INTERNATIONAL® SPACE UNIVERSITY

Space Studies Program

Strasbourg - France 24 June - 23 August 2019

SSP19 RETROSPECTIVE

#SSP19 #SpaceOptimist

Grand Est ALSACE CHAMPAGNE-ARDENNE LORRAINE

Université de Strasbourg

Strasbourg.eu eurométropole

STRASBOURG EUROPTIMIST

Carlosivorra

DIRECTOR'S RETROSPECTIVE

The 32nd Space Studies Program (SSP19) has returned to Strasbourg and the International Space University's Central Campus for the 6th time. The 37 nationalities were represented by 127 participants making this the 6th largest SSP since commencing. Coming 'home' to Strasbourg means that there were many international participants staff and alumni at the Central Campus over the summer, reaffirming the ISU as a place of multi-cultural exchange. This program had the highest number of participants and the highest number of local participants of any of the six SSP's held in Strasbourg. Something the ISU should be particularly proud of is the 40% female participation rate of SSP19, especially considering the aerospace sector typically has a 25% female workforce.

The SSP has evolved and changed since my first experience in SSP16 as the incoming Director, preparing to be the Director for SSP17 and the Southern Hemisphere-SSP. Since then, my team and I have continued to develop and modify the SSP. We have concentrated on rejuvenating the program, highlighted innovation, encouraged entrepreneurship, and brought a lot of new technological hot topics into the program. We have also increased the number of workshops the program offers whilst bringing in more individual lecturers to run workshops and participate in the delivery on content, many of whom do so at their own expense.

We were privileged to have welcomed some very high-profile individuals including Apollo Astronaut & former ISU Chancellor, Buzz Aldrin, who not only patiently posed for pictures and handshakes but talked with a TP on advanced propulsion systems and joined European Astronauts Paolo Nespoli and Jean-Francois Clervoy on our Astronaut Panel.

Other significant visitors included Pascale Ehrenfreund, the first female CEO of the German Aerospace Center (DLR) and current ISU Chancellor. Director General Johann-Dietrich Woerner, from the European Space Agency discussed the policy structures and economic principles of his agency as well as the technicalities of Mars missions. There was even a presentation from an elite magician, Till Haunschild, who integrates space, entrepreneurship and motivation together.

As I have worked at NASA over the last 20 years, I have seen the space sector change and evolve. The global space industry is worth nearly 400 billion dollars and is beginning to integrate into every industry and every corner of the globe. It is increasingly collaborative with more and more pioneering individuals investing time, energy and money to create space technology that shapes our world. The participants of SSP19 are the next generation of space leaders and so we tailor the program to meet their future needs, emphasizing cross industry innovation and entrepreneurship.

As part of the program, groups of participants visited some interesting facilities including the European Astronaut Centre in Germany, and CERN in Switzerland. Some global space companies like SES and ispace in Luxembourg and OHB in Munich. Some notable activities were a field trip to Reis Crater in Germany and a geocaching exercise in Colmar, south-west of Strasbourg.

All of this would not have been possible without the help of the Local Organizing Committee and the Eurometropolis of Strasbourg who have helped us gain access to the European Parliament, the headquarters of the Eurometropolis and the Town Hall whilst generously hosting receptions.

The program is designed to empower participants to take full advantage of the resources available to them and develop their own experience. As the program goes along, the participants inevitably grow closer and more reliant on each other. This process culminates with the Team Projects and presentations which each year show the diversity in knowledge, curiosity and innovative thinking amongst the participants. It is always a pleasure after the program to receive a call from a former participant to discuss their life and career. It proves to me that when you invest in people you get back more than just a product or a profit, you become part of a community.

Participants have been on an intense journey together, getting to know each other, learning from each other and growing with each other. They have connected through shared academic achievements, social gatherings and cultural experiences, creating lifelong memories and friendships. I wish you all the luck on your future endeavors, and look forward to connecting again in the future!

