurance aspects of Space Logistics satellite servicing fleet as well as the business development of their commercial and government satellite servicing customers. At Intelsat, he served numerous technical, managerial, strategy and business development roles including Vice President of Customer Solutions Engineering and Director of Space Systems Planning and Satellite Insurance Consulting Services. Mr. Anderson earned an MBA from George Washington University, an MS in Engineering from Stanford University, and a BS in Aerospace Engineering from the University of Minnesota.

Dave Fischer
Director of Business Development
RUAG Space USA

Dave Fischer leads commercial business development in the U.S. for RUAG Space USA. He's spent most of his professional career in the aerospace industry, working with commercial and US government customers, winning new business, and managing competitive intelligence and strategy development. He began his career designing remote sensing instruments for astrophysics, and oversaw the development of several new observatories in Antarctica. Dave holds a BA in Physics from the University of Chicago.

Dr. Peter Martinez
Executive Director
Secure World Foundation (SWF)

Peter Martinez is the Executive Director of the Secure World Foundation. He has extensive experience in space policy formulation, space regulation and space diplomacy. He also has extensive experience in capacity building in space science and technology and in workforce development.

Prior to joining SWF, Dr Martinez held the post of Professor of Space Studies at the University of Cape Town. Before this he acquired fifteen years of executive level management experience and associated general management skills gained in the research and development environment of the South African Astronomical Observatory, a National Facility under the South African National Research Foundation, where he served as Acting Director for two extended terms and for shorter periods on numerous other occasions. From 2010 – 2015 he was the Chairman of the South African Council for Space Affairs, the national regulatory authority for space activities in South Africa. From February 2011 to June 2018, he served as the Chairman of the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) Scientific and Technical Subcommittee's Working Group on the Long-Term Sustainability of Outer Space Activities. From 2012-2013 he was South Africa's representative on the United Nations Group of Government Experts on transparency and confidence building measures for space activities. He is a member of the International Academy of Astronautics, the International Institute of Space Law and a Fellow of the Royal Astronomical Society. He has authored or co-authored over 200 publications on topics in astronomy, space research, space law and space policy.

Bryan DeBates
Vice President, Education
Space Foundation

Bryan DeBates administers the development and implementation of the Space Foundation's education programs that support science, technology, engineering and mathematics (STEM) education. This includes establishing project goals and developing education programs, including the popular Discover the Universe field trips and the Space in the Community outreach program. He oversees the Space Foundation's Discovery Center space museum and education center in Colorado Springs, and its education labs, which include: Science On a Sphere®, Mars Robotics Laboratory and AGI Space Missions Simulation Laboratory.

Prior to starting his position at the Space Foundation in 2006, DeBates taught 5th grade at Timberwilde Elementary in San Antonio, Texas, and Title I math and reading at Ipswich Elementary in Ipswich, S.D. He has also been an adjunct professor at Adams State University and Colorado State University-Pueblo.

DeBates has been honored for his achievements in education through numerous awards, including being named the 2014 recipient of the prestigious Frank J. Malina Astronautics Medal, presented by the International Astronautical Federation.

In 2004, DeBates was inducted into the Space Foundation's inaugural class of Teacher Liaisons, and he has participated in the Zero-G Weightless Flights of Discovery.

DeBates earned a bachelor's degree in elementary education from Northern State University, and was selected as an Academic All-American football player in 1992. In 2006, he earned a Master's in Education degree, with an emphasis in space science education leadership, from Regis University, Denver.

John Holst
Senior Analyst
Space Foundation

John Holst monitors, researches, and writes about global space infrastructure activities, space products and services, and is responsible for content and production of the Space Foundation's quarterly publication, The Space Report. John's analysis draws from experiences in military space and missile defense operations, as well as living in Europe to look at the global space industry through many different points of view.

Thomas E. Zelibor
Chief Executive Officer
Space Foundation

Tom Zelibor joined the Space Foundation as Chief Executive Officer in April 2017. From Space Foundation headquarters in Colorado Springs, Colo., he oversees more than 60 team members across the U.S., including a Washington, D.C., office and field representatives in Houston and the Florida Space Coast.

Before joining the Space Foundation, he was Chairman and Chief Executive Officer for Lightwave Logic Inc. His wide-ranging leadership and entrepreneurial background includes having served as President and CEO of Flatiron's Solutions, and as a Vice President for Science Applications International Corporation (SAIC), among other commercial affiliations.

