

SPACE

THE NEXT GENERATION

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AUTUMN / WINTER 2016

THE MAGAZINE FOR ALL
INTERNATIONAL SPACE UNIVERSITY
ALUMNI

FEATURED

HUMAN SPACEFLIGHT IN LEO

6

Plus 12 A Look Back at SSP16 24 Space Entrepreneurs: Elon Musk 38 MSC 2016

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THE TEAM



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SPECIAL THANKS TO OUR CONTRIBUTING EDITORS FOR THIS ISSUE

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Dear all,

Welcome!

We're very happy to welcome you to the third edition of Space Talk – The Next Generation, the quarterly e-magazine produced by ISU alumni for ISU alumni of all ISU classes.

Our aim, with SpaceTalk-TNG, is to reach out to alumni of ISU from all countries, cultures, disciplines and generations. We are very aware that, to date, we have not been serving the Interdisciplinary aspect very well, with almost all articles being Space focused.

To that end, we would like to strongly emphasise that we welcome articles on all topics whether directly Space related or not. It is our attendance at ISU that unites us, not our area of expertise.

We're already beginning the planning of our fourth issue due out at the end of January. Please do consider making a contribution – this doesn't have to be a full article, but can take many forms:

- An article which can be from one to six pages, preferably with some high resolution photos or graphics
- A report on a recent alumni related event such as an alumni dinner or alumni reunion, an alumni wedding, etc. - preferably with some high resolution photos
- A planned alumni event such as those above

If you have an idea for a contribution and would like to discuss it, please do contact us at:
editor@spacetalk-tng.news

See the back cover for details on how to contribute. Submission deadline for the next issue is JANUARY 10TH

Many of you have taken the time to send us feedback and it's been a great boost to the team to hear from you!

Whenever you meet fellow alumni, could you please ask if they've heard of this magazine and, if not, pass on the link? We would really like to reach most of our community, but there's clearly still a way to go!

We hope you find something of interest within this issue and we strongly encourage you to get in touch, offer feedback and contribute something to future issues... ***What counts is to stay in touch!***



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LOST TO SPACE

Sadly, we start with the news that since our last issue, our community has lost two of ISU's strongest and longest serving supporters...

CAROLINE COPELAND BURKE, BELOVED LIN

29 NOVEMBER, 1927 - 31 AUGUST, 2016

In 1946 a few of us Navy flyers, in training at Glenview near Chicago, went to a soda fountain in Winnetka. Some attractive girls were there but they left before we could approach them. One, a beauty, bore an unforgettable nose.

Two years later, skiing at Mammoth Mountain in the Sierras, I saw that nose again and I took an unauthorised photo of its owner. We later met at a barn dance and our lifelong romance began.

Music, rockets, sailing, soaring, surfing, life in the high Wyoming Rockies, JPL, ISU and most enjoyable and important, making five wonderful babies who are now all grown and flourishing, made our life together one long delight.

On 31 August 2016 Lin died quietly at home in the embrace of her family. All who knew her will treasure unique memories.

Jim Burke



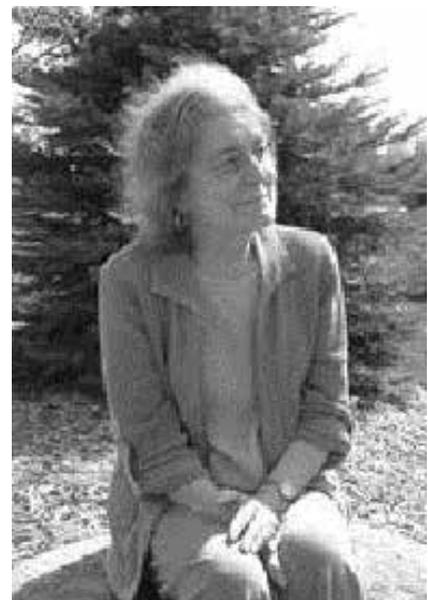
MARIE-PAULE JUNEAU PLUNKETT (NÉE PROULX)

6 JULY 1941 - 12 SEPTEMBER 2016

With deep sadness we announce the passing of Marie-Paule on September 12th. Daughter of the late Marguerite Mondoux and the late Camille Proulx of Aylmer, Québec. Beloved wife of Robert Michael Plunkett (Bob). Cherished mother of Francine Dewar (JD) and Marc Juneau (Natalie). Loving grandmother, “Cocotte” to William, and “Gramie” to Melanie, Melissa, and Nevan.

Marie was highly recognised for her administrative skills with NGOs and particularly the Canadian Foundation for the International Space University (CFISU). Marie was tireless in her efforts to ensure all Canadian ISU students had the best possible experience. She was the heart and soul of the CFISU, and we are all in her debt. She had a perpetual smile and positive attitude that lifted all those who worked with her. She touched many, many lives and will be sadly missed.

Lucy Stojak





CAPTURING 30 YEARS OF ISU HISTORY – WITH YOUR HELP

by Remco Timmermans, SSP13

Social Media Marketing Specialist and Owner at Seventy Media
ISU SSP16 TP Chair and Social Media Lead



Next year it will be 30 years since the famous ISU founding conference was held at MIT in Cambridge. The SSP17 Space Studies Program at CIT in Cork, Ireland, will mark the 30th edition of the ISU flagship summer program. To date, over 4,000 people have attended one of the ISU programs. This group of people is now leading the global space industry from a wide variety of locations, including many key decision making positions. It is the power of this network, in combination with the best academic program in the industry that keeps attracting young professionals from all over the world to ISU.

the material available from ISU itself. For several years 'memory CD's' were issued, containing a lot of material. These have now all been published in albums on the ISU Flickr page. You will also notice a lot of classes still missing though. Especially the SSP classes before 2000 and still all MSS, EMBA and SHSSP classes are missing.

<https://www.flickr.com/photos/internationalspaceuniversity/albums>

To celebrate this anniversary and bring the power of the network even more to life, we are working on a large image repository of all ISU classes to date. This obviously includes all 30 SSP classes, but also all MSS, EMBA and SH-SSP classes. Although ISU has collected a significant amount of material in its own archives, there is still a lot missing.

If you don't see your class in the list, and you have material to share, then we would really like to get in touch with you! If you can scan (or photograph) a few of your best photos, that you don't mind sharing with your fellow alumni and the world, we would be very grateful! Please contact Remco Timmermans (remco.timmermans@community.isunet.edu) to get the material onto the page. Obviously you will remain the copyright holder and be mentioned as the photographer.

So here is where we need your help!

Please have a look at the ISU Flickr pages, where we are building this repository. It already contains most of

The objective is to have a complete set of albums of every ISU programs by 2017.



HUMAN SPACEFLIGHT IN LOW EARTH ORBIT



by *Claudia Philpot, SSP09*

Senior Systems Engineer, DLR, Germany

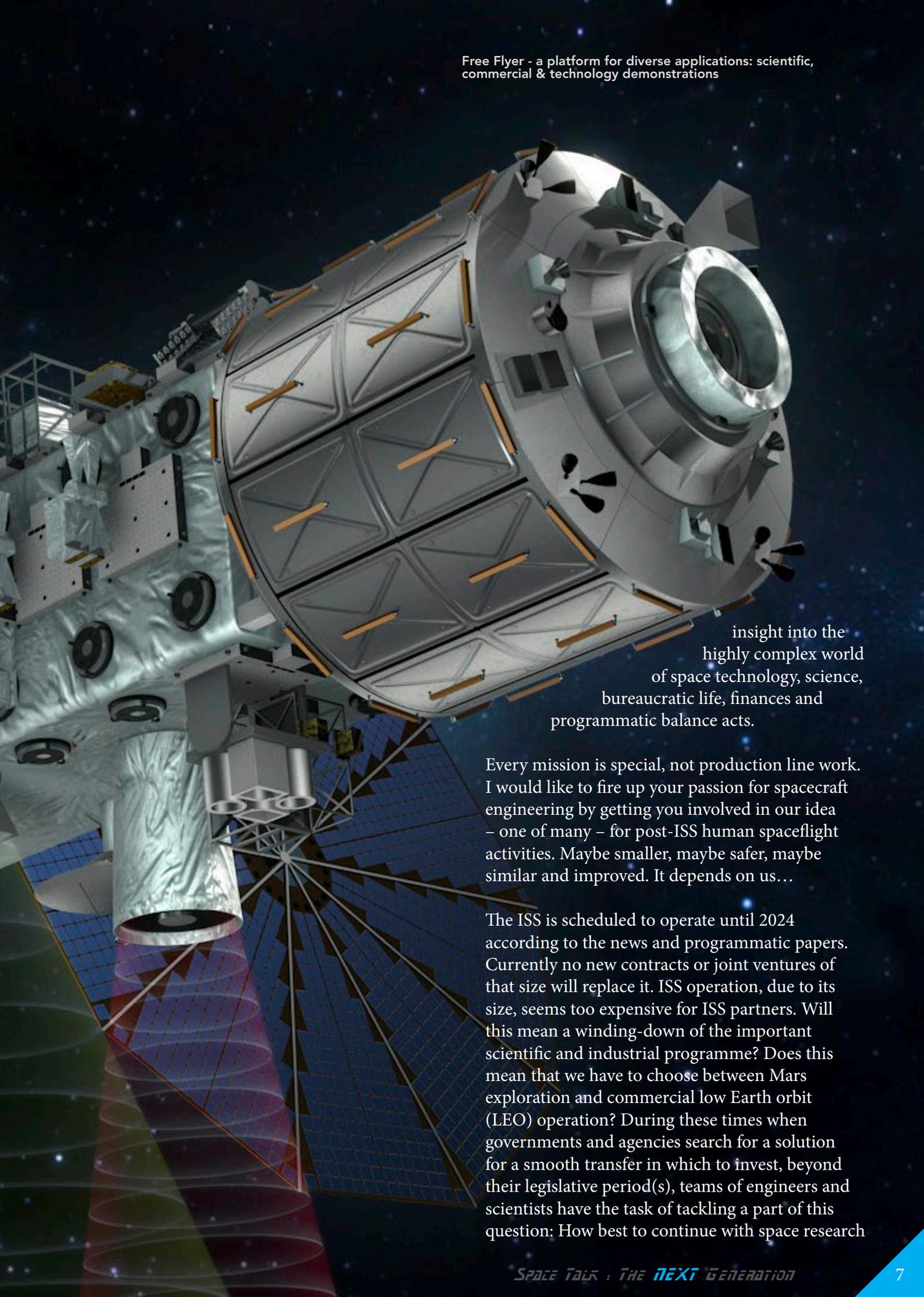
All images credit: DLR, except where noted

Imagine you are in outer space and cannot find your way back into your spacecraft! What would you do if your suit swelled up and the return to safety through the hatch is blocked by your own suit – the one thing that keeps you alive out there?

When I first shook hands with Alexey Leonov, to whom this catastrophe almost actually happened in 1965 during the Soviet Voskhod 2 mission, I knew that human spaceflight engineering was one of the most fascinating areas and one in which I wanted to work. Mr Leonov had to risk deflating his suit, and then squeeze back through the narrow hatch, close it and repressurise the capsule back to normal.

Fifty years later extravehicular activities (EVA), for maintenance and assembly of spacecraft and experiments, have become fairly routine space walks. This progress necessitated long-term multidisciplinary background planning. Improvements to space suits, procedures and space stations have all reduced the risk. Spacecraft engineers are passionate about their work and the missions in which they are involved - I certainly am.

In my own engineering life I have met and trained astronauts for my experiments and participated in programmatic discussions in the European space industry and agencies. With this I gained valuable



insight into the highly complex world of space technology, science, bureaucratic life, finances and programmatic balance acts.

Every mission is special, not production line work. I would like to fire up your passion for spacecraft engineering by getting you involved in our idea – one of many – for post-ISS human spaceflight activities. Maybe smaller, maybe safer, maybe similar and improved. It depends on us...

The ISS is scheduled to operate until 2024 according to the news and programmatic papers. Currently no new contracts or joint ventures of that size will replace it. ISS operation, due to its size, seems too expensive for ISS partners. Will this mean a winding-down of the important scientific and industrial programme? Does this mean that we have to choose between Mars exploration and commercial low Earth orbit (LEO) operation? During these times when governments and agencies search for a solution for a smooth transfer in which to invest, beyond their legislative period(s), teams of engineers and scientists have the task of tackling a part of this question: How best to continue with space research

and space technology development after the ISS utilisation period? A transition to a new concept without a critical loss of know-how takes 10 to 15 years. Therefore, the conceptualisation regarding technical layout, creating a road map and the development of an ISS follow-on outpost in LEO must be started **now**. Hence, we have started with the **Orbital Hub concept**.

USER DEMANDS DEFINE LEO PLATFORM

The German Aerospace Center, DLR, and the European Space Agency have collected requirements from many research disciplines regarding a future small LEO platform. In a concurrent engineering (CE) study here at the Concurrent Engineering Facility (CEF) in Bremen, straw man payloads were defined, analysed and designed for a base platform and a strongly requested Free Flyer. Both platforms together form the Orbital Hub as a possible ISS follow-on human spaceflight research platform in LEO.

Some of the top-level requirements are:

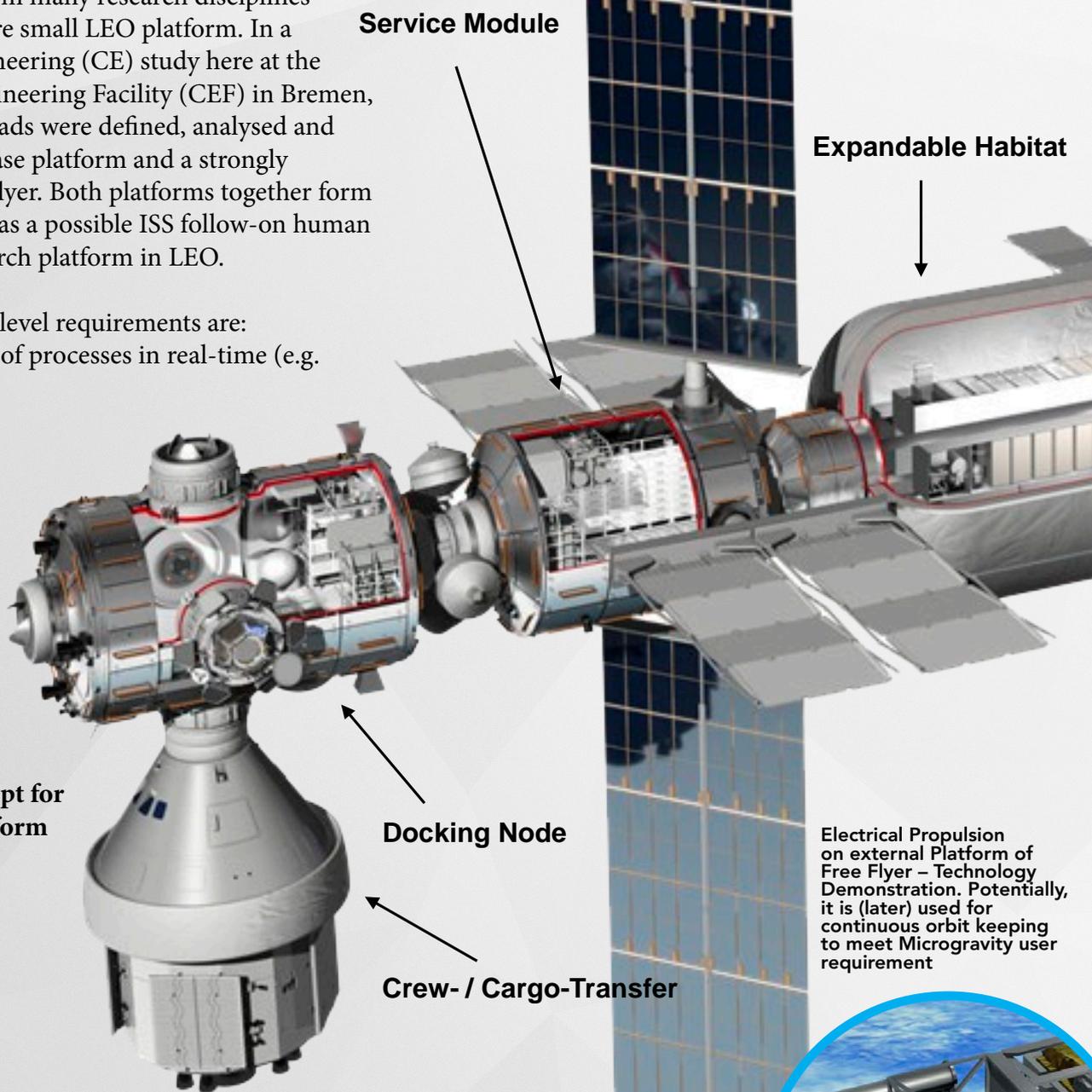
- Observation of processes in real-time (e.g.