Dr. Omar Hatmaleh
Director, ISU Space Studies Program

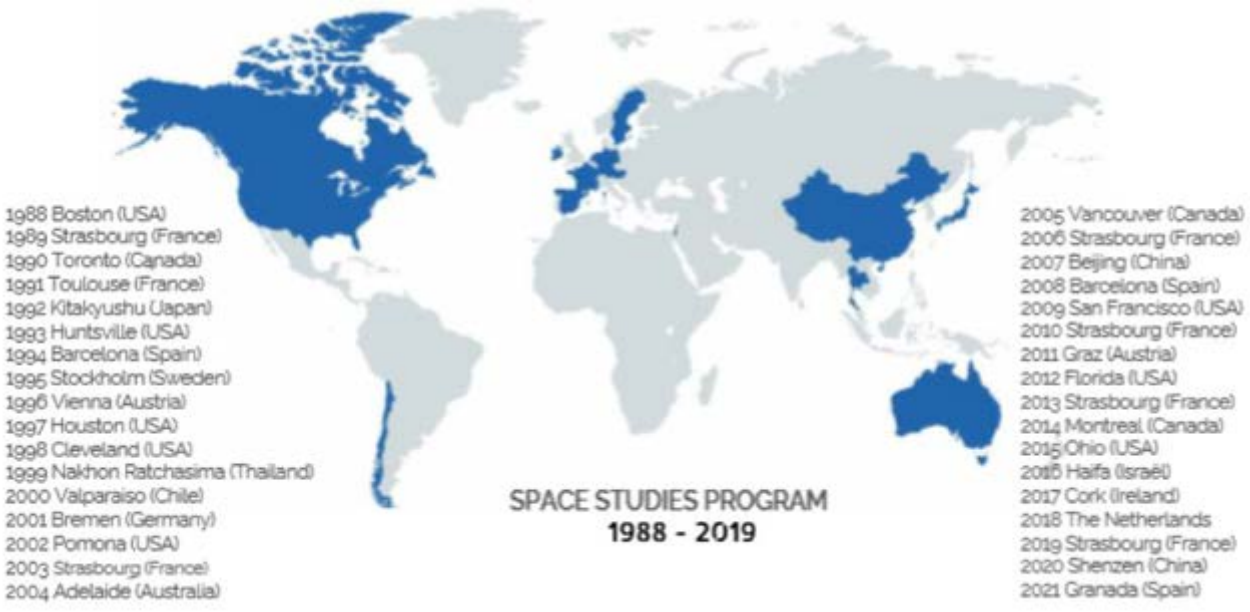
INTERNATIONAL SPACE UNIVERSITY

The International Space University was founded in 1987 by Peter H. Diamandis, Todd B. Hawley and Robert D. Richards with the vision to study, explore and develop space for the benefit of humanity. ISU provides a distinctive brand of space education that space agencies, the private sector and research institutions around the world look after. True to its founding principles, ISU's education focus on the three "I"s — International, Interdisciplinary, and Intercultural. Over the past 31 years, ISU has graduated more than 4,800 students from over 100 countries.

SPACE STUDIES PROGRAM (SSP)

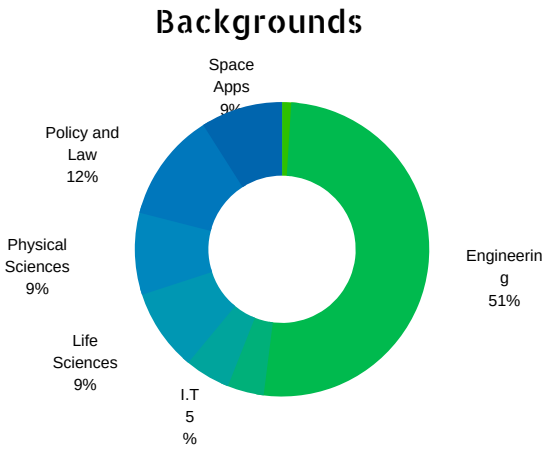
ISU provides several programs for distinct demographics, ranging from short-term executive programs to a one- to two-year Master's program. However, the Space Studies Program (SSP) is the university's longstanding, pioneering program. It is a graduate-level professional development program conducted since 1988. The curriculum includes both technical and non technical space-related fields: physical sciences, engineering, policy, law, business, management, humanities, life sciences, and space applications. The year 2019 marks the 50th Anniversary of Apollo 11's landing on the Moon, and the International Space University was proud to bring its Space Studies Program, 30 years later, back to Strasbourg, France. The program was conducted in ISU's Central Campus in collaboration with the Eurometropolis of Strasbourg, Grand Est Region and the University of Strasbourg.