Highlights of his extensive career in space-related positions include Director, eSpace Incubator at the Center for Space Entrepreneurship; Director of Global Operations, U.S. Strategic Command, Deputy for C4 Integration and Policy/Department of the Navy Deputy CIO; Director, Space Information Warfare, Command and Control Division, and as Commander, Naval Space Command. He also held the position of Dean, College of Operational and Strategic Leadership at the Naval War College in Newport, RI.

He received his Bachelor of Science degree in Oceanography from the United States Naval Academy in 1976. He was a Naval Aviator early in his Navy career before branching out into space and information technology assignments. The highlight of his military career was as Commander, Task Force Fifty, where he led three U.S. carrier battle groups, two NATO carriers, nearly 60 other U.S. and coalition ships, 300 aircraft and thousands of personnel in the North Arabian Sea conducting combat operations in Afghanistan after the attacks of 9/11.

Clémentine Decoopman
Executive Director
Space Generation Advisory Council (SGAC)

Clémentine Decoopman is currently the Executive Director of the Space Generation Advisory Council (SGAC). Responsibilities of the position include (but are not limited to) Operations Management, and Events Management. The Operations Management components of this role has an emphasis on administration of the organisation and communications management, including working closely with the Executive Office on the development and facilitation of opportunities for SGAC members in the space sector. The latter includes overseeing development of the SGAC brand, web and printed content, and supporting public relations and communication efforts. The Events Management component of this role is focused on overseeing and coordinating with the SGAC event managers to ensure success of our global events, such as the Space Generation Congress, Space Generation Fusion Forum, and SGx. The SGAC Executive Director also oversees the implementation of other SGAC activities including regional and local events.Clémentine also represents the SGAC at international conferences and at the United Nations (particularly at the UN COPUOS annual sessions) and contributes to the discussions by making regular statements at the plenary sessions

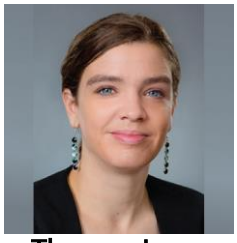
Dr. John M. Logsdon
Professor Emeritus
Space Policy Institute, The George Washington University

Dr. Logsdon is Professor Emeritus of Political Science and International Affairs at George Washington University's Elliott School of International Affairs. Prior to his leaving active faculty status in June 2008, he was on the faculty of the George Washington University for 38 years; before that he taught at the Catholic University of America for four years. He was the founder in 1987 and long-time Director of GW's Space Policy Institute. From 1983-2001, he was also Director of the School's Center for International Science and Technology Policy. He is also a faculty member of the International Space University. During 2008-2009, he held the Charles A. Lindbergh Chair in Aerospace History at the Smithsonian Institution National Air and Space Museum. He holds a B.S. in Physics from Xavier University (1960) and a Ph.D. in Political Science from New York University (1970).

Dr. Logsdon's research interests focus on the policy and historical aspects of U.S. and international space activities. His book John F. Kennedy and the Race to the Moon was published in December 2010. The book was named the 2011 winner of the Gardner Lasser Aerospace History Award of the American Institute of Aeronautics and Astronautics and co-winner of Eugene M. Emme Astronautical Literature Award of the American Astronautical Society. His book, After Apollo? Richard Nixon and the American Space Program, was published in March 2015. It was selected as the 2017 recipient of the AIAA Gardner-Lasser award. His account of civilian space decisions during the Reagan administration, titled Ronald Reagan and the Space Frontier, was published in December 2018. He was recently also the editor of the Penguin Classics compilation The Penguin History of Outer Space Exploration: NASA and the Incredible Story of Human Space Exploration, published in September 2018.

Dr. Logsdon is also the author of The Decision to Go to the Moon: Project Apollo and the National Interest (1970) and is general editor of the seven-volume series Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program. He has written numerous articles and reports on space policy and history. Dr. Logsdon has lectured and spoken to a wide variety of audiences at professional meetings, colleges and universities, international conferences, and other settings, and has testified before Congress on several occasions. He has served as a consultant to many public and private organizations. He is frequently consulted by the electronic and print media for his views on space issues and has appeared as an expert on all major television networks and public radio.