- materials); on-orbit analysis opportunity to significantly reduce the return of samples
- Low vibration levels (e.g. caused by astronauts or moving structures)
- High and flexible modularity (for easy access and exchange of samples or instruments)

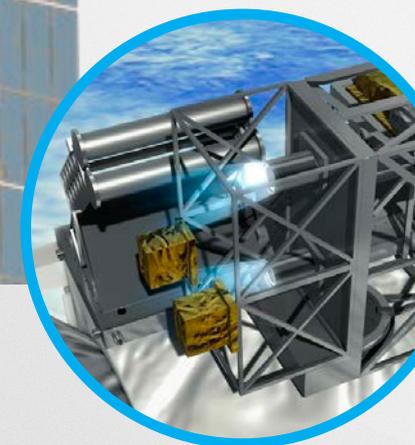


Free Flyer - a transition element from ISS age to follow on architecture. FF consists of a pressurized Module, an external Platform with Airlock for experiments, a Service Module

MAIN IMAGE
Engineering Concept for Modular LEO Platform



Electrical Propulsion on external Platform of Free Flyer – Technology Demonstration. Potentially, it is (later) used for continuous orbit keeping to meet Microgravity user requirement

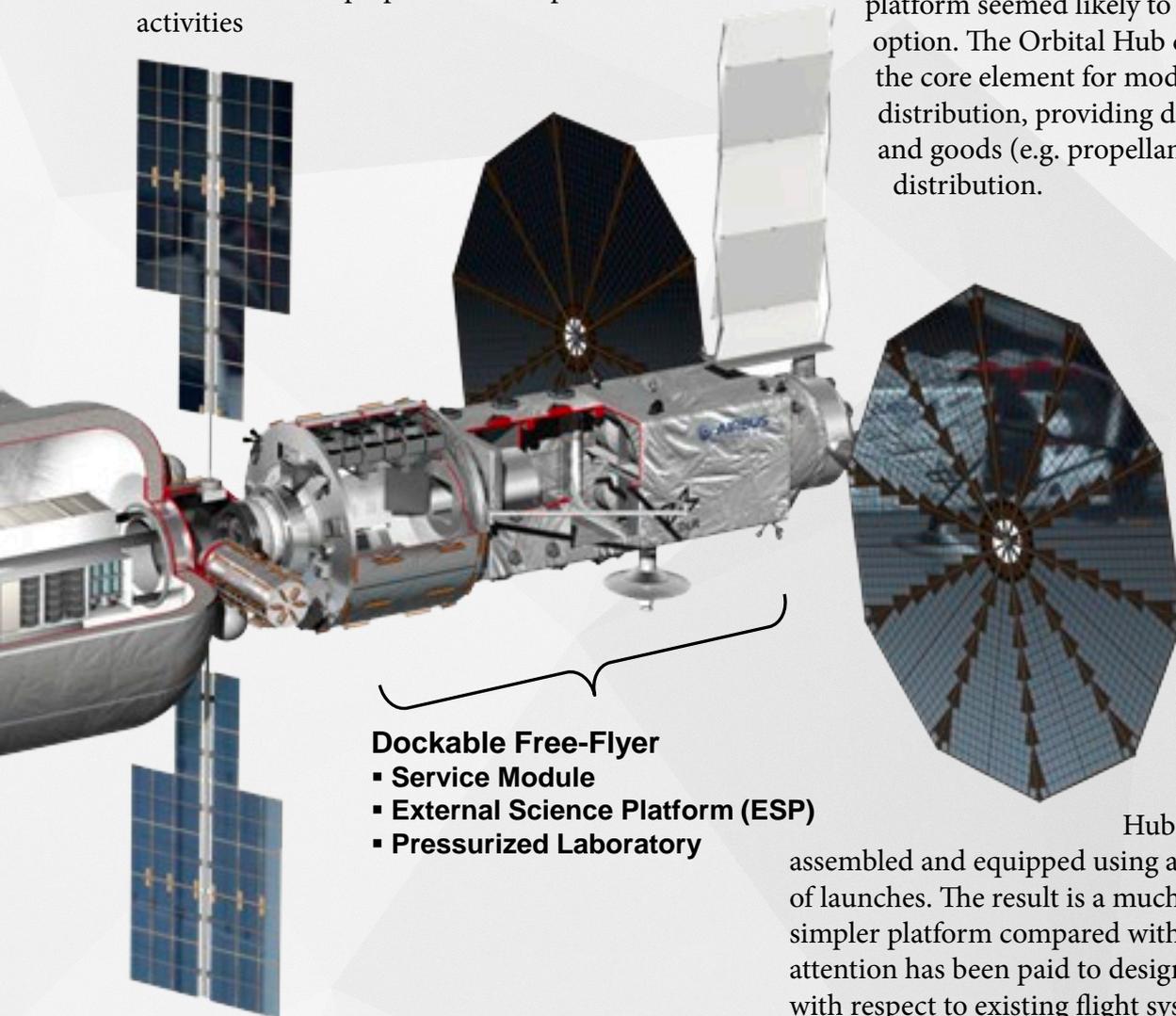


- High data transmission rate possibility and storage
- Storage for instruments, spare parts, new hardware, samples
- Long-term utilisation time (e.g. minimum 10 years)
- Robotic exchange of samples, higher autonomy
- Short-term crew exchange for extended complementary terrestrial research, long-term crew mission for preparation of exploration activities

activities or mechanical parts of the platform. The Free Flyer without crew presents one solution, along with electrical propulsion for orbit keeping on both platforms.

ORBITAL-HUB DESIGN

Several draft platform concepts were designed using DLR's CEF. A lean multipurpose platform with an additional dockable free-flying platform seemed likely to be the least costly option. The Orbital Hub concept would be the core element for modular logistics and distribution, providing docking, servicing and goods (e.g. propellant or experiments) distribution.



Dockable Free-Flyer

- Service Module
- External Science Platform (ESP)
- Pressurized Laboratory

Aspects like orbital structure layout and logistics, best location of payloads and secondary demands (e.g. data volume, interfaces, crew, lifetime and costs) were included. Once the system and experiments are in orbit, operational costs are intended to be reduced by, for example, implementing modularity of all experimental equipment, an improved station wireless network and improved data transfer options. Direct monitoring and control of experiments by users on ground is also key.

Scientific users also demand high pointing accuracy and low impacts caused by the crew

The Orbital Hub concept is to be assembled and equipped using a minimal number of launches. The result is a much smaller and simpler platform compared with the ISS. Particular attention has been paid to design the hardware with respect to existing flight systems, to reduce development time and cost.

The requirement is to maintain a crew of three plus possible visitors with at least one module for science laboratories, one module for crew accommodation and associated environmental control and life support systems. The design foresees an expandable habitat (e.g. as developed by Bigelow Aerospace and tested aboard the ISS) to cover these functionalities. The Base Platform should also be compatible with simultaneously visiting transport - and crew vehicles. Therefore, a five-point docking node is proposed at one end of the Base Platform.

BACKGROUND IMAGE

Dramatic scene during first Spacewalk with Mr. Leonov
Image credit: Energija Museum, Moscow

EVA's need a significant amount of the precious crew time for preparation and execution. In contrast to the ISS, the Orbital Hub concept is designed to limit the number of required EVA's by placing items externally using solely robotic manipulation. However, an EVA contingency airlock is foreseen for the Base Platform. Since the critical user requirements regarding attitude and disturbances are shifted towards the Free Flyer, the Base Platform is free to roll or yaw a certain amount. This allows for a one-axis rotatable solar panel concept which does not need additional truss structures, as on the ISS. The base configuration is thereby free to have the Habitat Module or the Docking Node point into the direction of flight. This enables thrust, either from the docked crew or the cargo vehicle, for station keeping and manoeuvres, reducing the need for regular refuelling for orbit maintenance.

The Free Flyer is intended to fly without crew in a safe formation with the Base Platform for, for example, three-month periods before it automatically docks to the platform for a short duration. Then it can be maintained, reconfigured, stocked up, and the payload transferred for return to Earth. The overall dimensions of the Free Flyer in stowed configuration are optimised to be in line with the envisaged single-launch scenario using Ariane 6-4.

INVITATION TO CONTINUE

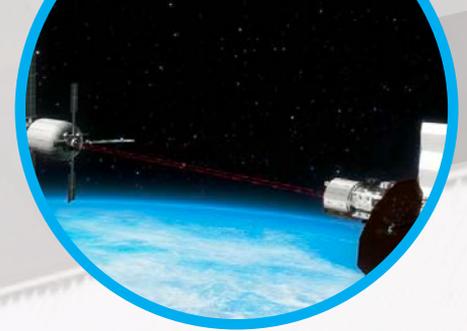
Concepts like the DLR ORBITAL-HUB are not just national preparatory work, but are mainly support for the establishment of future programmes in the broader field of human spaceflight, for securing ongoing international cooperation and long-



Orbital Hub as core for the future vision of a dynamic & evolving outpost

Acknowledgements

The activities described have been funded by the German Aerospace Center (DLR) and were strongly supported by the DLR Space Research and Technology Executive Board. The CE Studies / Design of the Habitat and Free Flyer were supported by engineering experts from industry and ISS cooperation partners.



Post-ISS – a Base Station replaces ISS. Here: Formation flying of Base Station and Free Flyer

term interdisciplinary research and astronomical activities in LEO.

The feedback from many scientists, experts, and ISS partners has shown sustained high interest in using the low Earth orbit environment on a multi-purpose mini-platform. A space laboratory is unique and not easy to replace. Orbital Hub represents the highest degree of maturity based on current technologies, operational/logistical systems, current commercial developments and financial aspects. Alternatively, parts of the concept could be implemented separately, for example, the Free Flyer only or Base Platform parts as a contribution to an upcoming modular station.

In general, future LEO architectures will probably be smaller, more modular and flexible than the current ISS. In addition to the conventional scientific utilisation, the hub should provide complementary payloads for Earth observation, technology demonstration and commercial applications, as well as opportunities for preparation of human planetary exploration.

The Orbital Hub or a similar concept could guarantee a smooth transition from the ISS to future human space activities in LEO and would represent an important step regarding long-term human space exploration beyond LEO, as described in the last issue of ISU Spacetalk magazine.

The Orbital Hub concept proposed here shows what can be done to create a safer, more modular, flexible and lower cost laboratory / test platform once the ISS is decommissioned, enabling transition without loss of know-how and resources.



3D PRINTED ROBOTS FROM ENGIMAKE

by Jack Scott-Reeve, SSP14

Developing Maker Robotics for Kickstarter
Mechatronic Engineering to ISU to Business!



My space dream is to build a city on the moon. I figured the most straightforward way to make that happen is to have lots of capital. To that end, I founded a company and will launch a Kickstarter campaign in November 2016 at getQuadBot.com.

WHAT ARE WE DOING?

EngiMake's mission is to get everyone making. Our first product, the QuadBot, is a 3D Printable walking robot. The people who buy it are makers - they use Arduinos, 3D Printers, go to makerspaces etc. or they want to take their first steps into making!

WHAT CAN YOU DO WITH THE QUADBOT?

The QuadBot gives you an opportunity to learn how to make your own robot. What you will take away from it is skills in electronics, coding, maths, 3D Design and 3D Printing, provided by the learning resources supplied with the kits. Backers who have access to a 3D printer will get "The Maker Kit" and 3D print their own robot! Backers without access to 3D Printer will get "The Full Kit" and will be robo-ready out of the box!

WHAT MAKES THIS PRODUCT DIFFERENT?

We're striving to break down the barriers to get people making and we really believe in strength of open source. The QuadBot is cheap, you have the freedom to change our freely provided 3D design and print to whatever you want. Users skill up with Coding languages, 3D design and 3D Printing software (Arduino, ArduBlockly and Fusion 360) that is high quality, free, open source and has tons of online support available. Perhaps the most differentiating is being able to learn and apply robotics' mat hs.

HOW CAN I HELP?

The best way you can help is to back the campaign, pre-ordering a kit or even a donation as low as £1. Due to internet wizardry, donating in the first day is highly desirable as it bumps the project up in the search algorithms and could even get on the front page of kickstarter! Liking, following, sharing @EngiMake on TWITTER, FACEBOOK, INSTAGRAM is more helpful than you know.

Get in touch at info@engimake.com if you or someone you know is interested in making this happen!



A LOOK BACK at SSP16 in Haifa, Israel



by *Miranda Bradshaw*
SSP 16

Miranda holds a PhD in optical metrology and works for Neptec UK, Harwell, building space sensor systems

SSP16 class photo, overlooking the bay of Haifa



lives, that we would make friends from around the world, and be inspired to move humanity forward in reaching the stars. Eight weeks of sleep deprivation didn't sound conducive to these life-changing activities. Luckily for us, as I'm sure the rest of the space mafia know, you come to love the sleep deprivation (almost) like you come to love all your fellow SSP'ers.

Week One of SSP16 began with the usual welcome dinner, where everyone tried to remember everyone's names (hooray for name badges), campus orientation (the Technion has some great sports facilities, including an outdoor pool complete with palm trees) and the class photo. Much time was spent in both the male and female dorms agonising over the best outfit to deal with the gorgeous (and hot) Israeli weather. Finally, we set off in air-conditioned buses to the top of Haifa, overlooking the Bahá'í Gardens and the surrounding bay – beautiful.

During Week One we had an Intercultural Awareness lecture, where we learnt that there are

no stereotypes, just “cultural tendencies”. Like the tendency of Swedes to put bananas on their pizza, and the tendency of Belgians, Germans and the French to disagree over whose beer is best (the answer is none of them – obviously Britain holds this trophy).

Weeks Two, Three and Four merged into a blur of lectures, punctuated by a world record – the first “space selfie”! All 103 SSP participants lay on the ground in the baking afternoon sun, dressed in white (or near enough), to be photographed by

We started SSP16 the same way any other SSP begins – by being told what ISU really stands for (Insufficient Sleep University, in case you thought otherwise). And not only that, but the usual nine to eleven weeks had been crammed into eight. Nervously, we looked at one another. We had been told by alumnus that this would be the greatest experience of our



The first-ever space selfie!

an Israeli satellite. Passing Technion students were greatly amused by the strange behaviour of their guests, but it was worth it – a world record was made! (In case you were wondering, I'm almost at the top of the right side of the "U").

Week Four ended with the annual space masquerade ball. The campus art shop was raided of all things remotely space-related (i.e., a lot of silver foil was sold), to create the best costumes the Technion, and quite possibly Israel, had ever seen. After much deliberation and a lot of brilliant dancing, individual first prize went to Daenerys Targaryen and her Dragon capsule egg, and the team first prize went to the Mercury Seven.

Week Five. The Humanities and Science departments visited to the Ramon crater, where I (with no bias at all) feel Humanities had the best time. The Humanities group sat above the crater, on a wooden deck overlooking the panorama, and discussed the Overview Effect with Loretta Whitesides (SSP2000). Down below, the Science team dug for would-be Martian samples in 40-degree heat, while over the hills the Engineering team chased a drone into the waters of the Gaza Strip.



The Dead Sea; my first salt-fringed beach



The SSP16 Mercury Seven crew take their weightlessness training seriously

At the end of Week Five we were given the opportunity to go on an Israel Heritage tour: to visit Jerusalem, swim in the Dead Sea and watch the Perseid meteor shower in a Bedouin camp. We started with a rather speedy tour of Jerusalem, as we were taken to a very detailed and informative Holocaust memorial museum – Yad Vashem – in the morning. After a quick peek into the Church of the Holy Sepulcher, and a short stop at the Wailing Wall, we jumped back onto the bus to the Bedouin camp. Once there we were treated with typical Bedouin hospitality: a tray of sweet tea, comfy cushions, and a friendly host. Note: if a Bedouin gives you a full cup of coffee, s/he would like you to leave as soon as possible. Introductions made, we were led to our next mode of transport; camels! Camel selfies abound, we rode around the area feeling like royalty. After dinner the fun began –



should we sleep outside, on rugs, in the cold, and watch as many shooting stars as possible? Or should we sleep inside the tent, on mattresses, and get enough sleep for the Dead Sea visit the next day? Some of us compromised and took the bedding outside, to fall asleep happily under the best meteor shower I've ever seen, and to be rudely awoken at 0200 by camp employees telling us they needed our rugs back.

Three hours later, we were up and "awake" for the bus ride to the Masada. This piece of architecture was built by King Herod (yes, the one from the Bible) and is famous for the siege of Masada, where 960 people committed mass suicide rather than be taken prisoner by the Romans. A cheery start to the day, but an amazing one – we reached the top of the fortress just in time to watch the sun rise over the Dead Sea. Stunning.

Back in the base of the valley, no-one prepared the Northern Europeans for the water temperature of the Dead Sea. Yes, it is extremely salty; yes, it is incredibly easy to float, but, boy,

is it warm! One clever Norwegian had the bright idea of swimming with a towel around his head; very handy for mopping your brow whilst bobbing past. After a few compulsory "reading while floating" photos, salt mining began in earnest, some of which did manage to get through Customs.

Week Six: We were up early to drive to a nearby kibbutz for the Engineering department rocket launch. A delicious breakfast was laid out under large sweeping white canopies, from under which the rest of us watched the Engineering teams scurry/bustle around in the heat, giving their rockets last-minute, competition-winning tweaks. The aim was to launch the rocket successfully and land it without cracking the bottle of local olive oil within, with the caveat of launching no higher than 500 m, in order not to activate the Iron Dome (and some awkward questions from the local armed forces). Luckily (depending on your point of view), all rockets stayed within the safe zone, and most landed without breaking their bottle, proving that it's not rocket science to launch a rocket. Oh, wait...



At the Ramon Crater overseeing the toil of the Science department far below



Winner of the "best selfie" competition, but was it awarded to the camel or Øystein?



G2 dips Dr Marit Meyer for the dramatic finish of the salsa routine



Week Seven: Team projects began in earnest. As a break from calculating space station strut loads, researching Martian perchlorate distribution, and investigating Big Data storage, we had Talent Night. This year featured among its acts Miss Chardonnay, possibly the first-ever performance of AC-DC on a ukulele and a group of non-dancers attempting to dance salsa (thanks, G2!).