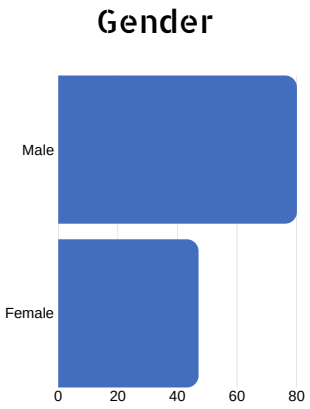
COUNTRIES WHERE THE SPACE STUDIES PROGRAM HAS TAKEN PLACE

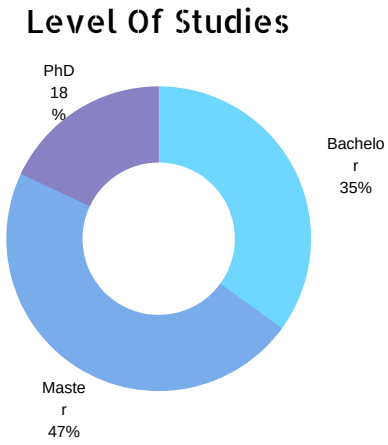


PARTICIPANTS

The class of SSP19 was composed of 127 participants representing 37 nationalities from 6 different geographical forms. The gender ratio was 40% Female and 60% Male. 47% of the participants had a Master degree, 35% a Bachelor's degree and 18% a PhD or equivalent.







FACULTY AND STAFF

SSP19 invited close to 200 experts and professionals from around the world to share their knowledge with the participants. This year's distinguished lecturers have included Dr. Mohammed Nasser Al Ahbabi, Director General of the Emirates Space Agency; former member of the NASA Advisory Council, John Logsdon; author Ramon Vullings; NASA's Mars Study Capability team Lead, John Connolly; entrepreneur Storm Boswick; Assistant professor of the Institute of Space and Astronautical Science of JAXA Ryudo Tsukizaki; Breakthrough Prize Foundation's Pete Worden; and Prof. Mikhail Marov, former chief scientist for Soviet Venera spacecraft studies of Venus, ESA's Director General Jan Woerner, DLR's Chair of the Board Pascale Ehrenfreund, NASA's Chief Scientist Jim Green and astronauts Buzz Aldrin, Jean-François Clervoy, Paolo Nespoli and Reinhold Ewald.

The SSP19 staff was composed of individuals from around the world, some of them were part of ISU, and others participated in previous programs or had an interest in space-related fields. The organization, logistics and academic tasks were carried with the expected quality thanks to the professional and responsible work of the staff, ensuring the success of the program once again.

The SSP19 staff has been amazing. Throughout the 9 weeks of the program, they have been extremely supportive and of a great company. SSP19 would have definitely not been the same without them! - Antonino Salmeri - SSP19 Participant

WHAT ARE THE BENEFITS OF DOING AN SSP?

INTERNATIONAL EXPOSURE;
SSP offers participants the opportunity to meet with the space industry's top experts, leading scientists and administrators from space agencies, private companies, nonprofit organizations and research institutions from around the globe.

INTERNATIONAL INTERDISCIPLINARY TEAMS:
SSP groups and teams combine participants from all national, professional, and educational backgrounds to develop the skills required to work in global teams. Bringing together these diverse perspectives creates a rich environment in which peers can learn from one another to accomplish common goals.

KNOWLEDGE IN ALL FIELDS OF THE SPACE SECTOR;
For nine weeks, participants are exposed to all major fields in the space sector, including engineering, sciences, applications, policy, economics, law, management, business, arts, and human performance in space.

CULTURAL EXCHANGE:
Living and working with fellow participants from around the globe provides everyone an appreciation of different cultures, which is critical in today's industry - dependent on international cooperation.

NETWORKING FOR LIFE:
The SSP experience doesn't stop after SSP ends. Years, decades after their SSP, participants acquire a wealth of opportunity through a network of alumni scattered all across the globe. This gives the SSP participants better opportunities within the space sector.

The SSP program offers what space should be about, 'the peaceful exploration for all humankind'. As Carl Sagan once said 'Drawn by a craving we can hardly articulate or understand'. The students of the SSP continue to follow their craving to explore, learn and above all work together in creating dynamic, strategic and revolutionary visions for the space sector. These are the future leaders of the space industry and much of what they are is due to the 9 week intensive program that can only be experienced here at the space studies program. Those places in the night sky that hold unforeseen fortunes, beckoning us to move forward. - Dillon O'Riley (Participant Liasion)

CURRICULUM

SSP's interdisciplinary curriculum emphasizes international cooperation and provides different perspectives on the space activities around the world to the participants. The program includes lectures by renowned experts in the field, practical activities and projects, teamwork exercises, and professional visits. Each year it adapts to meet the needs of the participants and their employers. There are three phases to SSP: Core Lectures, Department Activities, and Team Projects. All course work at ISU is conducted in English.