In 2003 Dr. Logsdon served as a member of the Columbia Accident Investigation Board. He was a member of the NASA Advisory Council from 1998-2001 and from 2005-2009, and recently has been named a member of the new Regulatory and Policy Committee of the Council. He is a recipient of the Exceptional Public Service, Distinguished Public Service, and Public Service Medals from NASA, the 2005 John F. Kennedy Astronautics Award from the American Astronautical Society, the 2006 Barry Goldwater Space Educator Award from the American Institute of Aeronautics and Astronautics, and the 2013 Frank Malina Space Educator Award from the International Astronautical Federation. He is a Fellow of the American Institute of Aeronautics and Astronautics, the American Astronautical Society, and the American Association for the Advancement of Science, and a member of the International Academy of Astronautics and former Chair of its Commission on Space Policy, Law, and Economics. He is a member of the Board of Directors of the Planetary Society. He is on the editorial board of the international journal Space Policy and was its North American editor from 1985-2000. He is also on the editorial boards of the journals New Space and Astropolitics.



Therese Jones
(@theresejones0)
Senior Director of Policy
Satellite Industry Association (SIA)

Therese Jones joined the Satellite Industry Association as its Senior Director of Policy in January 2018. In this role, Ms. Jones supports SIA's work on government services, regulatory, legislative, defense, export-control and trade issues of critical importance to the Association's members. Prior to joining SIA, Ms. Jones was an assistant policy researcher at the RAND Corporation, where she focused on space policy. In this role, she support U.S. government sponsors in assessing new space technologies, increasing the resilience of the national space architecture, and determining commercial acquisition strategies for communications and remote sensing services. Before transitioning into space policy, she worked as an astrophysics researcher focusing on galaxy formation and evolution.

General John E. Hyten
Commander
United States Strategic Command

Gen. John E. Hyten is Commander of U.S. Strategic Command (USSTRATCOM), one of ten Unified Commands under the Department of Defense. USSTRATCOM is responsible for the global command and control of U.S. strategic forces to meet decisive national security objectives, providing a broad range of strategic capabilities and options for the President and Secretary of Defense.

General Hyten attended Harvard University on an Air Force Reserve Officer's Training Corps scholarship, graduated in 1981 with a bachelor's degree in engineering and applied sciences and was commissioned a second lieutenant. General Hyten's career includes assignments in a variety of space acquisition and operations positions. He served in senior engineering positions on both Air Force and Army anti-satellite weapon system programs.

The general's staff assignments include tours with the Air Force Secretariat, the Air Staff, the Joint Staff and the Commander's Action Group at Headquarters Air Force Space Command as Director. He served as mission director in Cheyenne Mountain and was the last active-duty commander of the 6th Space Operations Squadron at Offutt AFB, Nebraska. In 2006, he deployed to Southwest Asia as Director of Space Forces for operations Enduring Freedom and Iraqi Freedom. General Hyten commanded the 595th Space Group and the 50th Space Wing at Schriever AFB, Colo. Prior to assuming command of Air Force Space Command, he served as the Vice Commander, Air Force Space Command.

Dr. Alice Bunn
International Director
UK Space Agency

Alice Bunn is International Director at the UK Space Agency, responsible for international engagement through multilateral and bilateral frameworks, capturing the wider societal benefits of space programmes and harnessing the inspirational effect of space for skills and education. She also leads security and resilience of the UK's infrastructure and space applications.

Alice is vice chair of the Council of the European Space Agency; sits on the Board of Directors at the US Space Foundation; and is a member of the Imperial Space Lab Strategic Advisory Board; co-chair of the World Economic Forum Future Council on space technology; and is a fellow of the Royal Aeronautical Society.

Alice also has a PhD in Metallurgy from Darwin College, University of Cambridge.

Michael "Sooch" Masucci
Astronaut, Test Pilot
Virgin Galactic

Bachelor's degree in Astronautical Engineering from the United States Air Force Academy , Master's degree in Mechanical Engineering from California State University Fresno, Served as a Combat Pilot in Operation Desert Storm, Iraqi Freedom, and Enduring Freedom, U-2 Test Pilot for over 10 years (engine, avionics, flying qualities, performance testing), Instructor Test Pilot in the F-16, T-38, and Glider aircraft at the USAF TPS, Squadron Commander of a developmental test unit, an operational test unit, a combat squadron, and a training squadron. Served as a Citation X Captain and Check Airman for XOJET, an aircraft charter company , Lead trainer pilot for Virgin Galactic. Captain qualified in the WK2/flown the SS2, FAA certified flight instructor and mentor