Week Eight: The culmination of the team projects is the presentation. Everyone slaved away for the 125-page final report and produced beautiful images for the glossy executive summary, but really, we just wanted to watch each other acting on stage. And all the teams delivered fantastically. We enjoyed a tour around an artificial gravity space

station, shared the Last Supper before a one-way trip to Mars, and experienced the deluge of the world's Big Data.

Finally, the whole program closed at Madatech, the National Museum of Science, Technology and Space, with the fabulous Closing Ceremony. Each of us walked across the courtyard to collect our graduation certificate, some with catwalk flair possibly aided by the open bar. John Connolly gave a heartfelt and moving speech about his time as ISU Director, before handing over to the new Director, Dr. Omar Hatamleh. We ended the night together, outside the fabulous Junta Bar, with



The "best decorated" rocket

Watch out ISU! SSP16 learns Krav Maga

tearful farewells, many laughs, and, strangely, a canoe (thank you, Canadian Culture Night).

And that is all the magazine space I have! So I will leave to your imagination the enthusiasm of Buzz Aldrin, telling us to get our ass to Mars; Jeff Hoffman demonstrating microgravity whilst stood on a chair; swimming in the Sea of Galilee at midnight; reinstating the toga party tradition of SSP; and all five of the hilarious and delicious Culture Nights. Thank you to all the

SSP16 participants – you are fantastic people! I made so many friends and had an incredible and unforgettable time. I look forward to working and partying again with each of you in the future – to the stars, Mafiosi!

One more thing: don't mess with our new Director – he knows Krav Maga.



Visiting the Land of Water and Space

by Ruth McAvinia, SSP10

Experienced writer, editor, and broadcaster

Ruth was a broadcast journalist when she attended SSP10 in Strasbourg and has since become a science communications professional and member of ISU faculty

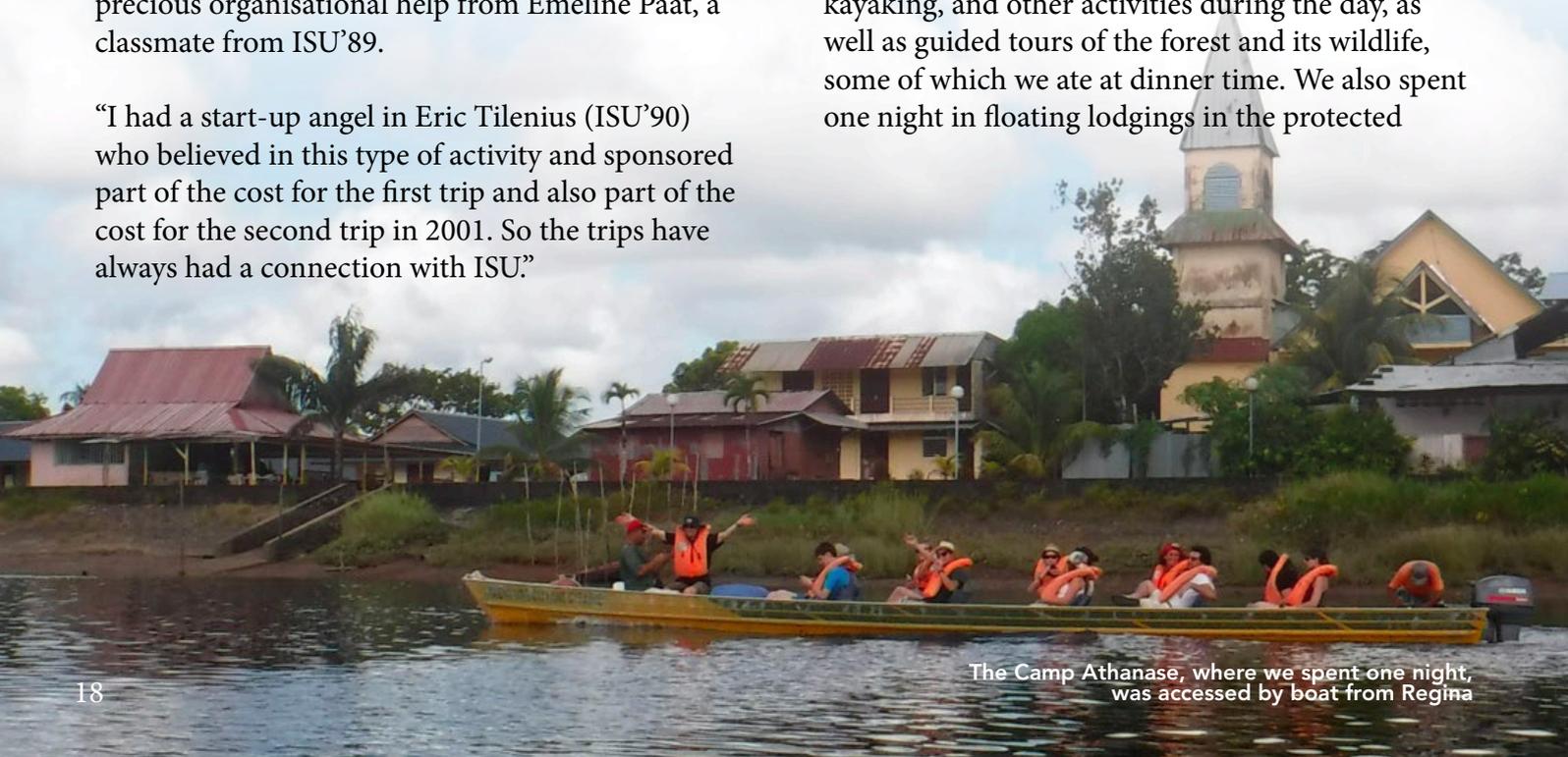
On 17 November, Ariane 5 successfully launched four Galileo satellites into orbit. Thanks to the efforts of Juan de Dalmau (ISU'89), some 26 young (or youngish) space enthusiasts had an opportunity to visit the rocket during assembly as part of a one-week tour of French Guiana. Juan, who is vice-chair of ISU's Academic Council as well as being former SSP Director, initiated the tours as an add-on to SSP in 2000, and has shepherded hundreds of people around Europe's spaceport and the surrounding area - particularly ISU alumni, and young professionals or trainees from ESA.

"My first year I organised for participants at the SSP2000 Chile session," he said. "That was quite an adventure because the group had to fly Santiago to São Paulo to Belem to Cayenne at the end of SSP. We had around 15 people and I was glad to get the precious organisational help from Emeline Paat, a classmate from ISU'89.

"I had a start-up angel in Eric Tilenius (ISU'90) who believed in this type of activity and sponsored part of the cost for the first trip and also part of the cost for the second trip in 2001. So the trips have always had a connection with ISU."

Juan was based in French Guiana for around 10 years at different stages of his career - among the first non-French to be based there when he worked there first for CNES at the age of 29. As you would expect from an interdisciplinary professional, his roles varied from range operations manager, to deputy division head for strategy and communication. He also went straight from French Guiana to Strasbourg when he became Director of SSP in 2002.

Most of the group assembled in Paris, because the most direct way to French Guiana is a flight from the French capital to Cayenne. From Cayenne, we piled into three minibuses - for us a journey into the unknown while Juan knew every step of the way. We visited two forest lodges - one accessible only by water. The group could choose swimming, kayaking, and other activities during the day, as well as guided tours of the forest and its wildlife, some of which we ate at dinner time. We also spent one night in floating lodgings in the protected



The Camp Athanase, where we spent one night, was accessed by boat from Regina

nature reserve of Kaw. There was a chance to see a wide variety of birds there, as well as several species of caiman.

From a wilderness devoid of telephone signals, the tour emerged into the future - the spaceport at the Centre Spatial Guyanais in Kourou. The group was hosted by the ESA office there, and shown around the Jupiter Control Centre before embarking on a tour across the huge site by bus. The visit included the Launch Control Centre, the site where the new Ariane 6 launch pad is under construction, the Soyuz launch pad, and quite exceptionally, the Ariane 5 Launcher Integration Building. The group was greeted by Didier Faivre, the new director of the centre for CNES, along with several of his senior staff. There was also an opportunity for informal discussion with a range of people working at Kourou, including Gianni Carra (SSP'96), over dinner in the evening. Several ISU alumni have worked at the spaceport for different companies and agencies, and opportunities are regularly advertised, particularly for young professionals from ESA Member States.

On our return flight, we met with Caroline Smoczarski (SSP'13) who, after three years as contracts officer at CNES in Kourou, is currently on secondment at ESA in Noordwijk.

Juan prepares the tour months in advance, as well as introducing participants to each other and to basic facts about French Guiana. Added to the work ahead of time, he accompanies the tour every step of the way. It may not be the most relaxing way to spend a week, but he is determined to continue.

"I enjoy helping people discover new places and things," he says,

The tour had up-close access in the Centre Spatial Guyanais



“Particularly because we may have one or more people who then apply to jobs in Kourou.”

As well as your reporter (SSP’10), Øystein Grøndahl (SSP’13) joined the tour from his native Norway. Øystein brought ISU spirit and tradition with him, particularly in presenting his own mini-Culture Night, much to the delight of his fellow travellers. AquaVit, Kvikk Lunsj (chocolate bar), and Seigmenn (jelly men) taste just as good, if not better, by the light of a tropical

moon, and Øystein also introduced the group to some of the space heritage of Norway, and particularly the island of Svalbard.

“I wanted to see French Guiana,” Øystein said of his decision to join the tour. “I wanted to see the Centre Spatial Guyanais and to experience being a tourist in the jungle. The highlight was visiting the space centre facilities and getting to talk to the people who work there. I would definitely recommend it very much.”

Juan already has provisional dates marked for next year’s trip. Keep in touch with him on LinkedIn, or on the ISU Facebook pages for when he begins to accept registrations to join the tour.

“I’ve always believed in bringing people from different cultures here,” he says, “I like to help people to see things that they would not otherwise see.”



The group at the Jupiter Control Centre, in the Centre Spatial Guyanais with some of our hosts from ESA and CNES

View from Ile Royale towards Devil's Island. The three islands that make up Iles du Salut are among the most popular tourist destinations in French Guiana. The islands are evacuated during launches for safety reasons, but the progress of each launch has been monitored from there since 1968



Caroline Smoczarski with Ruth, Juan and Øystein



Øystein Grøndahl (SSP13) enjoying the tour



The group back at Orly Airport in Paris after a week of adventure



by Justin Park

Master of Space Management, 2008
President of Intergalactic Education LLC

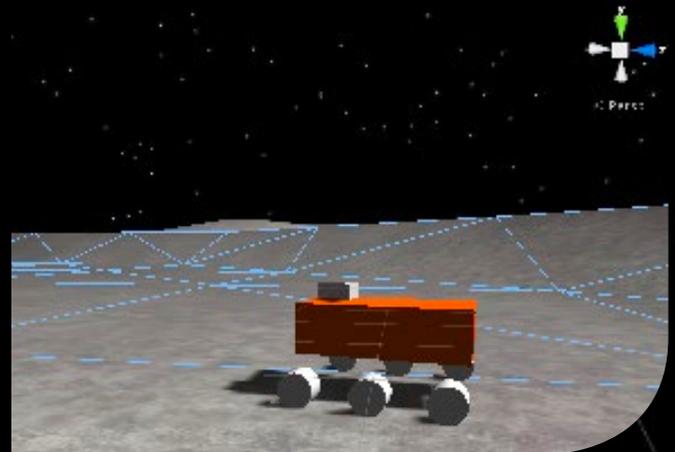
Intergalactic Education is an educational technology (EdTech) company rooted in ISU, and preparing to crowdfund its own game set in the world of the contemporary space industry. Players are challenged to create their own satellite system serving Earth with remote sensing and communications, but must observe real-world constraints.

The company was co-founded in Zug, Switzerland by Katrin Speck and ISU alumnus Justin Park (MSM 2008). Park attended the ISU Masters of Space Management (MSM) program in 2008 and completed his final module as an assistant for the ISU concurrent design facility (CDF) during the 2013 Space Studies Program (SSP) hosted in Strasbourg. In the summer of 2014, Intergalactic Education brought on its first full-time ISU intern – masters 2014 candidate Weihua Dong (David). Working with two software developers from the Zurich University of the Arts (ZHdK), the first 3D version of a game called Space World™ was born.

After graduating from ISU, David returned to China to continue his work for the Chinese Space Agency. Meanwhile, Intergalactic Education found another young, just-graduated ISU masters student – Sam Aghdam from Australia. Sam brought to the organisation many valuable graphic design skills and a keen eye for detail. A great amount of effort has been put into ensuring that the numbers and proportions used in Space World are a truthful representation of the real physical world. The game is also dedicated to using accurate financial statistics pulled from media sources like Space News. The goal is to teach players and help them to understand the orders of magnitude of how expensive launch vehicles truly are. One major objective in Space World is to create a global satellite system and provide communication and



INTERGALACTIC



EDUCATION

remote sensing services. By the end of 2014, several in-game launch scenes and a proper menu system had been built.

Unfortunately, the founders of the company decided to go in separate directions and in January of 2015 Justin returned from Switzerland to the United States to pursue a senior consulting position with Booz Allen Hamilton. All employees were furloughed and very little development was conducted during the following year.

In April of 2016, Justin created a new legal entity in the United States: Intergalactic Education LLC. The new company attempted to bring on board two ISU masters student candidates from India but was unable to procure work visas. Intergalactic Education instead hired five game design students from the greater Washington DC area. The startup was also inducted into a southern Maryland technology incubator program called TechFire. On the advice of one entrepreneur-in-residence from the TechFire program, Justin engaged teachers in the area to begin establishing a potential consumer-base within the local education system. According to Justin, “the goal has always been to sell the software as a learning assistant for teaching mathematics. Although, I also think knowing about the commercial space industry is just as important.”

Over the summer, Intergalactic Education was selected as a finalist in the National Creativity Network’s Creative Business Cup Competition. Justin has also been attempting to raise awareness of his company by reaching out to organisations such as the Space Foundation and NASA. He presented as an entrepreneur on the Startup Maryland tour and represented the company at the Washington DC District Arcade in September. Most recently, Intergalactic Education has entered the classroom to pilot its first educational version of Space World to a middle school in Charles County, Maryland. The company is planning to launch a Kickstarter for Space World in late November and is seeking additional angel investment funds.

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justin@intergalacticeducation.com

This year we had the 67th edition of IAC and this time around it was hosted in Guadalajara, Mexico. Each year the Congress gathers space professionals and enthusiasts in a different city around the world. Presentations at the IAC span from overall trends and prognosis about the space sector to highly specialized technical talks. Attendees range from students, and young professionals, through CEOs of leading space companies to the directors of the biggest space agencies in the world.

The 67th edition of the IAC wasn't an exception and gathered the largest space companies in the world, including; Blue Origin - founded by Jeff Bezos (founder of Amazon) - who are making significant progress in reusable rocket technology with their rocket launches to 100km altitude, Lockheed Martin - a leader in jet engine production and space tech, Boeing - worldwide airplane and spacecraft producer, and Virgin Galactic - the private endeavour of Richard Branson to deliver a sub-orbital space flight to the space tourist.

On Sept. 27, on the second day of the Congress, a key event happened - Elon Musk presented SpaceX's Interplanetary

Transport System. Mr. Musk is the CEO and founder of the private company with headquarters in Los Angeles, California. There was a great anticipation about his talk both on site at the IAC and online from people around the world, to hear what he had to say. People were queueing in front of the gates four hours before the event. By the time we were allowed to go in, the crowd amounted to more than 3,000 attendees.



by Tihomir Dimitrov, SSP 15

Planetarium lecturer at children's science museum "Muzeiko"
MS Astronomy student
Space science communicator
Rocket scientist
[The Human Adventures in Space Exploration](#)

Tihomir can be found tracking the Space Station after sunset or in the gym training for his 2020s missions to Mars on board one of SpaceX's spacecraft. In his spare time, he really enjoys writing about himself in the third person.

SPACEX - WORK HARD WITH A VISION FOR THE FUTURE

It is interesting to note why people from around the world are waiting anxiously to hear the plans to go to Mars of a private company when we have NASA and the other big space agencies. SpaceX is one of two companies (with Orbital ATK) that delivers cargo to the International Space Station in orbit and the only company that can bring cargo back from the Space Station. SpaceX develops and

Entrepreneurs: First Settlers on Mars

builds all of their components in their own factory at Hawthorne, CA – the Merlin rocket engines, the Falcon 9 rocket and the Dragon spacecraft. And as if that is not enough, they have been landing their rockets back on the surface of Earth for a year now (or by a controlled descent onto a barge in the ocean). All these achievements ensure a lower price tag per launch with many favourable implications in the future.

and utopist who knew what he wanted to achieve with the foundation of SpaceX. His company is making a revolution in space tech in such a way that soon space travel will become more affordable. Others have had similar ambitions before him but he is the first that looks really promising. It is not a coincidence that Elon became an enigmatic figure on a global scale, who manages to turn the tide towards STEM. It is sexy to be a rocket scientist nowadays!

WHY DO WE TRAVEL IN SPACE?

Rocket engineers are the “magicians” who invent the machines that will take us to Mars, of course, but why do we need to go anywhere at all? Earth is the best place for trillions of kilometres around (although we are trying our best to destroy the environment). Why don't we just stay here? There are a lot of pressing issues on our planet and one might say that we need to invest money in those, instead of going to Mars. The red planet is not the ideal place to live anyway.