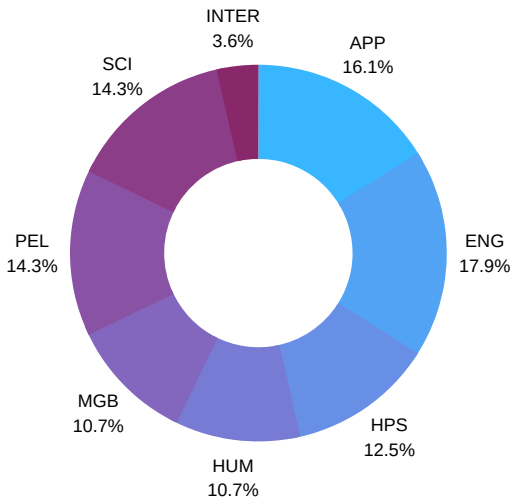
The core lecture series, combined with the departments and team projects is designed specifically to give participants an introduction to all aspects of space. My hope is that the participants will leave SSP19 confident to walk into almost any space environment and be able to start a conversation. We cover everything from management and entrepreneurship, to space law, and space science - and I think that's what makes ISU truly unique; nowhere else in the world can you find such an interdisciplinary, international, and intercultural experience, at least academically.
Alex Ryan - Academics Coordinator

CORE LECTURES

SSP19 had 56 core lectures covering ISU's main disciplines:

- 9 lectures on Satellite Applications (APP)
- 10 lectures on Engineering (ENG)
- 7 lectures on Human Performance in Space (HPS)
- 6 lectures on Humanities (HUM)
- 6 lectures on Management and Business (MGB)
- 8 lectures on Policy, Economics and Law (PEL)
- 8 lectures on Space Sciences (SCI)
- 2 interdisciplinary (INTER) lectures covering all disciplines and emphasizing the relationships between them.

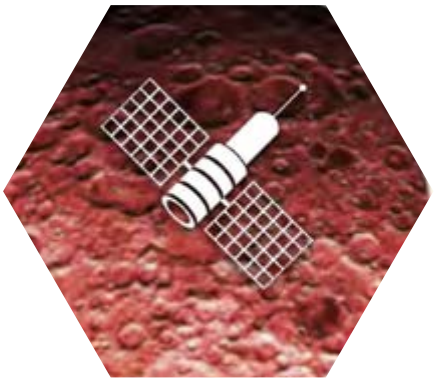
The lectures are designed to be accessible for participants with different academic backgrounds.



As an up and coming space entrepreneur, the core lectures gave me a firm base to stand on. I learned the basics of most aspects of space. I feel I can now dive into any topic I want, from space law to propulsion systems.
Gilad Sivan - Participant

The core lectures delivered the biggest amount of content in the shortest period of time I've ever had in my life. And it was awesome! We branched our minds out into several space topics and I feel like this is just the tip of an amazing iceberg we are all very excited to keep exploring.
Mirela Souza de Abreu - Participant

DEPARTMENT: SPACE APPLICATIONS



The Space Applications department at SSP19 was jam packed with professional visits, field trips and hands-on workshops. The focus on the department was to introduce the participants to various application areas such as satellite communication, remote sensing and geographic information systems. During this phase participants visited leading companies in the field, such as SES, iSpace, SPIRE and European Space Operations Center. Participants also had an opportunity to use the ISU concurrent design facility to design a satellite mission. Along with the Science department the participants visited the 14.5 million year old Ries crater in Bavaria, Germany.

ONE OF THE DEPARTMENT ACTIVITY WAS A FIELD TRIP TO COLMAR, FRANCE WITH THE SPACE APPLICATIONS GEOCACHING WORKSHOP.

THE GEOCACHING COMPETITION WAS DESIGNED TO TEACH PARTICIPANTS ABOUT GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) RECEIVERS AND THEIR APPLICATION THROUGH A FUN TREASURE HUNT AROUND THE CITY.

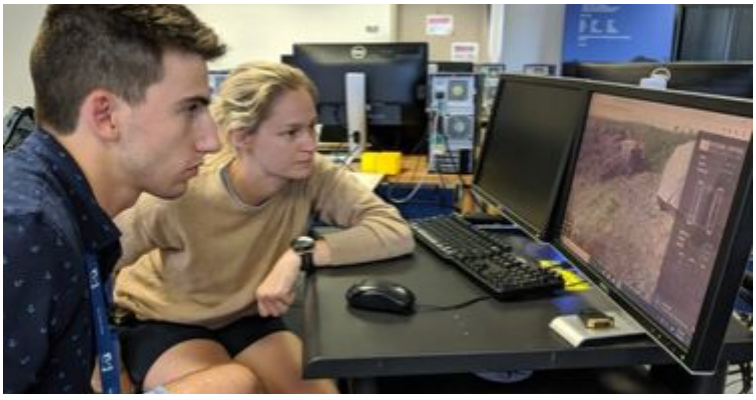
THE SPACE APPLICATIONS DEPARTMENT VISITED ESA´S SPACE OPERATIONS CENTER (ESOC), IN DARMSTADT, GERMANY. THE PARTICIPANTS WERE BRIEFED ON THE SPACEIL BERESHEET LANDER MISSION TO THE MOON BY A PRIVATE COMPANY IN ISRAEL. THEY HAD THE OPPORTUNITY TO SEE THE CONTROL ROOM, WHERE ALL THE MISSIONS ARE OPERATED FROM. LATER THEY GOT A TOUR OF THE CAMPUS AND CHANCE TO SEE 1:1 SCALE MODEL OF THE ROSETTA SPACECRAFT.