APPENDIX B: SGFF 2019 ORGANISING TEAM

Lauren Smith (USA - CA)
SGFF 2019 Manager

Lauren Smith works at Northrop Grumman as a Program Manager in Resiliency and Rapid Prototyping. She was recently the Mechanical Test Engineering Manager for the James Webb Space Telescope (JWST) program and was previously a member of the JWST Integration & Test (I&T) Senior Technical Staff as the I&T lead for all Nonexplosive Actuators (NEAs) and Deployments. Lauren loves a good engineering challenge whether it is in our atmosphere or in outer space; prior to JWST, she was a Program Manager for rapid development efforts in both space systems and autonomous aircraft systems. Before joining Northrop Grumman, Lauren was an engineer at NASA Glenn Research Center in the Simulated Lunar Operations (SLOPE) Lab. She also conducted her thesis work at Glenn, specializing in mechanisms and robotics. This work contributed to her being named one of Aviation Week's Twenty20s. Lauren graduated from Case Western Reserve University with a Master's degree in mechanical engineering, Bachelor's degrees in aerospace engineering and mechanical engineering, and a minor in political science. Lauren is currently a member of the SGAC Executive team and is also the Vice President of Caroline's Project, a nonprofit that awards scholarships to girls who wish to attend STEM summer camps. She was recently recognized as a 2019 Future Space Leader Grant Winner.

Tara Halt (USA - DC)
SGFF 2019 Deputy Manager

Tara Halt currently works as an Aerospace Analyst at Bryce Space and Technology and lives in the DC Metro area. In her role, she is the performance reporting lead for the Space Technology Mission Directorate and she supports the NASA Innovative Advanced Concepts program at NASA HQ. Tara graduated from George Washington University with a Master's in International Science and Technology Policy with a focus on Space Policy. In 2015, she graduated from Embry-Riddle Aeronautical University with a Bachelor of Science in Commercial Space Operations. Previously, Tara has interned at NewSpace Global, the FAA Office of Commercial Space, and the Commercial Spaceflight Federation. Tara first became involved with SGAC, when she attended the Space Generation Congress in Jerusalem, Israel. Ever since then, Tara has been an active member of SGAC and served on the organising teams for Fusion Forum (2016, 2018), and the Space Generation Congress (2016). Tara was recognized as a Future Space Leader Grant Winner in 2016.

Michael Barton (USA - DC)
Communications Team

Michael Barton performs aerospace software sales and business development for aerospace contractor a.i. solutions. After obtaining a master's degree in astrodynamics and space applications at Purdue University, Michael moved to the D.C. metro area in 2014 and supported flight dynamics for Goddard Space Flight Center missions such as Landsat, DSCOVR, and TDRS. A NASA nerd, Michael has also worked on the first A in NASA at Glenn Research Center, the Shuttle at Kennedy Space Center, and the NASA's Strategic Direction study at the National Academies. Now COTS Software Sales Manager, Michael leads a team that grows and maintains relationships throughout NASA, NOAA, and the Air Force, with a growing presence in the commercial sector. Michael also advocates for space on Capitol Hill, leading Maryland engagement teams for AIAA, Citizens for Space Exploration, and the new Goddard Advocacy Partnership. A prior attendee of SGx, SGAC AAS Next Generation, and EMER-GEN, Michael is very excited to make sure this year's Fusion Forum is a great experience for all involved.

Alyssa Deardorff (USA - CA)
Programs Team

Alyssa Deardorff works as a Systems Engineer at the NASA Jet Propulsion Laboratory in Pasadena, CA. She has a M.S. in Aerospace Engineering from Georgia Institute of Technology, as well as a B.S. double major in Renewable Energy Engineering and Systems Engineering from Oregon Institute of Technology. Alyssa has served as a delegate to SGFF twice and is excited to return to help this year on the organising committee!

Anna "sumo" Gunn-Golkin
(USA - DC)
Programs Team

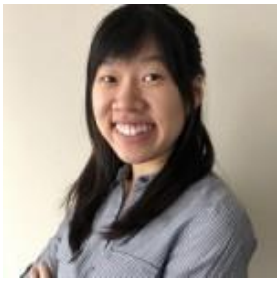
Anna Gunn-Golkin is an active duty Lieutenant Colonel in the United States Air Force serving as a Program Manager at the Rapid Capabilities Office. She has experience in space launch and operations, aircraft flight test, and instructing astronautical engineering at the Air Force Academy. She has completed Fellowships at both DARPA and NASA Headquarters. She has astronautical engineering degrees from the United States Air Force Academy and the Air Force Institute of Technology, and a Masters in Flight Test Engineering from the USAF Test Pilot School. She volunteers at the National Air and Space Museum and with the EAA Young Eagles Program.