Imagine a world, though, where humankind is out there among the stars, settled on Mars, and the moons of Jupiter and Saturn, and we are already travelling to Pluto. Martian cities have their own propellant stations that produce the fuel for the spacecraft that mine asteroids,

SpaceX has been financing itself for the last 14 years with the private funds of Elon Musk (from the sale of PayPal to EBay). The company was founded in 2002 and it nearly ceased to exist in 2008. NASA came to the rescue in that critical moment and signed a \$1.6 billion contract with SpaceX. The deal gave the company the opportunity to make 12 delivery cargo missions to the International Space Station.

Elon Musk is a hard-working engineer, a visionary



Interplanetary spaceship on the surface of Europa

and we are roaming freely between the planets. The moment the first humans step on the surface of Mars, our perspective will change dramatically because we will become a civilisation that managed to “swim” through the blackness of space to another heavenly body, thanks to its ingenuity and creativity – a multi-planetary species. This would be the greatest adventure mankind has ever undertaken and it would have more implications in technological, philosophical, historical and exploratory respects than any other moment in history.

The alternative way is to stay here on Earth, but until when? History shows that almost all life on Earth has been erased several times. The dinosaur fossil remains under our feet and in our gasoline tanks are a real testimony for this. Dinosaurs didn't have thumbs on their hands and a space program – that's their excuse. What's ours? We live in times when we start to appreciate the uniqueness of our civilisation and it would be reckless not to secure our survival with a colony on another planet. Bear in mind that we are not talking about abandoning our planet here.

WHAT IS THE BEST PLACE FOR A HUMAN COLONY IN THE IMMEDIATE FUTURE IN OUR SOLAR SYSTEM?

The choice is easy to make because all of our realistic possibilities in the immediate future end with Mars. Even though it is a planet with compromises, Mars is the friendliest environment in our local neighbourhood. The 20th century saw humanity's greatest achievement – the Apollo landings on the Moon, but even though being amazing, they were only a visit to our moon. We are aiming now for a sustainable human colony on the Red planet. If we ever want to achieve this, we need people who want to go to Mars but also ones who can afford it. Unfortunately, today no one can go to Mars even for an infinite amount of money because we haven't even built the spacecraft that will land people on the Red planet and bring them back alive.

THE INTERPLANETARY TRANSPORTATION SYSTEM

The key concept that will lower the cost of spaceflight is rocket reusability. This is even more important when it comes to human rated spacecraft. This is logical since all other forms

of transport we use are already reusable – from the horse to our airplanes! Cheap airplane tickets are a reality because we use airplanes multiple times. On the other hand, almost every rocket launched so far ended up at the bottom of the ocean polluting the environment and filling orbital space with debris. Rocket reusability is a serious engineering challenge and that's why it became a reality only last year, sixty years after the dawn of the space age. SpaceX has already done its homework by landing several of its Falcon 9 rocket boosters. The first flight that will use a reused booster will be launched by the end of the year.

LAUNCH TO LEO

According to SpaceX, the main component of the architecture is a giant rocket booster that firstly carries human cargo in a spaceship to Earth orbit and is subsequently reused several times with space tankers to carry fuel to orbit. The booster will employ a carbon-fibre structure, 122m tall, and it will be three times more powerful than Saturn V. It will be able to launch a whopping 300t of payload to LEO. After delivery, it will use the remaining 7% of its fuel to land back on the launchpad. The payload would be the 100 passengers with their luggage, travel provisions, and the materials needed to kickstart the human colony on the surface of Mars. This will become possible thanks to the 42 Raptor rocket engines, powered by deep cryogenic liquid oxygen and cryogenic methane ignited under 300 bars of pressure. The hot exhaust gases that come out of such an engine will travel with a speed of 3.7 km/s! Seven of these engines, located at the centre, will use a gimbaling system that will be able to change the vector of velocity of the whole 275-ton booster. The fuel needed to deliver the interplanetary

If we ever want to be able to have a permanent presence in space, we need to drop the price of space travel by a factor of 100.

Falcon 9's first stage landed on Dec 21, 2015.

spaceship to LEO and to land the booster back on the launchpad amounts to a staggering 6700t of propellant! Even people who witnessed the amazing Saturn V launches last century, can only imagine the monstrous power of this giant rocket.

IN-ORBIT REFUELLING

Once all passengers are in orbit, the booster returns to Earth and is quickly refuelled. Then they put another spacecraft on top of it, similar to the first one, but with a totally different purpose. This is going to be a giant space “tanker” that won’t have any human compartment but instead, it will use the space to fit its propellant tanks. Four or five such trips with the tanker will give the interplanetary spaceship the necessary fuel to set out on its voyage to Mars.

TRAVELLING TO MARS

Elon states that the interplanetary spaceship will be a fun place where the passengers will be able to play zero-gravity games and to feel cosy. The ship won’t feel crowded. No human being can describe the feeling of travelling to Mars because nobody has ever undertaken such a voyage yet. Even the astronauts who spent a whole year in orbit around Earth cannot fully understand what this will be like, as they had the chance to look at Earth.

ON MARS

After a 4 month trip to Mars, the interplanetary spaceship will enter into

Mars’s atmosphere, straight from interplanetary space with a speed of 8.5 km/s. Its aerodynamic heatshield will need to withstand temperatures in excess of 1700 degrees Celsius. The PICA heat shield is a phenolic-impregnated carbon ablator (hence the name) that features a lightweight material designed to withstand high temperatures. The astronaut-settlers will be subjected to a force of 4-6G during Mars entry and 2-3G when they return to Earth. These are high but tolerable forces.

After landing on the Red planet, the interplanetary spaceship will need to be refuelled with propellant but there is no oil or factories on Mars. That’s why the architecture incorporates cryogenic liquid oxygen and methane. Engineers count on the vast amounts of moisture in the soil and ice under the Martian surface, and on the main component in the Martian atmosphere – carbon dioxide.

Chemistry and our experience, show us that we can extract oxygen on the Red planet via water electrolysis, and hydrogen from that can be used with carbon dioxide to produce methane via the Sabatier process. The other by-product of this reaction is water, which can be recycled into the system or to be used for other necessities on the surface of Mars. The most difficult part of these reactions is the supply of power which can be solved by using big solar panel farms.



The usage of the right combination of propellants and their production on the surface of Mars (known as in-situ resource utilization – ISRU) are key elements of the whole architecture and it would be impossible without them.

PRICE TAG AND FINANCING

The booster that will take the ships and tankers to Earth’s orbit is going to be needed only on our planet. Other potential planets and celestial bodies in our solar system where we can visit, have much shallower gravity wells and the spaceship’s engines will be sufficient to take off. The booster will have a presumable lifetime of 1000 launches, the tanker – 100, and each interplanetary spaceship – 12. The fabrication cost of the whole system of a booster, tanker and a ship will be more than half a billion dollars but the launch expenses per trip would be only several tens of millions of dollars! SpaceX

a space faring civilization
nent human existence in
crease substantially the
y reusing our rockets and
acecraft

e landing back on Cape
3, 2015 - the first rocket
back on Earth



VEHICLE SIZE	●	●	●
COST OF PROP	●	●	●
REUSABILITY	●	●	●
MARS PROPELLANT PRODUCTION	✗	●	●
PROPELLANT TRANSFER	●	●	●

Characteristics of different propulsion methods
 This diagram shows the advantages of a methane/oxygen propulsion method over other propulsion methods

- GOOD
- OK
- BAD
- ✗ VERY BAD

calculates a price of \$168/ton of propellant. The first trips to Mars will be more expensive but the price per trip will fall relatively quickly soon after that down to 100 – 200,000 dollars, depending on the amount of luggage the settlers take with them. SpaceX aims to make the trip to Mars so affordable that nearly everyone who decides to go, to be able to do it.

Elon impresses with his sense of humour when he talks about billions of dollars. He suggests that SpaceX will need more than \$10 billion for the development of the whole architecture. The current launch manifest of the company can only partially cover this amount. Elon hopes that funding will accelerate once the whole endeavour gains popularity – private companies and investors, online Kickstarter campaigns, and even whole governments will be able to support the campaign. Moreover, Elon’s personal motivation of accumulating assets is to help fund the missions to Mars and make life multi-planetary.

TIMELINES

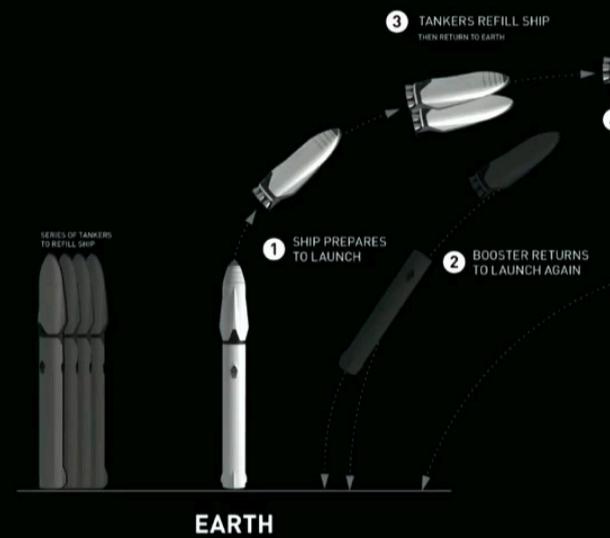
SpaceX is planning to produce the booster and the spaceships during the next 3-4 years and to test them at the beginning of next decade. The plan is the first human mission to Mars to be launched from Earth in 2024 and to land on Mars in January, 2025.

SpaceX has a lot to learn about interplanetary travel

FULL RE
 REFILLING
 PROPELLANT PRO
 RIGHT PR

The four essential concep
 permanent human

SYSTEM ARCHITECTURE



Schematic of the SpaceX

but the company has already proven that it can achieve huge advances with hard work and discipline. Starting 2018, SpaceX is going to send its Dragon spacecraft to Mars to investigate further how to transport and land large payloads on the Red planet, to look for potential landing sites that hold large pockets of ice, to look for suitable locations for the first Martian city, and to demonstrate key surface capabilities on Mars.

In typical SpaceX manner, the company has already built the big liquid oxygen reservoir (that will



USABILITY

G IN ORBIT

DUCTION ON MARS

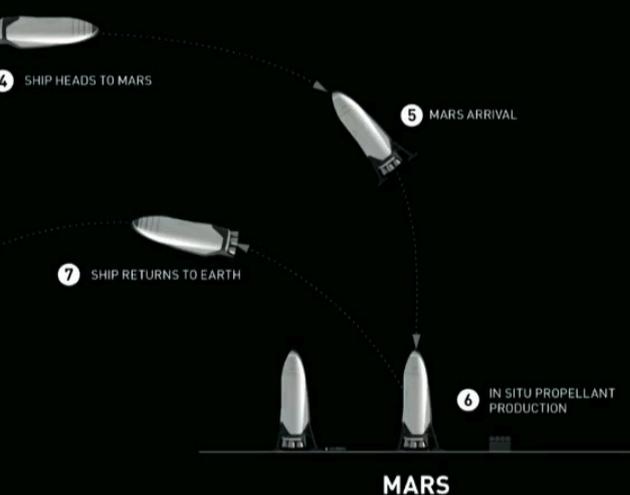
PELLANT

ts of any architecture for
existence in space



In-orbit refuelling is essential
for decreasing the price of
travelling to other places in
our solar system

TARGETED REUSE PER VEHICLE
1,000 uses per booster
100 per tanker
12 uses per ship



architecture to reach Mars

power the spaceship) and has already successfully tested it. The company has also already tested the Raptor rocket engine at its test stands in McGregor, Texas. Elon states that once the Mars initiative gains some speed, funding will be raised among private as well as government entities.

Elon's presentation at the IAC in Mexico created a lot of noise in the space industry and many experts started analysing the viability of his plans. Some of their suggestions are untenable but Dr. Robert Zubrin from the Mars Society offers a number of

meaningful improvements. The basis of his suggested improvements is to divide the interplanetary spaceship into a second stage booster and a spacecraft that will take the settlers to Mars. The second stage booster will provide enough initial velocity to the spacecraft for its interplanetary voyage and then it will return back to Earth orbit where it has the potential to be refilled another five times (in the span of 2 months). This will ensure five times more useful mass to be sent on its way to Mars every 26 months when the two planets align. The trip to Mars can also be lengthened by several months to compensate for a certain amount of propellant. Dr. Zubrin also suggests that once landed on Mars, the interplanetary ship has to be used for the needs of the settlers instead of it being returned back to Earth. As a result of these improvements, the cargo that will be sent to Mars will increase in mass enormously.

We really live in interesting times today when, for the first time, people dare to not only dream, but to actually plan to go to another planet. Elon Musk is an enigmatic figure with big goals who works tirelessly, achieves real results and makes a revolution in the most hectic industries in the world. Only time will show if his plans for Mars are viable but the future is for the brave!

All photo credits: SpaceX



Deep cryogenic LOX tank test in the sea



by Tina Rawlinson

**ISU Executive Space Course in 2011
Director with Cavendish Trust Company Limited, a leading Corporate Service Provider based on the Isle of Man which specialises in assisting space related businesses to establish in the Isle of Man. Tina is also a member of the Isle of Man branch of the SSPI.**

The Isle of Man is a land mass of approximately 300 square miles (765 square km) which is situated in the Irish Sea, almost equidistant between Ireland and Great Britain. Whilst technically the Isle of Man is an island in the middle of the Irish Sea, it has become better known as an 'Island in Space'. This reputation has been built up over a period of 16 years and includes a number of very notable successes along the way.

The birth of the island's space sector is down to one individual, namely ISU Board of Trustees member Chris Stott. Chris was born in [Douglas, Isle of Man](#), and went on to work in some of the biggest space companies in the United States. He was Director of International Commercialisation and Sales with [Lockheed Martin](#) Space Operations. Chris came to Lockheed Martin from the [Boeing](#) Space and Communications Company in [Huntington Beach, California](#), where he worked on international business development for the [Delta Launch Vehicle](#) program. In 1998, Chris formed ManSat Limited on the Isle of Man. ManSat carries out satellite filings for the Isle of Man under contract with the Isle of Man Government's Communications Commission. Isle of Man satellite filings are made to the International Telecommunications Union (ITU) in Geneva via Ofcom, the administration of the United Kingdom. Since that time, Chris has been an ambassador for the Isle of Man and its space industry and with the assistance of other Isle of Man entities such as Cavendish Trust Company Limited, has seen the space industry on the Isle of Man grow from strength to strength.

The space industry has become the Stott family business as Chris is married to [Nicole P. Stott](#), an American astronaut who served as a Flight Engineer on ISS [Expedition 20](#) and [Expedition 21](#)

The Isle of An Island



and was a Mission Specialist on [STS-128](#) and [STS-133](#).

The Isle of Man offers many advantages to resident space industry companies:

- access to orbital filing slots.
- access to launch licences through an agreement that the Isle of Man Government has with the UK Space Agency.
- the UK Outer Space Act 1986 has been extended to the Isle of Man and therefore the Isle of Man is able to benefit from its provisions.
- a corporate tax rate of 0%, which results in satellite and space companies being able to achieve significant savings by structuring the operations of

Man - Island in Space

Nicole Stott flies the Manx flag on the International Space Station



group holding companies or subsidiaries in the Isle of Man or by establishing R&D or manufacturing centres on the island

- an established base of space, aerospace and high tech industries
- an established captive insurance market
- the island is recognised as being British for the United States' ITAR purposes
- a 'pro-space' Government with a political commitment to develop space commerce
- space friendly legislation
- an established and highly regarded professional services network
- a world class telecommunications infrastructure
- free movement of goods within the EU
- financial incentives and grant aid for businesses which create new jobs on the island

Over the years, the Isle of Man has attracted a wide range of space industry businesses. Well-known companies that have established on the island include the likes of SES, Inmarsat, Telesat, Avanti, Odyssey Moon, and Excalibur Almaz.

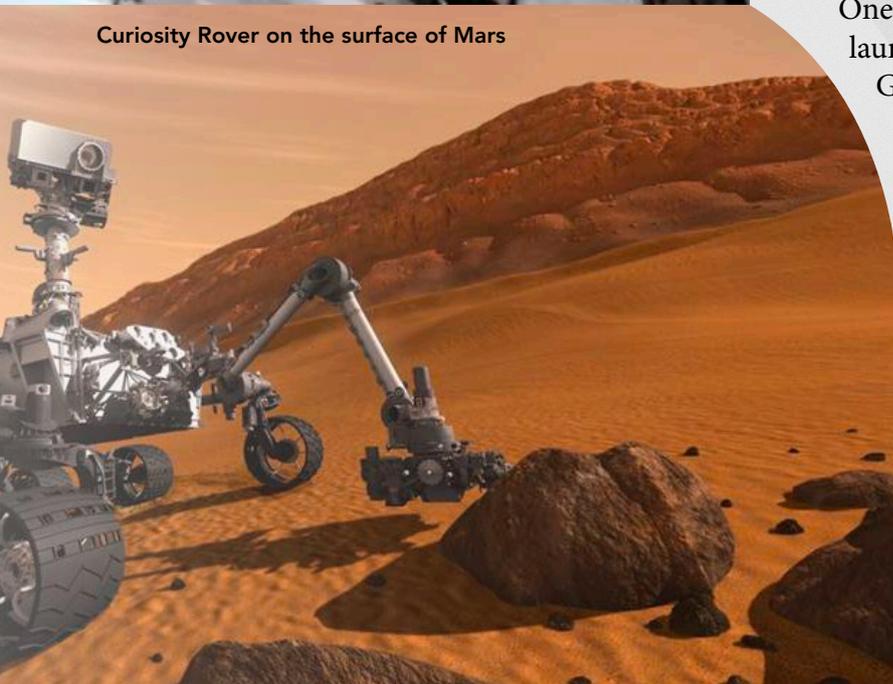
The Isle of Man has also attracted a number of global not-for-profit companies including the International Institute of Space Commerce, the Space Data Association and the Satellite Interference Reduction Group.