DEPARTMENT: SPACE ENGINEERING

The Engineering Department provided participants an opportunity to learn about the aspects of space systems engineering through various hands-on workshops. The Rocket workshop, the Entry, Descent, and Landing workshop, the CubeSat workshop, and the Miniaturized Drone workshop had the participants designing, building, and testing a product to meet specific requirements. While Space Debris workshop, Concurrent Design workshop, and Rover Mission Execution workshop had participants using various software to complete an exercise.

THE DEPARTMENT TRAVELLED TO GERMANY FOR PROFESSIONAL VISITS THAT INCLUDED THE PROPULSION FACILITY OF DEUTSCHES ZENTRUM FÜR LUFT- UND RAUMFAHRT (DLR) AS WELL AS THE INSTITUT FÜR RAUMFAHRTSYSTEME (IRS) AT UNIVERSITY OF STUTTGART.

PARTICIPANTS HAD THE UNIQUE OPPORTUNITY TO USE THE SOYUZ SIMULATOR AT INSTITUT FÜR RAUMFAHRTSYSTEME (IRS).



PARTICIPANTS REMOTELY DRIVING A PLANETARY ROVER DURING A MISSION EXECUTION WORKSHOP.

DEPARTMENT: HUMAN PERFORMANCE IN SPACE

The Human Performance in Space department was Chaired by Dr. Volker Damann, with Kwasi Nkansah as the Teaching Associate. 19 participants joined the department to learn about space physiology, role-play as flight surgeons, rescue an astronaut from a landing site, and learn about life support systems, human systems integration, and the mind-body-soul of space medicine.

GROUP PICTURE AT EAC (ESA´S ASTRONAUT CENTRE) IN ONE OF THE DEPARTMENTAL ACTIVITIES CARRIED BY HPS.

PARTICIPANTS AND THEIR TEACHING ASSOCIATE VISITED A STRASBOURG HOSPITAL AND LEARNT HOW TO DESIGN A MEDICAL FACILITY ON THE MOON OR MARS.

PARTICIPANTS ON A BOTANICAL TOUR TO LEARN ABOUT LIFE SUPPORT SYSTEMS. THEY SAMPLED WATER-BEARS (TARDIGRADES) FROM WATER AND OBSERVED THEM UNDER A MICROSCOPE.

DEPARTMENT: SPACE HUMANITIES

The Space Humanities Department offered participants a truly unique opportunity to break free and think differently. They explored the meaning and significance of humankind's expansion into space in a supportive and creative environment. There were 15 departmental activities spread out through the three weeks during which the participants travelled offsite to simulate and understand the "Overview Effect', design a mission patch, create their own piece of art, explore the European Astronaut Centre, develop communication skills and have interviews at the European Parliament.

THE PARTICIPANTS TRAVELLED TO COL DU DONON IN FRANCE TO GET AN INTRODUCTION TO "OVERVIEW EFFECT" BY VIRGIN GALACTIC FUTURE ASTRONAUT LORETTA WHITESIDES.

THE PARTICIPANTS WORKED ALONGSIDE THE PROFESSIONAL GRAFFITI ARTIST SHANE SUTTON TO CREATE UNIQUE PIECES OF SPACE ART WITH SPRAY PAINT.

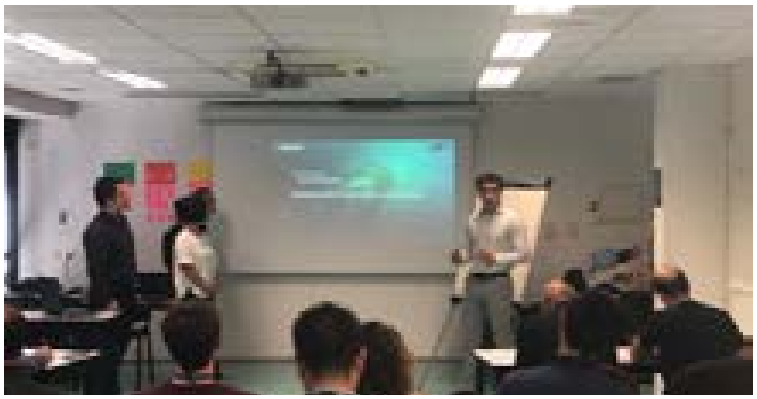
AN UNFORGETTABLE EXPERIENCE OF THE "OVERVIEW EFFECT" WITH LORETTA WHITESIDES, ON TOP OF A MOUNTAIN IN THE VOSGES REGION OF ALSACE.