Ajeet Hansra (USA - NY)
Delegates Team

Ajeet Hansra is an investment professional at New Mountain Capital, a New York based alternative asset manager which manages private equity, public equity, and credit funds with over $20 billion in aggregate capital commitments. He currently focuses on private equity investments in the aerospace & defense, healthcare IT and financial services sectors. He previously served as a business analyst and as the Deputy Chief Of Staff to the Global Managing Partner at McKinsey & Company, a global management consulting firm. He has also served as SGAC's Treasurer and ECOSOC Coordinator. Ajeet graduated from Duke University in Durham, North Carolina, with a degree in Mechanical Engineering.

Kirstyn Johnson (USA - TX)
Logistics Team

Kirstyn Johnson is a project engineer at NASA Johnson Space Center (JSC), working in the Orion program with the Crew Survival Systems team. She is responsible for the design, development and management of crew hardware for use with the vehicle's launch and entry space suit. In recognition of her efforts, she was presented with the 2018 NASA Trailblazer award for young professionals. Prior to entering the workforce, Kirstyn graduated from the University of Colorado-Boulder in 2015 with her Bachelors and Masters in Aerospace Engineering Sciences, and a concentration in Bioastronautics. She first fell in love with aerospace after seeing a rocket launch at Wallops Flight Facility as a student employee with the Colorado Space Grant Consortium's RockSat-X program. At JSC, she is part of the leadership team for the Emerge early career employee group, looking to provide resources and development opportunities to those new to the workforce. She is excited to continue that work with SGAC at the Space Generation Fusion Forum.



Caroline Juang (USA - NY)
Ops & Publications Team

Caroline Juang works as a Landslide Citizen Science Project Coordinator at NASA Goddard Space Flight Center and Science Systems and Applications, Inc. There, she manages all aspects of Landslide Reporter including research, data input and validation, website curation, branding, and outreach. Prior to NASA, Caroline was a Brooke Owens Fellow in summer 2017, interning with the Business Development team of Bryce Space and Technology in Alexandria, VA, and co-authored a report on the state of the very small satellite industry. Motivated by her passion to increase access to opportunities in space, she volunteers for the Brooke Owens Fellowship, NASA, the Harvard Club of DC's mentorship program, and now the Space Generation Advisory Council. Caroline graduated in May 2017 with an A.B. in Earth & Planetary Sciences and a minor in Environmental Sciences and Public Policy from Harvard University. Her senior thesis research titled, "25 Years of Carbon Exchange and its Factors in the Harvard Forest", received an Honors recommendation.

Tobias Niederwieser (USA - CO)
Logistics Team

Tobias Niederwieser is a research associate at BioServe Space Technologies where he helps to design, build, and test payloads for scientific research onboard the International Space Station. Examples are the Space Automated Bioproduct Lab (SABL), an incubator for biological experiments, or the Animal Enclosure Module – Environmental Control (AEM-E), a life support system for the transport of rodents to the ISS. Tobias recently earned his PhD on evaluating bioregenerative life support system technologies using green algae for air revitalization, waste water recycling, and food production in spacecraft. Previously, Tobias earned his Bachelor's degree in aerospace engineering from the Technical University Munich, Germany in 2013 and his Master's degree from the University of Colorado Boulder in 2015.

Viha Parekh (Australia)
Delegates Team

Viha Parekh currently works as a structures engineer at Boeing Aerostructures Australia in Melbourne, Australia, designing next-generation commercial aircraft. With a keen interest in developing the local aerospace industry, Viha is actively involved in the broader aerospace community and local STEM initiatives. Having grown up in Brisbane, Australia, she has a Bachelor of Mechanical and Aerospace Engineering from the University of Queensland. During university, Viha studied abroad at Purdue University (USA), interned with Northrop Grumman Australia and volunteered with the Australian Youth Aerospace Association. This engagement, along with research completed for her honors thesis with the University of Queensland's Centre for Hypersonics, led to being named in American Institute of Aeronautics and Astronautics' and Aviation Week's 2016 "20 Twenties: Tomorrow's Engineering Leaders" on graduation.A recipient of the 2017 Australian Space Generation Innovators Award, Viha has previously attended the 2017 Space Generation Congress in Adelaide, Australia. She looks forward to helping make the 2019 Space Generation Fusion Forum a success.