Furthermore, the island has achieved success in the field of space related manufacturing including Manx Precision Optics (MPO). Isle of Man manufactured optics have been included on the last three Martian rovers and at one point were instrumental in the discovery of high altitude snow on Mars.

One of the largest communication satellites launched in recent years is ViaSat-1. It holds the Guinness World Records title as the world's highest capacity communications satellite, with a total capacity in excess of 140 Gbit/s, more than all the satellites covering North America combined, at the time of its launch. ViaSat-1 operates on Isle of Man registered ITU frequencies.

With the combination of the many corporate benefits, the established space cluster and the proven track record, it is easy to see why the Isle of Man is now well known as the 'Island in Space'.

Curiosity Rover on the surface of Mars



A DAY IN THE LIFE

Will Pomerantz, MSS 2004

Vice President,
Special Projects at Virgin Galactic



All photo credits: Virgin Galactic

Please list your ISU affiliation - Program & Year

I'm a graduate of the MSS, class of 2004.

Tell us a little about yourself - Personal Background (Social, Economic, Educational)

I grew up mainly in the United States. My family moved around every few years, so before I started university, I'd lived in Buffalo, New York; Cambridge, England; Houston, Texas; Providence, Rhode Island; and Orlando, Florida. Despite having spent a combined 10 years growing up in cities with a significant space industry (Houston and Orlando), no one in my family had ever worked in the space industry before. Nevertheless, I fell in love with space as a young child, like so many others.

In university, I majored in Earth and Planetary Sciences (EPS). At least at the time I was a student, though, Harvard's EPS department was basically all Earth sciences and hardly any planetary sciences, but clearly the planetary stuff is what interested me the most. But despite my love for planetary sciences, I grew frustrated with how infrequent the missions and the research opportunities were. When I finished my

undergraduate degree, I wasn't sure if I wanted to attend ISU or to press on towards an advanced degree, so I deferred my ISU admissions one year to work in a research

lab at Brown University, focusing on some unexplained topographical features on the surface of Mars.

After a year of that, I'd decided that I

didn't want to make planetary science as lifelong career. Fortunately, I'd used the year to win some scholarships and to save up some money to support a trip to ISU. I showed up in Strasbourg in August 2013, eager to meet the members of my new ISU family.

Do you still work in the space sector?

Yes! And gladly so.

Please summarize your role in 2 sentences

I feel lucky to have a very ISU-like job that allows me to be incredible interdisciplinary. Since joining Virgin Galactic five years ago, I've helped start up our suborbital research flight

program and our small satellite launch vehicle program, plus helping out with communications, project management, sales, and investor relations.

ISU INVOLVEMENT

How did ISU influence or assist you in your career & current role/function?

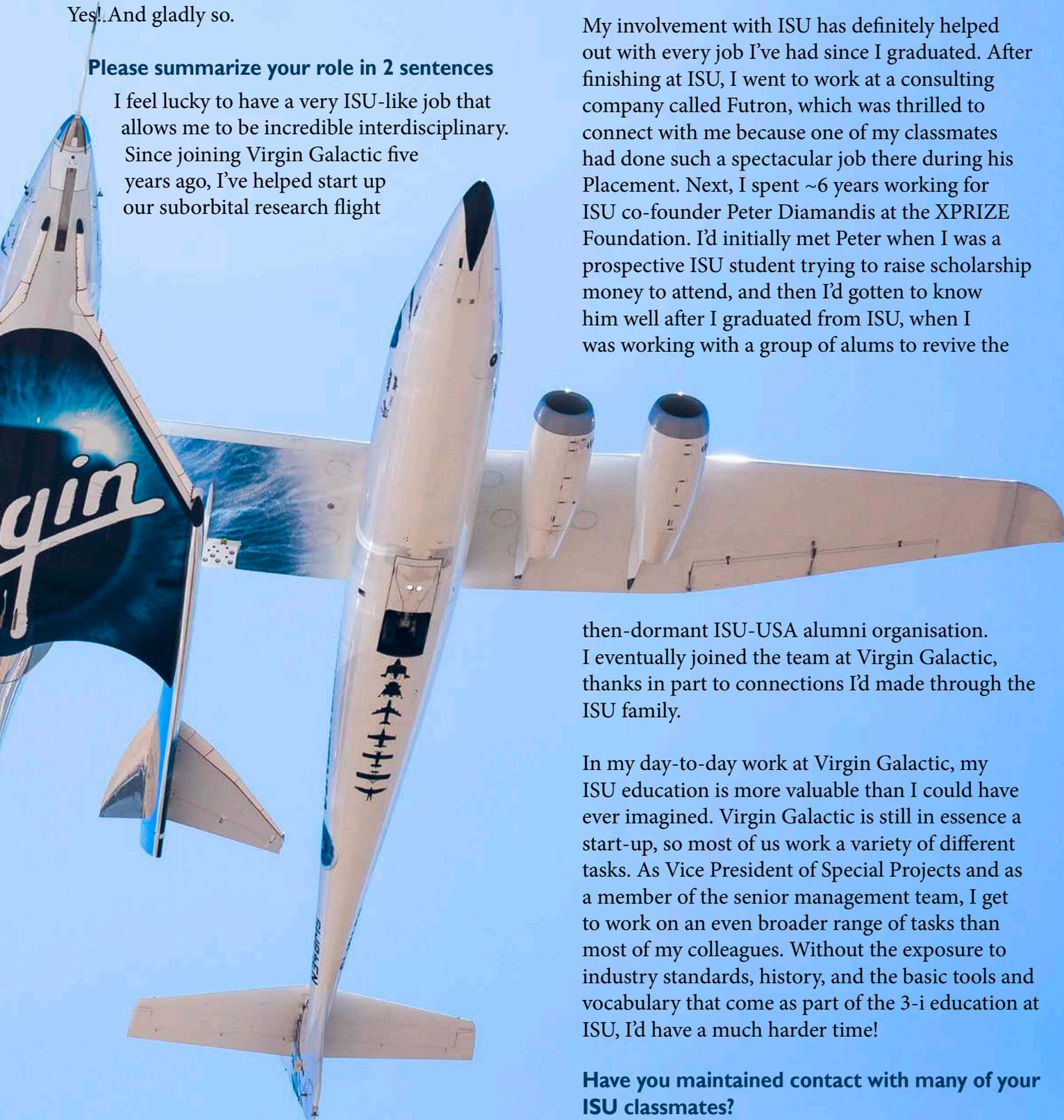
My involvement with ISU has definitely helped out with every job I've had since I graduated. After finishing at ISU, I went to work at a consulting company called Futron, which was thrilled to connect with me because one of my classmates had done such a spectacular job there during his Placement. Next, I spent ~6 years working for ISU co-founder Peter Diamandis at the XPRIZE Foundation. I'd initially met Peter when I was a prospective ISU student trying to raise scholarship money to attend, and then I'd gotten to know him well after I graduated from ISU, when I was working with a group of alums to revive the

then-dormant ISU-USA alumni organisation. I eventually joined the team at Virgin Galactic, thanks in part to connections I'd made through the ISU family.

In my day-to-day work at Virgin Galactic, my ISU education is more valuable than I could have ever imagined. Virgin Galactic is still in essence a start-up, so most of us work a variety of different tasks. As Vice President of Special Projects and as a member of the senior management team, I get to work on an even broader range of tasks than most of my colleagues. Without the exposure to industry standards, history, and the basic tools and vocabulary that come as part of the 3-i education at ISU, I'd have a much harder time!

Have you maintained contact with many of your ISU classmates?

Definitely! I wish that I got to see more of them more often, but thankfully, I've managed to stay



close to many of my MSS'04 classmates. Since graduating from ISU, I've started a small business with my classmate Nick Skytland, shared an apartment with [the late] Brooke Owens, had Munir Jojo Verge over for family holidays, and made great new memories with several other members of our class.

How often do you leverage your ISU network to achieve your role/function objectives?

At the start of my career, my ISU network was absolutely critical. As mentioned above, I got my first job after ISU in part because my classmate David Vivanco had done such an incredible job working at that company during his placement. While there, I collaborated with classmate Nick Skytland to start SpaceAlumni.com. And working with the ISU-USA alumni community, I got to know Peter Diamandis better, which led to getting a job offer at the XPRIZE Foundation.

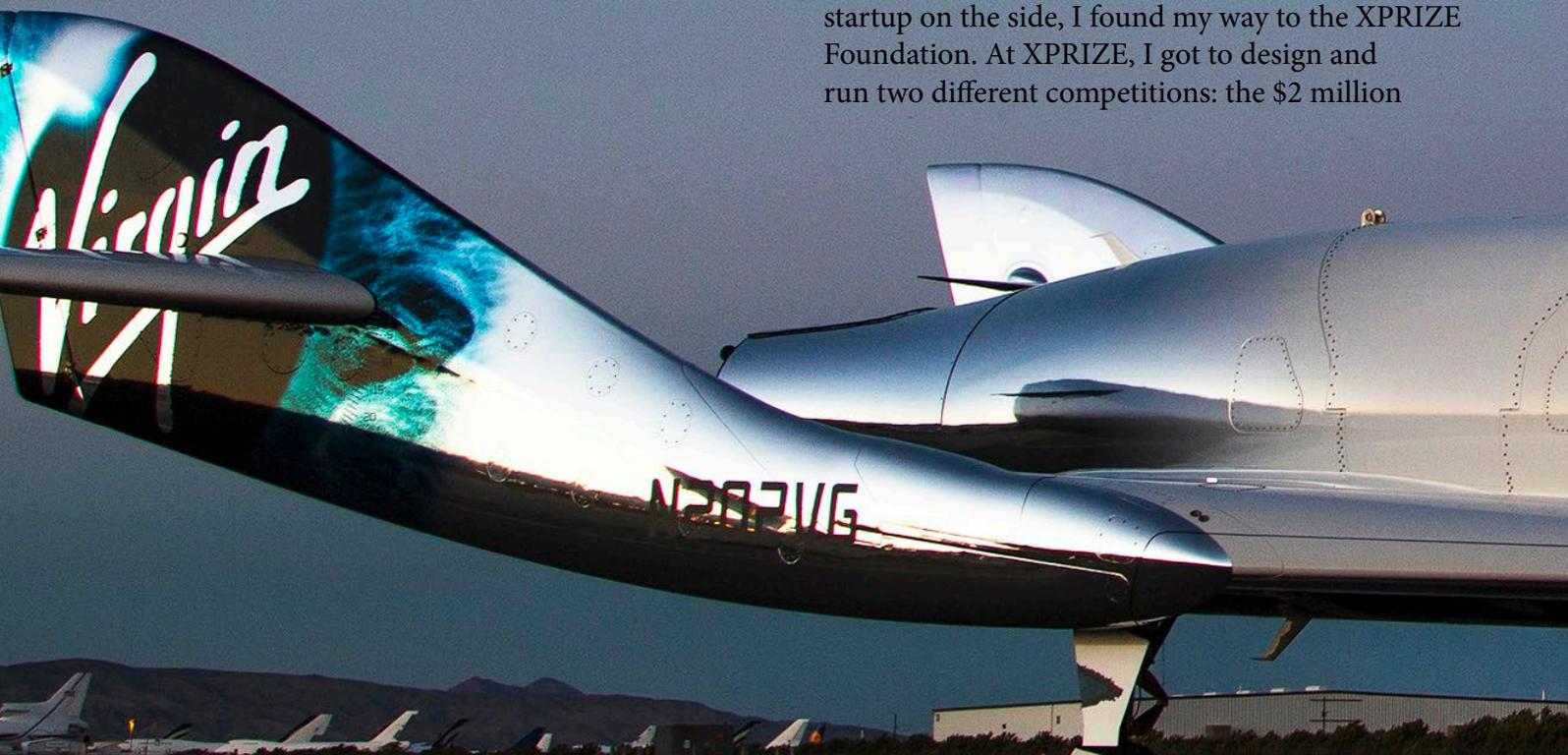
Nowadays, I call on my ISU network a bit less, but it still remains a valuable resource.

for me – although I found (and still find) it very intellectually engaging, I was frustrated by how infrequent the missions were. So I decided perhaps my calling was to help increase space access – figuring that, among other benefits – if there were better access to space, there would be more planetary missions.

I didn't know how exactly to help with space access, so I made my way to ISU to learn more about the industry. ISU proved to be a great place to get a sampling of all of the world's programs and to learn more about what I personally liked, what didn't interest me as much, and what seemed to be missing.

I've always been interested in entrepreneurship and in working for smaller companies, so I found myself called to the emerging "NewSpace" sector. I had also discovered that I really enjoyed the Interdisciplinary aspect of ISU, so I tried to find jobs where I could exercise many different parts of my brain.

After a brief period of consulting, with a small startup on the side, I found my way to the XPRIZE Foundation. At XPRIZE, I got to design and run two different competitions: the \$2 million



CAREER PATH

How has your career developed to arrive where you are?

I started out my career in aerospace by working as a planetary scientist. I didn't last very long in that field before I decided it wasn't the career

Northrop Grumman Lunar Lander Challenge, and the Google Lunar XPRIZE. The job was very interdisciplinary, as it required everything from technical requirements writing to complex legal contract to fundraising to marketing and communications. It was also quite international, at least for the Google Lunar

XPRIZE, which attracted teams headquartered in 16 different countries.

5 years ago, where did you see yourself today?

Helping people get to space, and having fun while doing so.

5 years from now, where do you see yourself?

Why?

What does this mean to you?

- Personally
- Professionally

Helping people and satellites get to space, and having more fun while doing so!

CURRENT JOB

What do you most love about your job/business? (What gets you up in the morning?)

I feel incredibly lucky to have a job in an industry I love, and which allow me to work with brilliant and inspiring people from all around the world.

I also love that I work in a spaceship factory. It's the job I dreamt I would have when I was a five-year-old.

cause of making space more open, more accessible, and more inclusive.

What are you working on, now? Why does this matter to you?

As a rule, I split my time at Virgin Galactic between our human spaceflight program (with SpaceShipTwo) and our small satellite launch program (with LauncherOne). At the moment, most of my focus is on LauncherOne.

I've become a big believer in the importance of small satellites over the past few years, as I've gotten to work with many of the companies and projects out there that are developing smaller satellites (everything from ~300 kg down to 1U cubesats) that are taking on a wide variety of missions. We're already seeing data streaming back from small satellites that is generating real revenue and also helping us better understand and manage some of the most pressing challenges on the planet. I recently heard an analysis that proposed that small satellites could be used to monitor, measure, and enforce key aspects of fifteen of the seventeen Sustainable Development Goals recently adopted by the United Nations—that's just one metric of success, and only time will tell if those predictions are precisely correct, but I think they are quite believable.



Beyond that, what gets me going in the morning is the fact that (as of this writing) only 555 human beings have ever been to space. That's a far cry from the science fiction future I imagined as a child. For all the wonderful things space does for our world, I think we've only just begun to scratch the surface. I'm honoured to contribute whatever I can to the

In general, I like the fact that all of our projects at Virgin Galactic are about bringing down the price of what you might call the quantum unit of spaceflight. Other companies and space agencies are actively working on pushing our frontiers ever further—which is both exciting and important.

But I think it's just as important to develop space access that comes at a much lower price tag and that allows space to become a much more inclusive place, home to activities and nations and demographics that have always been priced out of spaceflight in the past.

How do you measure success personally?

Obviously, there are lots of different specific metrics – budgets and schedules met, customer satisfaction, and the standard set. But the ones that are most important to me are how well my team is doing, how much fun I'm having, and how my staff and my colleagues assess feel about the same two questions.

What are the most important changes happening in the Space industry from your perspective and how do you think they'll affect your present role?

I love the fact that the industry as a whole now has viable efforts at two different ends of the spectrum: the biggest and most ambitious on one side, and the most affordable and sustainable on the other side. Just as you wouldn't design a football (soccer) team to have 11 strikers nor to have 11 goalkeepers, I think the space industry was worse off when so much of it was focused almost entirely on admittedly cool but unsustainably expensive projects.



What was your most significant success?

- What was it?
- Why did it work?
- What did you learn from it?

On that I've been thinking of a good deal lately was a program I ran while I was at the XPRIZE Foundation called the Northrop Grumman Lunar Lander Challenge. This was a two million dollar technology incentive prize aimed at fostering a new generation of precision Vertical Takeoff Vertical

lander, working on a big contract for DARPA. Other teams have faded away, but actually many of them exist on in other forms – great individuals hired on at other space companies, teams that evolved into suppliers of tanks and other materials, and more.



Landing rocket systems. At the time we announced the prize, there had basically been three VTVL rocket projects in history - the Apollo LEM, the Delta Clipper, and an ISAS/JAXA project – and relatively little current activity.