DEPARTMENT: SPACE MANAGEMENT AND BUSINESS

The Management and Business Department this year focused on the major shift from government and large traditional space companies to commercial space startups emerging all along the value chain. Department chair Walter Peeters organized a Business Pitch Competition. Participants were schooled in Finance, Venture Capital, Law, Intellectual Property, Entrepreneurship, Marketing, Management, plus more with excellent support from the associate chair, Natalia Larrea. Professional visits were to the SEMIA startup incubator in Strasbourg, as well as SES in Luxembourg.

SSP19 MANAGEMENT AND BUSINESS DEPARTMENT FINAL DAY AT ISU´S PIONEERS' HALL.

TEAM ORBITEYE PRESENTING THEIR BUSINESS PITCH TO THE ASSEMBLED EXPERTS AT THE FINAL OF THE BUSINESS PLAN COMPETITION INCLUDING STEPHANE CHAUFFRIAT AND SEBASTIEN CARRARO FROM SEMIA, CLAUDE ROUSSEAU FROM NORTHERN SKY RESEARCH, AND YANNICK LAFUE OF RHINESPACE.



THE DEPARTMENT CONDUCTING A TEAMWORK EXERCISE WITH CONSULTANT NETA VIZEL.

DEPARTMENT: SPACE POLICY, ECONOMICS AND LAW

For those involved in the Policy, Economics and Law (PEL) department, SSP19 is known as 'the year of PEL'. Close to thirty leading experts travelled from several regions of the globe to instruct an action-packed curriculum of space law and regulation, space finance and economics, space strategy and security, and space policy and sustainability

Under the guidance of a highly motivated team consisting of Tanja Masson-Zwaan and Dimitra Stefoudi from Leiden University, assisted by Australian lawyer Scott Schneider, the equally motivated participants took part in 15 activities of discussions and workshops. By the end of the departmental phase the participants had acquired the tools and know-how to compete in an exceptionally impressive moot court performance held at the Eurométropole of Strasbourg.

THE MOOT COURT AT THE EUROMETROPOLIS OF STRASBOURG - SIMULATING AN INTERNATIONAL SPACE LAW DISPUTE HEARD AT THE INTERNATIONA L COURT OF JUSTICE. FORTUNATE TO HAVE A BENCH OF DISTINGUISHED GUESTS SITTING AS JUDGES INCLUDING, DR PETE WORDEN OF THE BREAKTHOUGH INITIATIVE, DEEPIKA JEYAKODI OF AIRBUS DEFENCE AND SPACE, PROFESSOR TANJA MASSON ZWAAN OF LEIDEN UNIVERSITY.

DURING THE STRATEGIC SPACE LAW SESSIONS, PARTICIPANTS PLAYED THE ROLE OF FICTITIOUS NATIONS AND ENGAGED IN DIPLOMATIC DISCUSSIONS AND ACTIONS TO AVOID INTERNATIONAL CONFLICTS.

THE PLANETARY DEFENCE WORKSHOP REQUIRED PARTICIPANTS TO REPRESENT VARIOUS NATION STATES, CONSIDER THEIR RESOURCES AND WORK TOGETHER (OR INDEPENDENTLY) TO SAVE THE EARTH FROM THE IMPACT OF ASTEROIDS.

DEPARTMENT: SPACE SCIENCES

The Space Sciences department gave the participants an insight into space physics and technology, astronomy, astrophysics, space environment, microgravity science, and astrobiology. All the workshops and visits allowed the participants to interact and discuss directly with the experts, allowing them to make the most of every activity. Among the distinguished guests, the participants had the opportunity to meet experts such as John Zarnecki, who was involved in the scientific Package of the Huygens Titan Probe; Dr. Chris McKay, one of the top astrobiologist in the world; and Dr. Nigel Mason (OBE) a professor of Molecular Physics and Head of the School ofPhysical Sciences of the University of Kent, United Kingdom