Tasman Powis (USA - NJ)
Delegates Team

Tasman Powis is an Australian expat, currently completing his PhD at Princeton University within the Mechanical and Aerospace Engineering Department. His research focus is on the physics of fusion energy and the modeling of advanced spacecraft propulsion concepts. Recently he has also become involved in researching regulations and policy regarding the use of nuclear power systems in outer space, with the aim of motivating the peaceful, safe and reliable use of nuclear materials. Tasman is a long time SGAC member and is fortunate to have attended numerous SGAC events since his first in 2012, he excited to continue giving back to the community which has given him so much.

Kat Robison (USA - AL)
Communications Team

Kat Robison is the Recruitment Manager for the Space Generation Advisory Council, where she previously served as Project Groups Coordinator. Kat is also the Program Coordinator for The University of Alabama's Tide Together Graduate Mentoring Program, which serves underrepresented populations in graduate education, including Women in STEM. In this role, she works closely with graduate students and faculty to help prepare students for success before and after graduation, including professional development in areas such as interviewing and networking. Kat is also a Ph.D. Candidate (ABD) in the Department of Political Science at The University of Alabama where her focus is on how political communications shapes and informs space policy both in the United States and around the world. She has traveled extensively around the world, including intensive language training in Turkey, undergraduate study in Botswana, and volunteer work in China.

Manny Shar (UK)
Programs Team

Manny Shar is the Head of Analytics at Bryce Space & Technology, leading consulting engagements for government and commercial clients. He has worked across the board on innovative projects from early stage investment to commercial model development in the satellite communications sector, having previously managed a multi-billion-dollar portfolio of assets and supporting cross-functional strategic business development activities. His background includes international consulting work in complex business environments for Fortune 100, FTSE-100, mid-size and emerging businesses in the US and Europe. Manny is actively involved with the Space Generation Advisory Council (SGAC), a non-governmental organisation that supports the United Nations Programme on Space Applications. Manny also advises numerous space start-ups, providing strategic business and technical advice. He is a contributing editor of ISU's alumni magazine and enjoys promoting STEM education through public outreach. Manny holds a master's degree in space studies from the International Space University and a bachelor's degree in computer science from the University of Kent, Canterbury, England.

Olga Stelmakh-Drescher
(Germany/USA)
Programs Team

Dr. Olga Stelmakh-Drescher is the Director of Business Development and International Affairs at the International Institute of Space Commerce. She has an extensive background in space matters, having worked in the space sector for 15 years, including seven years of governmental and parliamentarian engagement. Prior to her present role, she worked with McGill Institute of Air and Space Law, George Washington University's Space Policy Institute, the Parliament of Ukraine, German Aerospace Center, Ukrainian Space Agency, and European Space Agency. She has become noted as a lawyer with strong business background and fluency in five languages, working around the globe, combining public service with academic work and legal practice. An alumna of Paris-11 Institute of Space and Telecommunication Law and International Space University, Dr. Stelmakh-Drescher holds a Doctorate in International Law specializing in Space Security, two LLM degrees, and two Master degrees in Business. Professionally, she is a member of many high-profile groups, including: International Institute of Space Law, Women in Aerospace, Global Diplomacy Lab, and the Global Future Council on Space Technologies of the World Economic Forum. In 2013, she was honored with the IAF Emerging Space Leaders recognition award, in 2015 – with Secure World Foundation award and in 2017 – with Space Generation Leadership award. For the past three years she has been a judge of the regional rounds of the Manfred Lachs Moot Court Competition. She currently heads the Election Committee of the International Institute of Space Law. Dr. Stelmakh-Drescher is a frequent speaker at many international space fora (US, Europe, Middle East and Asia-Pacific) and publishes extensively on space-related topics.

Anthony Yuen (USA - NY)
Delegates Team

Dr. Anthony Yuen is a medical doctor with a degree in mechanical and space engineering from the University of Queensland in Brisbane, Australia. He is currently an emergency physician and an Assistant Professor of Clinical Emergency Medicine at NewYork Presbyterian-Weill Cornell Medical Center. Prior to medical school, he was the Chair of the 2006 Queensland Youth Aerospace Forum and attended the 2007 Space Station Design Workshop in Sydney. His experiences span areas as diverse as ramjets, global health, artificial hearts and medical simulations. His eventual goal is to develop innovative approaches that encompass medicine, engineering and technology to overcome the challenges of long duration space flight on the human body.

We'd love to stay in touch!

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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.

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