With our little competition, we were able to incentivise the creation of more than ten new and distinct rocket designs that each made it off the ground – including four different rockets that claimed prize money. At least two of these matched the performance of the Delta Clipper, a well-managed program that cost taxpayers about \$100 million. The winning team is now doing great stuff – flying the GNC software for the Mars 2020

This competition taught me that when we attract bright people from other industries to come and try their hand at rocketry, great things are sometimes possible.

What was your most significant failure?

- What was it?
- Why didn't it work?
- What did you learn from it?

I've worked hard over the years to make sure that I have lots of little failures, rather than a small number of big failures. That's another lesson I learned from the Lunar Lander Challenge – if you are testing every idea often and in real life scenarios, you will encounter failure basically every day, but almost never have regrets.



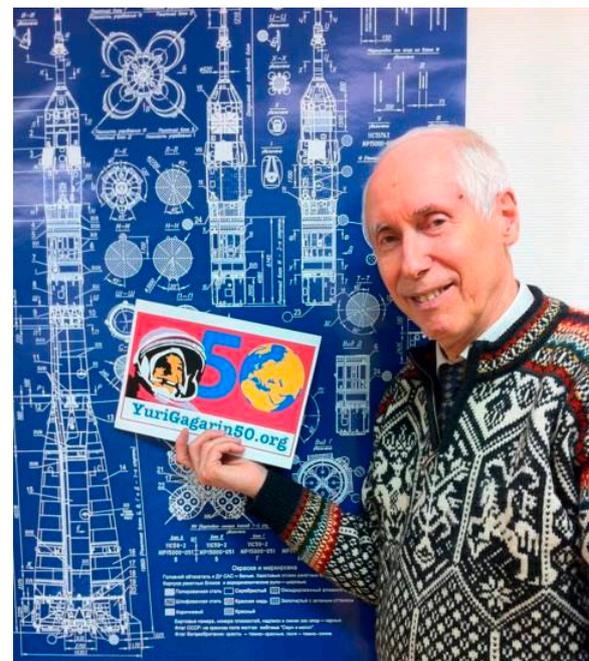
MSS CLASS OF 2016

by Anushree Soni, SSP 15 and MSS 16

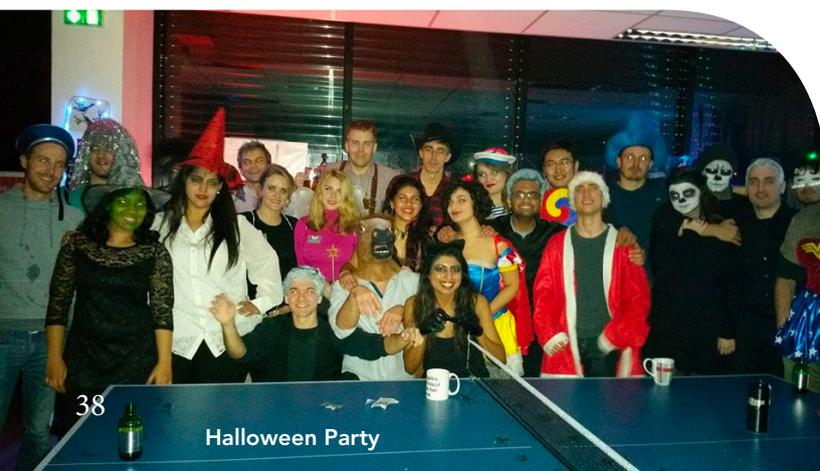
Intern, Office of the Chief Scientist
at NASA Ames Research Center

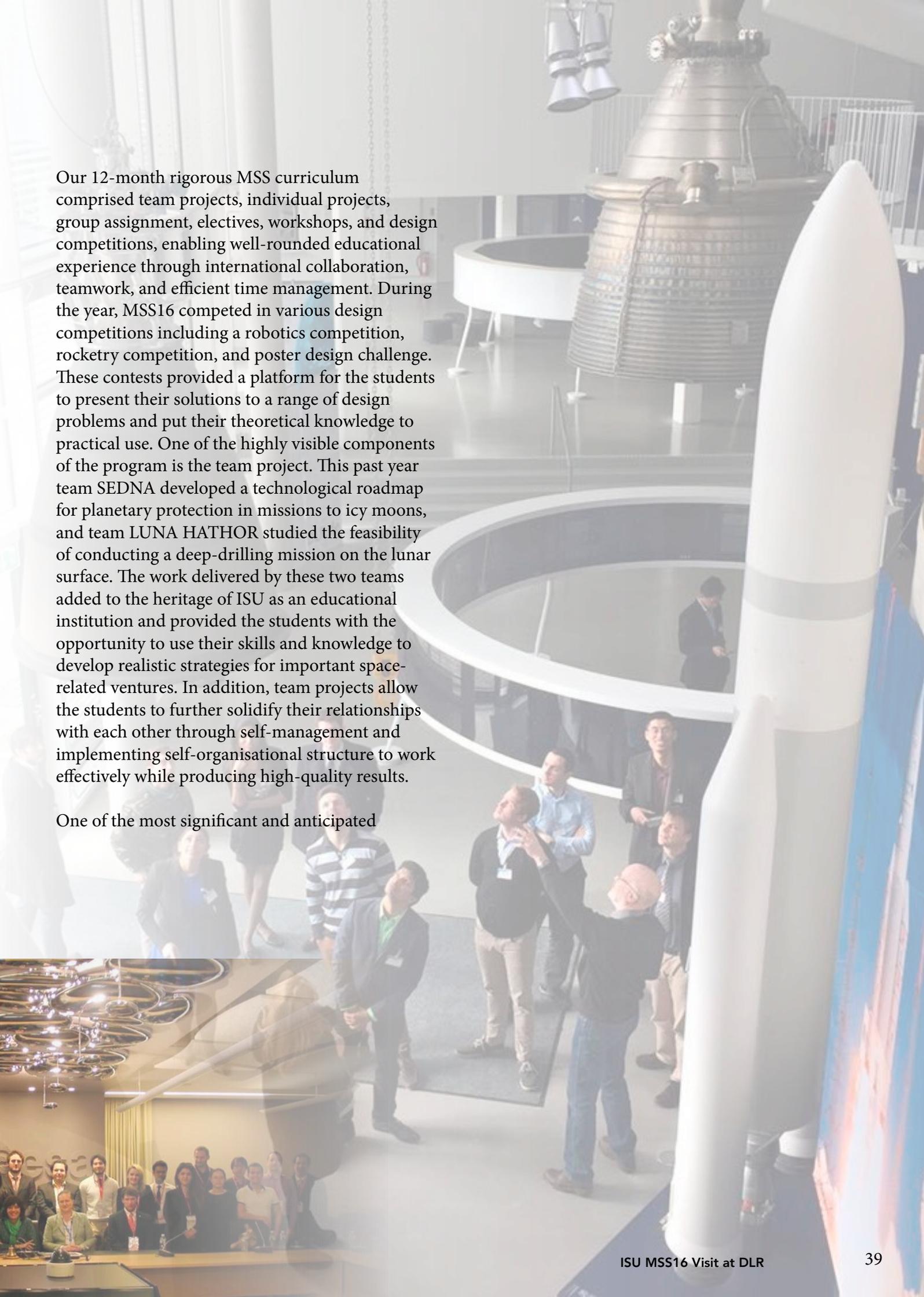
The MSS class of 2016 consisted of a diverse and talented group of individuals from different walks of life, with varying different levels of professional experience, aiming to enable advancement of humanity into space. Coming from 25 different countries we were engineers, physicists, chemists, artists, architects, educators, and people in a wide variety of jobs and businesses. It provided an innovative environment fostering an interactive global network and promoting international understanding and cooperation.

ISU headquarters in Strasbourg proved to be an excellent geographical location due to its proximity to various agencies, academic institutions, and companies, which provided a great opportunity for us to experience European culture and connect with a wide range of professionals in the space sector. The multi-faceted 3Is nature of the program provides an opportunity to learn and transfer skills amongst different disciplines, such as engineering, space sciences, human performance in space, law and policy, business and management, space applications, and humanities. This nature of education promotes international understanding and cooperation and further encourages the development of innovative ideas for the peaceful uses of outer space and also the use of space technology to improve life on Earth.



Dr. Nikolay Tolyarenko





Our 12-month rigorous MSS curriculum comprised team projects, individual projects, group assignment, electives, workshops, and design competitions, enabling well-rounded educational experience through international collaboration, teamwork, and efficient time management. During the year, MSS16 competed in various design competitions including a robotics competition, rocketry competition, and poster design challenge. These contests provided a platform for the students to present their solutions to a range of design problems and put their theoretical knowledge to practical use. One of the highly visible components of the program is the team project. This past year team SEDNA developed a technological roadmap for planetary protection in missions to icy moons, and team LUNA HATHOR studied the feasibility of conducting a deep-drilling mission on the lunar surface. The work delivered by these two teams added to the heritage of ISU as an educational institution and provided the students with the opportunity to use their skills and knowledge to develop realistic strategies for important space-related ventures. In addition, team projects allow the students to further solidify their relationships with each other through self-management and implementing self-organisational structure to work effectively while producing high-quality results.

One of the most significant and anticipated



On March 12th, 2016, ISU hosted a second Open Day event at the main Strasbourg campus. This event involved an overwhelming participation from all the MSS students, ISU alumni, and the staff. It was an opportunity for ISU to share the vision and aim of space school with the general public and encourage students in high school to pursue hard sciences in college and/or university. Open Day included various activities such as sun viewing using the telescope, Newton's apple demonstration, the tour of the Concurrent Design Facility, introduction to robotics, rocket launch, space medicine, 3D printing, impact

elements of the program are the professional visits to various commercial companies, space agencies, and academic institutions, which provided a unique educational opportunity leveraging learning experiences beyond the confines of classroom lectures. SES, Airbus, ESA Headquarters, ESOC, and IRS were some of the institutions that hosted professional visits for the class of MSS16. These visits provided students with a whole new outlook on the professional world and allowed one-to-one interactions with industry professionals, which helps establish important contacts and networks.

In today's world of growing competition and increasing international collaboration, there is a need bring people together in many ways that express their ideas, traditions, and values. Cultural nights at ISU do exactly that by providing an opportunity for students from each country to share their culture with their colleagues and ISU staff through cultural presentations, food, music, dance, and art. This year hosted a total of six Culture Nights representing more than 20 countries. These events created a platform for the participants of the program to learn about the values and ideas of different cultures and learn the skills needed to work efficiently and effectively in culturally diverse teams.



TP Luna Hathor Presentation Day

crater demonstration, and women in aerospace. This provided an opportunity to the MSS students to conduct effective outreach with the students and share their knowledge with the high school students. The general public also got the opportunity to interact with two former French astronauts, Dr. Claudie Haignere and Dr. Jean-Jacques Favier. Additionally, the presence of Mme Catherine Trautmann allowed ISU to showcase the importance of space education and potential ways ISU can contribute to the French society. This year also witnessed another milestone for the institution by supporting and inaugurating



Women In Aerospace Booth at the Open Day

the launch of Women in Aerospace-Europe-Strasbourg (WIA-E-SXB) chapter. The framework development of this chapter was a joint effort of myself, and ISU lecturers, Ms. Danijela Stupar and Ms. Zhuoyan Lu. WIA is an organisation dedicated to expanding women's opportunities for leadership and increasing their visibility in the aerospace sector. It acknowledges and promotes innovative individuals who strive to advance the aerospace industry as a whole. The WIA-E-SXB group will be dedicated to continuously increasing the awesomeness of women in the aerospace sector by providing seminars, professional training programs, and networking events for women in the

by his charisma and for some of us it certainly changed our outlook on life and provided the extra boost to kickstart our careers in the space sector.

The program concludes with three to six-month internships, providing an opportunity to enhance classroom learning by gaining real-world professional experience. ISU's connections and world recognition allow the international students to have the opportunity to apply to world-famous and competitive companies and organisations. Each year ISU's MSS class vies for coveted internships at various space agencies, academic institutes, and commercial space sector. This provided an opportunity for the MSS16 students to infiltrate nearly every key company and agency involved in space, including NASA, ESA, Centre National d'études Spatiales (CNES), Cité de L'Espace, European Space Operations Centre (ESOC), Tohoku University, Inmarsat, SES, Thumbsat, Organisation for Economic Cooperation and Development (OECD), NIGCOMSAT Ltd Abuja, and Comex.

Moving forward, most of us are embarking on our journeys to accomplish our respective career goals, with the common aim of helping humanity further advance in the field of space exploration and development. The benchmark of the university lies in the success of its graduates, and the graduates of MSS16 are accelerating their career growth with the hope of soon fostering great ventures!



aerospace sector around the Strasbourg region.

This past year witnessed the loss of one of longest supporters and enthusiast of ISU, Professor Nikolai Tolyarenko. He dedicated most of his late life towards developing a strong platform to educate the next generation of space enthusiasts and experts and was very well known for his specialisation in orbital mechanics and propulsion systems. His work and actions touched the lives of many ISU alumni. For a short period of just three months, various MSS16 students were mesmerised



THE ARCH FOUNDATION



by Nova Spivack, ISU '92

Entrepreneur, CEO, investor, futurist; Founder of the Arch Mission as well as many commercial ventures

Image credit: NASA

Hello ISU community!

It's been many years since I attended ISU'92 in Kitakyushu, Japan, where I had one of the greatest experiences of my life with our incredible faculty and students.

Since that time, I have been busy starting and building technology ventures, including several that have gone public or been acquired. You can learn more about what I've been up to since ISU, [here](#)

But more importantly, I have continued to pursue my interest in space, and am now starting a new initiative called the [Arch Mission Foundation](#), which I would like to invite all of you to help with. The goal of the Arch Mission is to preserve and disseminate humanity's most important knowledge across the far reaches of space and time.

[I first wrote about the concept](#) in 2015, and today I am happy to announce that in 2016, we officially incorporated The Arch Mission as a not-for-profit organisation.

Co-founders include [Nick Slavin](#) (venture capitalist and philanthropist), [Michael Paul](#) (Director of Space Systems Initiatives at Penn State and Team Leader for Penn State Lunar X Prize entry) and Robert Bishop (distinguished engineer, science advisor to Arthur C. Clarke).

VISION

We believe that the purpose of intelligent life is to spread intelligence and knowledge. Ancient civilisations preserved and transmitted their knowledge to the future using stone, a very long lasting medium. For example, the pyramids have remained for thousands of years.

But our civilisation's knowledge exists increasingly on perishable digital storage media that persist for only 50 to 100 years. What would happen to all this knowledge if there was a planetary catastrophe? In a short time, there would be almost no trace of our civilisation's knowledge left on Earth.

We must find better ways to protect and transmit our digital knowledge across vast distances in time and space. Not only is this an important backup for future generations in case of a planetary disaster, it is also a key enabler for our coming spacefaring civilisation as humanity spreads across our solar system and beyond.

The Arch Mission exists to help humanity fulfil its purpose in the universe – to protect, preserve and transmit our most important knowledge for future generations across the vast distances of space and time, wherever we may go.

TECHNOLOGY

The Arch Mission designs, builds, and delivers specialised archives housed in devices called Archs™ that are intended to survive in extreme environments for long periods of time. Archs are being developed with different form factors for space, as well for the surfaces of planets, moons and asteroids.

The first Archs will contain a complete digital copy of the Wikipedia, which is the most widely participatory encyclopedia in the world and whose accuracy has been significantly improving (<http://www.livescience.com/32950-how-accurate-is-wikipedia.html>) as well as additional materials as space and budget permits. These additional data sets may include textbooks and reference materials

for all academic fields, academic papers, artworks, musical works, literature, history, languages, schematics for various devices, and genome maps for species on Earth and even custom content archives from sponsors.

The Arch Foundation will deliver Archs to as many locations as possible, both on Earth and beyond. We aim for massive redundancy and diversity of locations – a strategy that nature itself has successfully employed - to improve the chances for Arch survival and discovery in the long-term future.



BENEFITS

A PLANETARY BACKUP

Archs serve as backups of important human knowledge, which could be useful in the remote but not impossible case that such a backup is ever needed. While we hope that this particular benefit of the Arch project is never necessary, it's wise to have an insurance policy just in case.

In fact, there have been tens of thousands of known civilisations that have risen and fallen in the history of our planet and on average none of them has lasted more than a few thousand years at most.

Extinction level events such as asteroid impacts, orbital shifts, solar flares, global vulcanism, ice ages and dramatic sea level increases, have happened many times in our geologic past and by some accounts the probability that another one will strike is increasing. Whether it is decades or thousands of years before the next one, eventually our fragile ecological niche will be threatened, and our only hope of survival is to spread beyond it.

But today as well as all the standard natural risk factors, humanity's own technologies are introducing new risks that didn't exist before: environmental destruction, genetic damage, nuclear war, electromagnetic pulse weapons,

damage from out of control biotechnology and nanotechnology, and many other self-made threats could collapse our civilisation, destroy our species, or knock us back hundreds or thousands of years in our development.

How can we preserve our vital knowledge in the case of a severe threat to our existence? Other than stone, most storage media decays rapidly with time. Our own present civilisation is increasingly reliant on digital storage media that lasts only around 50 to 100 years and are highly vulnerable to a variety of electromagnetic risks such as EMPs. Without a concerted effort to backup this knowledge in a form that can survive for millennia it is more likely than not that it will perish.

With all these risks, it would simply be unwise not to take steps to preserve our knowledge in a safe place, and in a form that can survive for the long-term, beyond the fragile ecological niche of Earth.