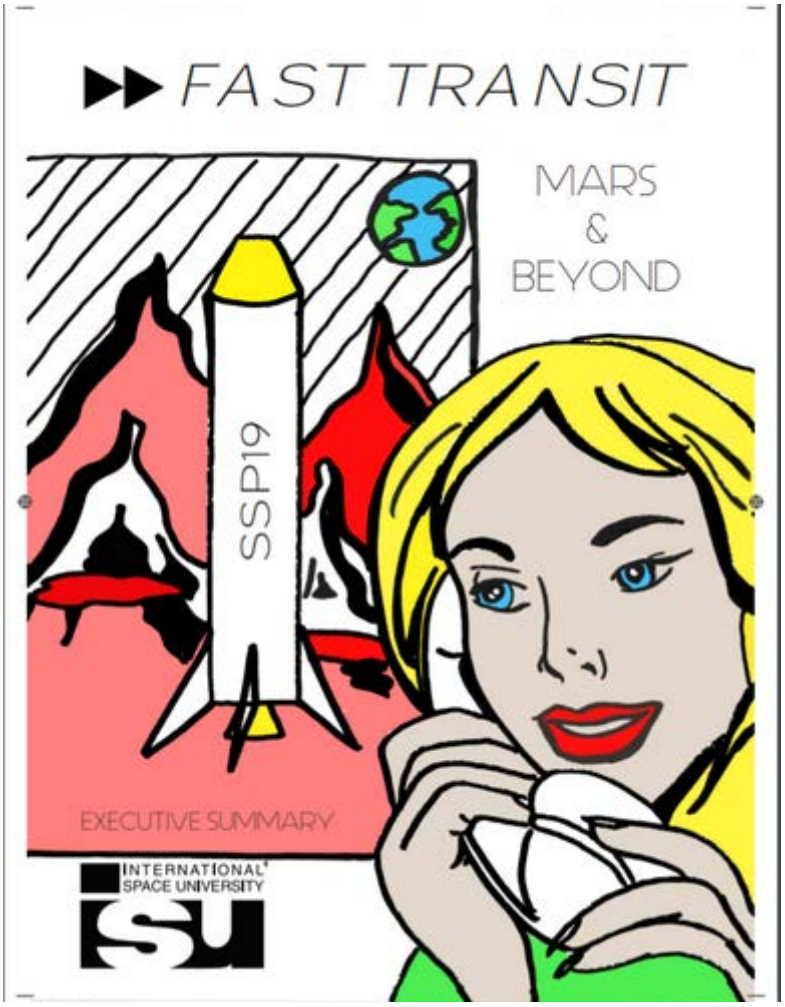
SPACE SCIENCES PARTICIPANTS DURING THE FIELD VISIT TO THE RIES CRATER IN NÖRDLINGEN, BAVARIA (GERMANY).

DURING THE FIELD TRIP TO THE RIES CRATER, PARTICIPANTS COMPLEMENTED THEIR KNOWLEDGE ON IMPACT CRATERING WITH A FIELD VISIT TO THE LINDLE QUARRY AND THE RIES CRATER MUSEUM.

DURING THE VISIT TO ISPACE, A COMPANY WITH STRONG LINKS TO ISU, THE PARTICIPANTS OPERATED A ROVER DESIGNED UNDER THE HAKUTO-R PROGRAM, FOR LANDING AND DEPLOYING ROVERS ON THE MOON FOR DATA COLLECTION.

TEAM PROJECT: FAST TRANSIT TO MARS

Chair: Geoffrey Steeves
Associate Chair: Jaroslaw Jaworski
Teaching Associate: Øystein Borgersen



Electronic copies of the Final Report and the Executive Summary can be downloaded from the ISU Library website at http://isulibrary.isunet.edu/

ABSTRACT:

The team's goal was to determine a method for crewed fast transit using continuous acceleration to reduce the mission length from eighteen months to weeks. This would minimize exposure to radiation and the effects of low gravity on human travelers.
Reflecting ISU's spirit of interdisciplinary research, work was organized in sub-teams to handle mission feasibility and hazards, mission profile and orbits, aspects of business and law, spacecraft design, human performance in space, and humanities.
After defining the mission's top level requirements, a wide range of propulsion technologies was reviewed and compared. The most promising technologies proved to be antimatter catalyzed fusion propulsion and magnetic inertial confinement fusion. Despite the current relatively low level of technical readiness, both solutions seem to be capable reaching up to 1g acceleration.
In the second part, a mission scenario demonstrates how this technology could be applied to a fast transit to Mars, and a roadmap shows the path towards 2050.
The report also identifies new opportunities arising from this technology and discusses potential impacts of this travel on our society. The report concludes with a summary and pledge for decision makers.