EDUCATION AND UNDERSTANDING

The Arch Mission will serve as an inspiring catalyst for space education and international collaboration and understanding. We plan to involve students and educators at all levels in helping to curate data sets, and to design and distribute Arch devices.

As well as design competitions and conferences, we also intend to provide grant funding and internships for students and researchers to help further the goals of the Arch Mission in the future, while inspiring future generations of students and researchers to help humanity become a spacefaring species and civilisation.

INNOVATION AND NEW TECHNOLOGIES

The Arch Foundation will catalyse the development of many new technologies as a by-product of developing Archs.

To disseminate Archs across the solar system and out into the cosmos we will need to develop many new technologies for long-term data and biological storage that can survive in the harsh environments of space and other worlds. We will also need to develop new delivery vehicles and new software and hardware to enable Archs to autonomously interact, teach, explore and learn.

FACILITATING A SPACEFARING CIVILISATION

In addition to the many benefits cited above, the Arch Mission will play an important role in facilitating humanity's transition to a spacefaring species and civilisation.

As we spread across our solar system and eventually beyond it, we need to bring our knowledge and biological record with us so it is accessible locally wherever we go. The Arch Mission will develop the technologies to make this possible.

In the near-term Archs can function as a deep space peer-to-peer network of store-and-forward data caches, making vast amounts of big data and knowledge accessible anywhere in our solar system. Knowledge could be uploaded to the nearest Arch and could then be replicated across the entire Arch network to other Arch nodes located around the solar system. This would make it possible to access the Arch network locally from any planet or location in our solar system, with out long delays.

As humanity sends out deep space probes and interstellar exploration missions, we will piggyback Archs along with them, spreading the Arch Mission and the Arch Network farther into space over time.

Perhaps one way to gauge humanity's maturity as a spacefaring species could be by measuring how far away from Earth our Archs have spread.

ROADMAP

We have been working in stealth for many years.

In 2015, early design concepts for the Mission were developed in partnership with science and engineering advisors.

In 2016 we formally incorporated the Arch Mission as a non-profit foundation, and to began planning to become more public about the Mission.

We also began to design our first generation

of production ready Arch devices, as well as a set of experiments to conduct. We also began conversations with a number of space agencies and commercial launch providers to secure delivery to Arch locations in space.

Currently we are actively working to grow the team, fundraise, and achieve our first major milestone of delivering an Arch containing a copy of the Wikipedia into Earth orbit in 2017. We will also install several Archs at Earth locations in 2017 and 2018.

We are working on initiatives to deliver Archs to the orbit and surface of the Moon in 2018 - 2019, and to the orbit and surface of Mars by 2025, as well as to other locations throughout our solar system by 2030.

GET INVOLVED!

If the vision of the Arch Mission appeals to you, we welcome your support and assistance.

We are still in the early days of the Arch Mission and there are many ways to get involved, from science and engineering, launch and payload delivery, mission operations. In addition, we soon will need help with outreach and fundraising, archive curation, legal, marketing, space agency relations and other are as of the project.

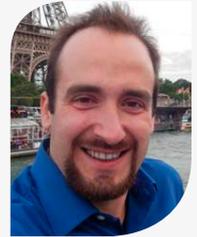
If you believe you can make a significant contribution, please contact us via the Arch Mission website www.archmission.com, and make sure to join our mailing list.

I can be reached directly at nova@novaspivack.com

The **Self-deployable** Habitat for **Extreme Environments** (**SHEE**)

by Joshua Nelson, SSP09

Project Engineer,
International Space University



All photo credits: The SHEE Consortium

There are many extreme environments both on and off the Earth where life may not exist unsupported for extended periods. Reasons for venturing into extreme environments range from altruistic exploration to disaster response and resource exploitation. Whatever the environment, it is essential that humans have a safe, habitable volume to retreat to for shelter, rest and recovery.

The Self Deployable Habitat for Extreme Environments was a three-year European Commission Framework Seven Project (EC FP7) to develop a deployable habitat demonstrating deployment technologies that may one day be used in extreme environments both on and off the Earth. From its inception, the applicability of the SHEE results to both space explorers and people

here on Earth has been one of the principle design drivers.

This project involved seven partners from five European countries including the Project Coordinator, ISU, Liquifier Systems Group in Austria (co-founded by an ISU alumnus, Barbara Imhof, MSS97), Compagnie Maritime d'Expertises (COMEX) from France, Space Application Services (SA) from Belgium, University of Tartu, Estonia, and two partners from the Czech Republic, Sobriety (SO) and Space Innovations (SI) (also founded by an ISU alumnus, Ondrej Doule, MSC08).

This was ISU's second FP7 funded project and the first for the school as Project Coordinator.



SHEE during its first field test in Minas De Rio Tinto, Spain. Of special note is the Gandolfi 2 spacesuit simulator mounted to the SHEE suit port



ISU faculty member Barnaby Osborne takes advantage of the clean environment in the SHEE workshop to assemble the test model of SMiLE, ISU's first ISS payload experiment

As completed, the SHEE prototype has a deployed volume of 50 m³ and a mass of 5.5 tons excluding consumables. In its deployed configuration, the SHEE measures approximately 5.9 x 6.5 x 2.8 meters. When packed for transportation the size is reduced to 5.9 x 2.4 x 2.8 metres, a reduction of over 4 metres in diameter. This packed configuration allows the SHEE prototype to be transported by normal flatbed lorries without having the inconvenience of being classified as an “oversized load”. In theory, the sizing of this design would allow for similar SHEE units to be transported aboard heavy lift launch vehicles to extra-terrestrial destinations.

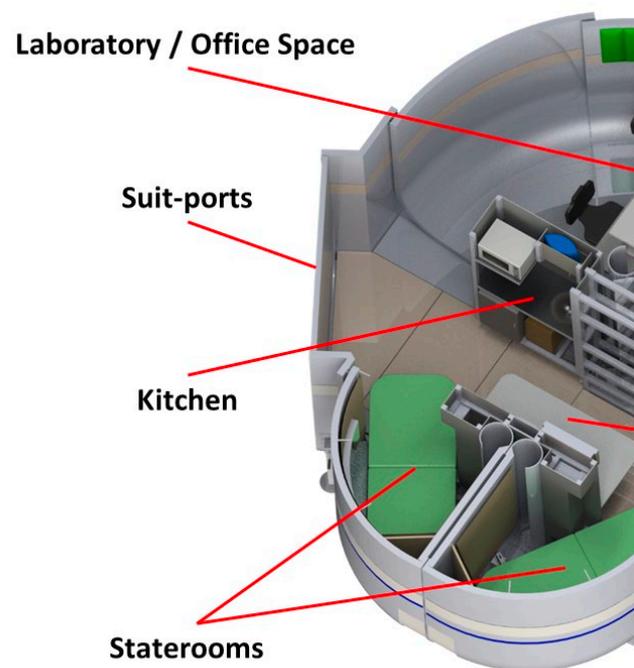
Each SHEE unit is designed to provide everything necessary to support two crew members for periods of at least two weeks at a time. Multiple SHEE units can be linked together to form a “SHEE village” that is scalable to support missions of any size. i.e. For a six person mission, one would dock three SHEE units together.

The SHEE prototype is divided into five distinct “zones” including two living quarters, a kitchen / meeting area, laboratory and hygiene facility. In a “SHEE village” each unit would have the two bedrooms, while the other sections would be configured for other purposes such as a greenhouse, infirmary, storage room, robotics facility, communications room and more...

Ingress and egress from the habitat is achieved using “suitports” designed to match the Gandolfi 2 Spacesuit Simulator designed and built by COMEX. This dramatically reduces the time it

takes to ingress and egress the habitat compared to traditional airlock systems while also reducing atmospheric losses during cycling and the amount of exterior contamination reaching the habitat interior.

Once completed in December of 2015 the SHEE prototype was offered to the European research community as a space analogue habitat for isolation studies and analogue research programs. The first program to take advantage of the unique capabilities of the SHEE was another FP7 funded project called “Moonwalk”. During this two-week campaign in the Minas de Rio Tinto, Spain, SHEE served as the main base of operation for analogue



Internal overview of the SHEE prototype as delivered

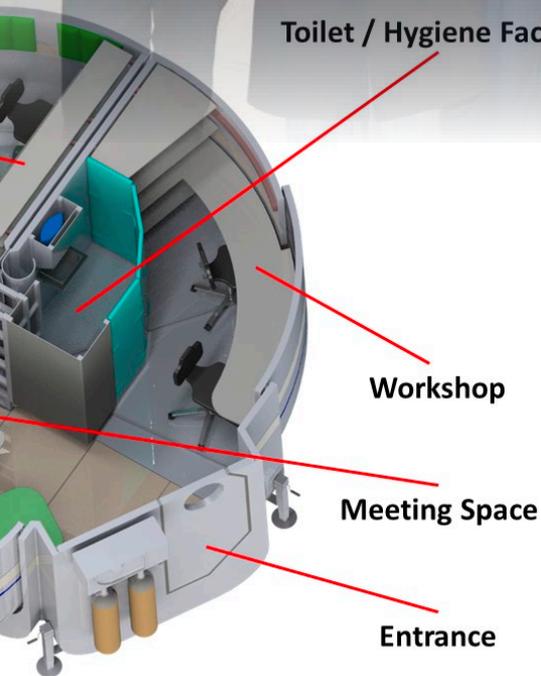
astronauts conducting research on robotic support for EVAs. SHEE received excellent reviews from the Moonwalk project, with many scientists and support staff choosing to operate out of the SHEE as it was more habitable than the shipping container brought with them as their bases of operation.

With the Moonwalk expedition successfully completed, the SHEE will next head to the European Astronaut Centre in Cologne where it will reside in the main training hall, supporting ESA's human exploration program.

Over the past 30 years, ISU has primarily made



Toilet / Hygiene Facility



Workshop

Meeting Space

Entrance

The SHEE Consortium and the European Commission Project Officer for the SHEE project, Christos Ampatzis pose in front of the completed SHEE prototype

a name for itself as an educational rather than a research institution. This reputation is rapidly changing with the SHEE being the second successfully completed FP7 funded project undertaken by the ISU. In the next few years ISU will be rapidly ramping up its research activities with several payloads flying to the International Space Station, and a number of other research projects.

Most ISU research projects (including SHEE) began their life as ideas proposed by ISU alumni and students.

Alumni interested in proposing a joint research project with the ISU should contact the ISU Research Program Director, Professor Jean-Jacques Favier (jean-jacques.favier@isunet.edu / +33 3 88 65 54 30) at the ISU Central Campus in Strasbourg.

Chair of the DLR Executive Board and ISU Vice Chancellor Pascale Ehrenfreund (centre) tours the SHEE with ISU faculty member Barnaby Osborne (left) and ISU President Walter Peeters (right)





by Joshua Nelson, SSP09
Project Engineer, ISU

ESC 2016 Seattle



For years the Executive Space Course (ESC) has been one of ISU's secret success stories. The ESC has been a regular ISU course offering since 2003.

The objective of this twenty participant course is to provide a one week in depth overview of the space industry for people working in a space or space-related organisation without a traditional space background. All of the three I's of ISU, International, Interdisciplinary and Intercultural remain the driving forces behind the shortest of ISU's course offerings.

Whilst successful, it can be difficult for people from outside of Europe to travel to France for a one week course. In order to make the ESC accessible to a wider range of people, the decision was made to take the ESC "on the road" to promising locations

outside of Europe.

Seattle, USA was chosen as the host site for the first ever non-Strasbourg ESC. This north-western American city is quickly establishing itself as a new hub for space companies from both "old space" and "new space" alike. This influx of space companies has also resulted in Seattle becoming one of the largest concentrations of ISU alumni in the USA.



ISU Masters program director Chris Welch teaching the ESC about the basics of orbital mechanics



ESC course participants and local organising committee members pose in front of the Space Shuttle Trainer at the Seattle Museum of Flight

These factors made Seattle the obvious choice for the first ever non European ESC.

ESC Seattle is an initiative of two alumni, Erika Wagner SSP01 and Ofer Lapid SSP08. It was held in partnership with the Seattle Museum of Flight from October 3rd – 7th this year. Fifteen participants attended the course with backgrounds from a wide range of disciplines such as legal,

investment management, manufacturing, IT, business operations and more. Organisations that encouraged their employees to take part include, Blue Origin, Vulcan Aerospace, Virgin Galactic, NASA Ames, Museum of Flight, OMNE Group, SAIC, Caelus Partners LLC, Esterline Engineered and the University of Nebraska.

The visiting lecturers represented an equally

impressive cross section of the space industry ranging from ISU mainstays such as Prof. Chris Welch, Dr. Dan Glover and Dr. Su Yin Tan to guest lectures and facility tours from Spaceflight Industries and Planetary Resources. Lectures included all seven ISU discipline areas including engineering, physical sciences, business & management, policy and law, satellite applications, human performance and humanities.

Reactions from the participants, lectures, staff and the ISU Board of Trustees have been incredibly positive, with 91% of the participants saying the course exceeded expectations! Hopefully we will be seeing many more ESCs both in Seattle and across the globe in the near future!



Group photo of the ESC Seattle participants with Phil Wagner after their tour of Spaceflight Industries



Participants and faculty of the ESC Seattle received a special tour of the Blue Origin factory in Seattle with ISU alumnus Erika Wagner

BOARD OF TRUSTEES

ALUMNI REPRESENTATIVE REPORT

by Julio Aprea, MSS 05

Alumni Representative on the ISU Board of Trustees
Launchers Development Programme Support
Officer, European Space Agency



The 55th ISU Board of Trustees (BoT) meeting took place on October 27th, 2016. The BoT meets twice a year, determines ISU's overall objectives and oversees the University's affairs.

Several meetings took place on committees on October 26th, these committees then report to and advise the board:

- Administration and Finance Committee
- Academic Advisory Committee
- Strategic Development and Fund-Raising Committee
- BoT Executive Committee

Many topics were addressed during all these meetings, some of which I highlight below:

PROGRAMS:

- SSP16 in Haifa was a really successful event. However, participants felt that 8 weeks were too short. Based on this feedback the Board decided to extend SSP17 in Cork back to a 9-week duration programme.
- Another very successful event was the Executive Space Course that took place in Seattle. New Space companies were well represented and participants were really satisfied. This event was an alumni initiative and it could not have been done without the efforts from Erika Wagner (SSP01) and Ofer Lapid (SSP08).
- The Board agreed to put together a working group for updating the ISU Code of Conduct and a zero tolerance policy when it is not followed.

EVENTS:

- ISU is organising a SpaceUp unconference on March 11th 2017.
- Next year, on April 12th, ISU will turn 30! I will be reporting back as soon as I know more about celebration arrangements.

HOW CAN ALUMNI HELP ISU?:

- Two years ago, a scholarship payback scheme was implemented: once graduated, alumni would repay 50% of the funding received back to ISU. This is a great opportunity to give back and give the opportunity to others to attend ISU. This is it not retroactive, however, I would like to hear from alumni and see if there is interest to voluntarily join this scheme, please contact me with your thoughts.
- ISU is now registered as one of the entities in Amazon Smile*. This means that at no cost to us, when we buy at <https://smile.amazon.com/>, we can give ISU a percentage of our expenditure, this is really easy to do

and it can really help our university, I encourage Amazon customers to do it.

- There are other ways to help ISU, all options are listed at <http://isunet.edu/portfolio/make-a-gift>

HOW TO CONTACT ME:

- For general news, I post on the Facebook public group <https://www.facebook.com/groups/International.Space.University/>
- For issues to be discussed that concern only alumni, I created a dedicated Facebook group were to gather alumni globally. Please join at <https://www.facebook.com/groups/ISUAlumni/>

Julio Aprea
ISU Alumni Representative

* Please, note that this is only applicable when using the “US Amazon”.

Members of ISU's Board of Trustees



SILICON VALLEY ALUMNI CHAPTER GATHERING

by Arif Goktug Karacalioglu, SSP10 & MSS14

**Alumni Contact Point for Silicon Valley
Participant Liaison for SSP13 and SSP16.**

**Researcher at NASA Ames Research Center and a member of the editorial teams of
IAASS Space Safety Magazine and Space Frontier Foundation's NewSpace News**



ISU Silicon Valley Alumni Chapter (SVAC) gathered together at Silicon Valley's famous Rainbow Mansion on the 30th September, to hear the stories of SSP16 from Gökтуğ Karacalioglu, who was the Participant Liaison during the summer.

Interestingly all of the attendees of the event were from the Master classes of ISU ranging from MSS07 to MSS14.

The group also discussed their possible contributions for the upcoming SSPs to be held in Ireland and the Netherlands.



ISU '91 25TH ANNIVERSARY REUNION

by Steve Elsner, ISU '91

Steve spent 33 years at NASA working on the space shuttle, international space station and commercial crew programs before transitioning to other pursuits in 2015



With contributions from fellow ISU'91 classmates; Audrey Robinson-Seurig, Rolf Pollmeier and Roland Seurig

It was 1991 and much was going on in the world. In April, a cease-fire ended the Persian Gulf War. The South African Parliament repealed apartheid laws, which was followed by the ending of European sanctions on that country. China accepted the nuclear non-proliferation treaty. France signed the 1968 treaty banning the spread of atomic weapons (better late than never!). Presidents Bush and Gorbachev negotiated reductions in strategic arms. Communist governments and their influences were waning. By the end of 1991, the USSR was dissolved after 69 years. National identities, boundaries and priorities were changing before our very eyes! Imagine leaving home only to return to a new nation!

This incredible turn of events led many to look outward again with renewed hope. For some of us, we believed "Space is Our Future" and dreamed of pioneering that frontier! This focus on space was guiding our education and careers. We were convinced that cooperation in space held promise to improve life on Earth. The Space Shuttle program was flying regularly again after recovering from the Challenger tragedy. Plans for building a space station that would be international were underway. Men and women were pioneering long



duration space flight on Mir. The Hubble Space Telescope was in its first year of circling the Earth. Despite temporarily blurred vision, it carried with it astronomers' dreams of galactic discovery.

As our world was changing, a select group of men and women each took their own "small step" by attending the fourth International Space University Summer Session Program in mid-1991. Originally planned for Moscow, the session was relocated to Toulouse, France. The setting and program content reinforced the importance of the ISU mission – to create an identity as citizens of the Earth, by working together on projects that are international, interdisciplinary and intercultural.

ISU'91 was hosted jointly at l'Ecole Nationale de l'Aviation Civile (ENAC) and Formation Internationale Aeronautique et Spatial (FIAS). The 10 weeks of intense study, project design and of course lots of "social studies" was conducted from June 25 to August 30. 137 students attended from 26 countries.

At ISU '91 we looked beyond Earth to another world that has fascinated humans for centuries. We heard the call "Get your ass to Mars" and responded! All of us contributed to the one class project of designing an International Mars Mission. This was a daunting task to accomplish in a short Summer Session Program. We had help from expert faculty, including Wendell Mendell. In the end we produced a study that many of us believe made significant contributions toward one day putting humans on the Red Planet. According to Wendell, the breadth of the IMM study exceeded that of most Mars mission studies of the past, encompassing attributes such as:

- Political organisation for long-term commitment
- Multinational management structure and Cost analysis
- Mission architecture and vehicle configuration
- Crew health and life support
- Mars surface infrastructure including Martian resource utilisation and technology evaluations and risk assessments
- Mission operations and science and exploration planning
- Communication networks

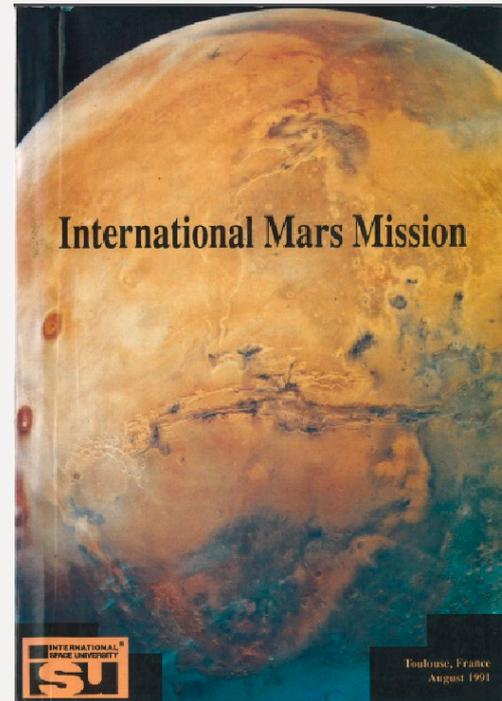
The IMM Final Report had particular value for those seeking insight into the choices made by a

multinational group working in an apolitical environment on the problems of international cooperation in space.

For diversion from the busy on-campus schedule, we explored many attractions in the region. This included relaxing on the French plage (beach), challenging the bulls in Pamplona, and enjoying a wild "spring break" in Rosas, Spain.

Our Summer Session Program had cultural nights (parties) typical of ISU in those days. All these experiences gave us

Classmates relieving stress during "spring break"



Cover of the 1991 Class Project Report





All of us except for Michel at Munich's Olympic Park

improved vision with which to see the world. This was our “giant leap” to becoming inspired citizens of the ISU community. Furthermore, lasting friendships were forged in the crucible of that hot summer in Toulouse.

It has been 25 years since ISU 1991. Rolf Pollmeier promoted the idea of having a reunion to renew friendships, to be held July 8-10, 2016, in Munich, Germany. Twelve of us traveled from around the globe to travel back in time, reminiscing about our lives during our 10 weeks together. Classmates and guests attending included: Michel Berthus (Belgium), Odd Bolin (Sweden), Steve Elsner and fiancée (USA), Tania Grasseschi and husband (Australia), Jus Kocijan and wife (Yugoslavia/Slovenia), Chie Nakatani (Japan), Ken Oyamada (Japan), Rolf Pollmeier (Germany), Vijay Rangarajan (UK), Willi Stoffel (Germany), Ramon Torres (Spain), and one of the ISU '91 couples

Audrey Robinson-Seurig (USA) and Roland Seurig (Germany). Note that country of citizenship during ISU'91 is listed in parentheses.

Many thanks to Rolf and Audrey who planned reunion events that included tours of the city, Olympic Park, Neuschwanstein Castle, and Bavarian Biergartens. These events showcased the history, scenic beauty and culture of southern Germany.

Our time together in Munich was quite rich, because we had much more to talk about than just ISU. As Willi so aptly summed up our conversations, “It wasn't always about sentimental memories of what we experienced in Toulouse, but also about how our lives developed after 1991. The most striking thing was, although we are all 25 years older (some of us put on some weight, some got less and/or grey hair), it was refreshing to

have the same heated discussions about all kind of things [particularly Brexit and US politics]! And, although we didn't agree on every point, we shared friendship and respect, both things we shared in Toulouse."

We found it fascinating how our lives have unfolded since ISU. Some of us have spent our careers in space-related businesses. For many, though, the road after that experience in Toulouse vectored off in surprising directions. Among our reunion group are a career diplomat, a CFO, a healthcare professional, business owners, and a lawyer. Throughout our careers, whether or not space-related, we still share enthusiasm over the role of space in our future. All of us agreed not to wait another 25 years to stoke that enthusiasm!



Lunch before touring Neuschwanstein Castle

Pictures of the 1991 summer session and of our 2016 reunion are available at:

<https://goo.gl/photos/CZLmkeo44g7fwVth6>

Steve, Jus and Willi at breakfast the first morning



ISU at IAC 2016, Guadalajara



Geraldine Moser, ESC 2008, ISU Head of Business Development Unit and Nassim Bovet, MSS2001, ISU Head of Admissions & Alumni Affairs - reporting from Guadalajara

The International Astronautical Congress 2016 in Guadalajara, Mexico was – as usual – a very successful event for ISU. Several hundred people came by our booth to enquire about ISU, with many directly pre-registering for ISU programmes. More than 100 ISU Alumni were present at the conference, joined at the ISU/SGAC/Young Professionals reception by Dr. P. Ehrenfreund, Chairman of the DLR Executive Board & ISU Vice-Chancellor, and Dr. C. Sallaberger (SSP88), Chairman of the ISU Board of Trustees.

Furthermore, ISU alumni made a clean sweep of the IAC16 IAF awards: SH-SSP16 Alumna Melissa Merino received the prestigious IAF Luigi G Napolitano Young Researcher & Hermann Oberth student awards. Her charismatic speech and thanks to ISU generated a loud round of applause and



cheering by the 3000 delegates! Dr Li Ming (SSP91) from CAST accepted the IAF Hall of Fame award on behalf of Dr. Wang Xiji. Victoria Alonsoperez (SSP11) and Jessica Culler (MSS06) collected the 2016 Young Leaders Recognitions. And 5 out of the 14 Emerging Space Leaders grants were awarded to ISU alumni: Yuval Brodsky (MSM10), Ishraj Inderjeet (SH-SSP16), Marta Rocha de Oliveira (SSP15 & MSS16), Michaela Musilova (SSP15) and Lisa Stojanovski (SH-SSP16).

Recently graduated ISU alumni value the opportunity to put skills and intercultural learning gained during the academic year, into practice. MSS16 alumna Paul Ilife said: "Attending a conference like IAC is a really good thing to meet people in the industry, present myself, network, learn new things and see what is going on. It is really recommended for anyone who is interested in space to try the ISU and try the IAC!"

See you next year at IAC17 from 25 to 29 September 2017 in Adelaide, Australia.



MANX PRECISION OPTICS 2016

by Dr Helmut Kessler, ISU Executive MBA 2010

Managing Director, Manx Precision Optics Ltd
Member of ISU Board of Trustees



Stan Kaethler from Canada has won the Manx Precision Optics Prize at the International Space University (ISU) in Strasbourg, France. The prize is awarded to the Master of Space Studies (MSS) student who receives the top mark for his or her Individual Project as part of the course.

Stan's Project was "Developing a DEM production and analysis pipeline for Mars HiRISE imagery". Dr Helmut Kessler, Manx Precision Optics' managing director commented: "Stan has delivered an Individual Project of the highest calibre and all of us at MPO congratulate him on his achievement. We wish him all the best for his future career.

The award ceremony took place on the 8th September in ISU's Space Pioneers' Hall on the ISU Campus in Strasbourg, France.

Manx Precision Optics Ltd., an Isle of Man based and owned precision optics manufacturer, is a corporate member of ISU's Board of Trustees and has strong links to the space sector.



Stan Kaethler (on the left) and Prof. Hugh Hill of ISU at the awards ceremony

UPCOMING ALUMNI EVENTS

If you have any alumni events planned from November onwards, why not drop us a paragraph about it so we can include it here in the Spring issue, due out at the end of January?

LONDON ALUMNI GATHERING LAGA 3 DEC

by Graham Weaver, ISU '90
(Dinosaur)



Well, the Christmas holidays are nearly upon us so I'm planning for the Winter London Alumni Gathering (LAGA). This will be held on the 3rd December.

Due to limited availability at other venues in the run-up to Christmas, I've decided to stick with the 'classic' format - starting in the Rising Sun pub on Tottenham Court Road (W1T 2ED) from 4pm, then a meal at Pizza Express on Charlotte Street (W1T 1RG) starting at 6.00pm. The nearest Underground stations are Tottenham Court Road and Goodge Street.

As always, the event is open to all alumni, wherever you're living and no matter your nationality - this is **NOT** a "Brits only" event.

We already have over 20 alumni signed up but we have room for more... so if you fancy coming along, please let me know ASAP via email graham.weaver@btinternet.com, or sign up on Facebook at: <https://www.facebook.com/groups/ISU.UK.Alumni>

You don't have to attend both parts of the event - you can just come for a while at the pub or just the meal - it's up to you... Just let me know which!

I hope to see many of you there!

PARIS ALUMNI GATHERING PAGA 25 FEB 2017

by Nicolas Chuecos, SSP 14
SETI - Ingeniere Conseil



ISU*France Alumni Association is very pleased to announce that the next PAGA (Paris Alumni Gathering) will be organized on February 25th, 2017.

The dinner will start at 19.30 and will take place at the Le Plomb du Cantal restaurant, 4 Boulevard Saint Denis, 75010 Paris. <http://www.leplombducantal.com>

The closest metro station is Strasbourg Saint Denis, close to Gare du Nord where Thalys arrives and which links to CDG airport via RER B.

Do not hesitate to contact us if you have allergies or follow a specific regime.

RSVP before February 14th via email nchuecos@gmail.com or via the Facebook event on the ISU*France Facebook page, <https://www.facebook.com/groups/ISU.France>

Cheers!

There are three main ways to keep in touch with the alumni community:

- *A network of Alumni Regional Contacts*
- *Regional Facebook Groups*
- *Connect2ISU*

Alumni Regional Contact Network & Facebook Groups

Region	Alumni Contact			Facebook Group
Africa	Olufemi Arosanyin	SSP2002/ MSC2004	olufemi.arosanyin@ericsson.com	https://www.facebook.com/groups/41160815723/?fref=ts
Arabian Gulf States	Dr. Saeed Al-Dhaheeri	ISU'88	ddsaeed@gmail.com	
Australasia	George Dyke	SSP2002	george@georgedyke.com	https://www.facebook.com/groups/ozisualumni/?fref=ts
Austrian Space Forum (OeWF)	Dr. Gernot Groemer	SSP1997	gernot.groemer@oewf.org	
Bulgaria	Tihomir Dimitrov	SSP2015	tihomirdimitrov@yahoo.com	https://www.facebook.com/groups/space.adventures/
Canada	Amir Komeily	SSP2007	amir.komeily@comdev.ca	https://www.facebook.com/groups/caisu/?fref=ts
China	Zhe Hu (胡哲)	SSP2005/ MSC2006	hupxy@126.com	
France	Nicolas Chuecos	SSP2014	nchuecos@gmail.com	https://www.facebook.com/groups/ISU.France/
Germany	Ryan Laird	SSP2013	ryan.laird@community.isunet.edu	https://www.facebook.com/groups/214940778529000/?fref=ts
Greece	Dr. Adrianos Golemis	MSC2013	adriangolemis@outlook.com	https://www.facebook.com/groups/561814420533121/?fref=ts
Isle of Man	Simon Clucas	SSP2002	snclucas@gmail.com	
Israel	Daniel Rockberger	MSC2006	danielrockberger@yahoo.co.uk	https://www.facebook.com/groups/ISU.Israel/?fref=ts
Italy	Dr. Maria Antonietta Perino	ISU'88	mariaantonieta.perino@thalesalieniaspace.com	
Japan	Maruyama Kenta	SSP2007	maruyama.kenta@jaxa.jp	https://www.facebook.com/groups/
Latin America	Eric Villard	MSS2002	er.villard@gmail.com	https://www.facebook.com/groups/ISULatinAmerica/?fref=ts
Netherlands	Dr. Juan de Dalmau	SSP1989	Juan.de.Dalmau@esa.int	https://www.facebook.com/groups/139968992705753/?fref=ts
Poland	Dr. Damian Maria Bielicki	SSP2009	dmbielicki@gmail.com	https://www.facebook.com/groups/ISU.Poland/
Romania	Florin-Cristian Lazar	MSS2015	FlorinCristian.Lazar@community.isunet.edu	
Russia	Tigran Shahverdyan	SSP2012	tigran.shahverdyan@gmail.com	https://www.facebook.com/groups/383259485072653/?fref=ts
Scandinavia	Katarina Eriksson	MSC2010	katarina.eriksson@community.isunet.edu	https://www.facebook.com/groups/ISU.Nordic.Alumni/?fref=ts
Spain	Xavier Alabart	MSC2007	xavier.alabart@aetherconsulting.net	
Turkey	Dr. Ozgur Gurtuna	MSS1999	gurtuna@turquoisetech.com	
United Kingdom	Graham Weaver	ISU'90	graham.weaver@btinternet.com	https://www.facebook.com/groups/ISU.UK.Alumni/?fref=ts
United States	Joshua Nelson	SSP2009	joshua.nelson@isunet.edu	https://www.facebook.com/groups/6473216389/?fref=ts
USA, Silicon Valley	Arif Göktuğ Karacalıoğlu	SSP2010	gkaracalioglu@gmail.com	
USA, Washington DC	Angela Peura	SSP2007	angela.peura@gmail.com	

Connect2ISU

Since the demise of the ISUTalk and ISUNews email lists, Connect2ISU is ISU's main way to keep in touch with its alumni.

All alumni are given a profile on Connect2ISU but it relies on alumni taking the time to keep their contact information up to date. This is now easier than it was with more immediate IT support through a HelpDesk contact.

So do please consider updating your contact information and I suggest joining the ISUNews Group so that you can be easily really reached, not just by ISU but also by your classmates and yes, us at the magazine.

Just go to: <https://connect.isunet.edu/> or via Facebook at <http://apps.facebook.com/isuspacecommunity/>

On the Login page you'll find links to get your Username & Password or to email IT support.

What does Connect2ISU offer?

From the ISU website:

- An Alumni Directory with an easy search of ISU alumni
- Updates of your profile anytime you need
- Privacy options: you will be able to decide who you wish to share your information with
- Creation of single and/or group profiles
- A place to share your videos, photos and projects
- Event management: you wish to share a space or ISU related event, Connect2ISU will allow you to advertise an event.

You will either be able to extend the invitation to the ISU global community or to restricted group(s) of your choice.

- Discussion forums: this new service will replace the ISUTalk and ISUNews services by giving you the opportunity to continue sharing news and experiences on Connect2ISU. Join the group ISU News!

Community Email

More recently ISU has begun allocating an ISU community email address to each programme participant, in the format firstname.lastname@community.isunet.edu". These can be retained after graduation and, I understand, they can also be made available to alumni of earlier years upon request – although I've seen no clear information from ISU on this. One advantage of this is that as personal emails change over time, this can remain unchanged...

Writing for

*SPACE TALK : THE **NEXT** GENERATION*

Subject Matter

Articles can be on any subject you'd like to write about - but should, in general, be related to Space, ISU or your current work (whether Space related or not).

Of particular interest would be articles on recent alumni reunions/events or planned events.

Article Requirements

- Article size is not fixed – various sizes can be accommodated depending on the subject matter. Potential authors are recommended to discuss this with the Managing Editor at editor@spacetalk-tng.news
- Text should be submitted as an MS Word document and use UK English
- Articles should be accompanied by the author's bio photo, their ISU course & year and a one sentence bio text
- Authors are strongly encouraged to submit photos with their articles wherever appropriate as this can greatly enhance the overall look
- Photos should be in **JPG** or **PNG** format (if you use transparency) and be as high a resolution as possible but file size should no exceed 10MB
- Every photo should be accompanied by a short caption text

The deadline for the next issue is **January 10th**

CONTACT US

For all questions, comments and article submission,
you can contact us at:
editor@spacetalk-tng.news

If you prefer us to email the magazine directly to you
then you can also send your email to us at the above
address.