TEAM PROJECT:
ENHANCING INDUSTRIAL SPACE COMPETITIVENESS - GLOBAL TRENDS AND LOCAL POSITIONING

Co-Chairs: Jan Walter Schroeder and Vasilis Zervos
Teaching Associate: Hashmitha Koka

Electronic copies of the Final Report and the Executive Summary can be downloaded from the ISU Library website at http://isulibrary.isunet.edu/

ABSTRACT:

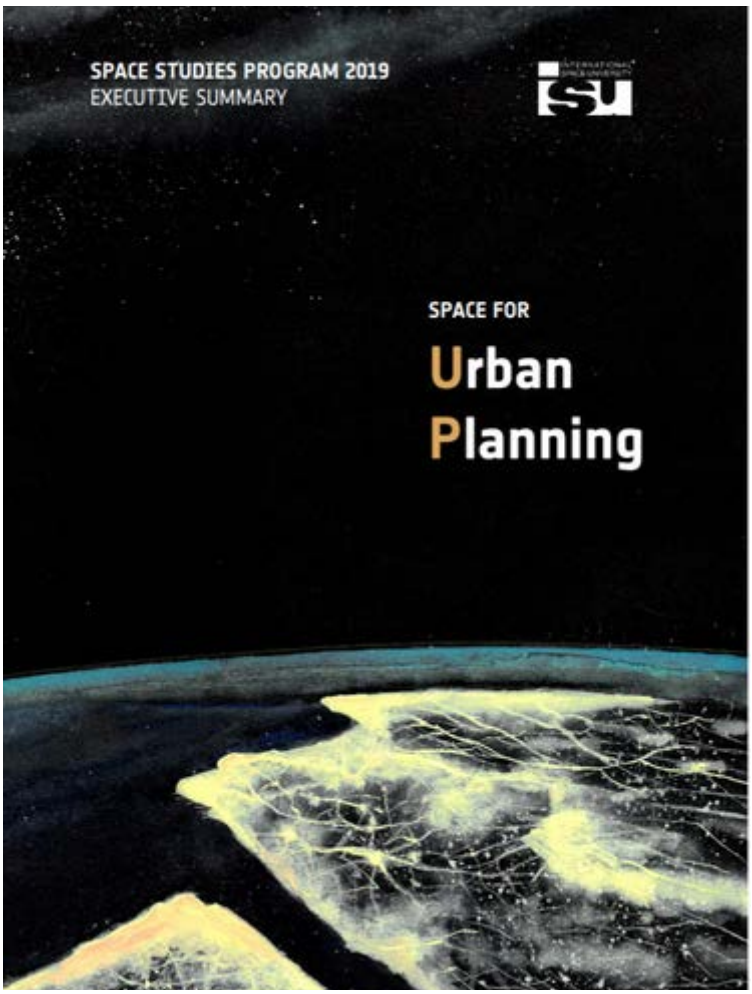
All over the world, countries and their regions are becoming increasingly interested in how to anticipate and enable their economies and societies to prepare and take advantage of the promising new opportunities in space exploration and development At the same time, a shift has taken place where governments were the only competent space actors, and now private actors have or are developing space competencies. As a result, nations and their regions need to have a thorough understanding of their space competencies and industrial expertise. Governments can stimulate industries through enacting policies, and have a parallel aim to encourage space related industries from which their societies can benefit.

The Grand Est region has potential to participate and contribute to the global space economy and should take a proactive role to support and accelerate its contribution to the space industry, for the benefit of the people in this region of France. The report presents the concept of SpacEst and develops guidelines to help Grand Est boost its regional space competitiveness. Current space industry trends worldwide were analyzed, as was the industrial competitiveness of the region, and innovative methodologies to determine policies, methods and tools were applied to come up with recommendations for Grand Est.

This innovative methodology allows an instant overview of what pillars of industrial competitiveness can be enhanced, and shows the potential for the region to enhance its competitiveness in the global space industry. For the Grand Est region, the four most promising areas identified are labor market efficiency, technological readiness, business sophistication, and innovation. From a more detailed analysis, a set of recommended policies matching these four pillars of industrial competitiveness were made, such as adopting a longterm investment strategy, utilizing satellite observation data for precise agricultural practices, water management and vineyard management.

TEAM PROJECT: SPACE FOR URBAN PLANNING

Chair: Graziella Caparelli
Teaching Associate: Siobhan O'Neil



Electronic copies of the Final Report and the Executive Summary can be downloaded from the ISU Library website at http://isulibrary.isunet.edu/

ABSTRACT:

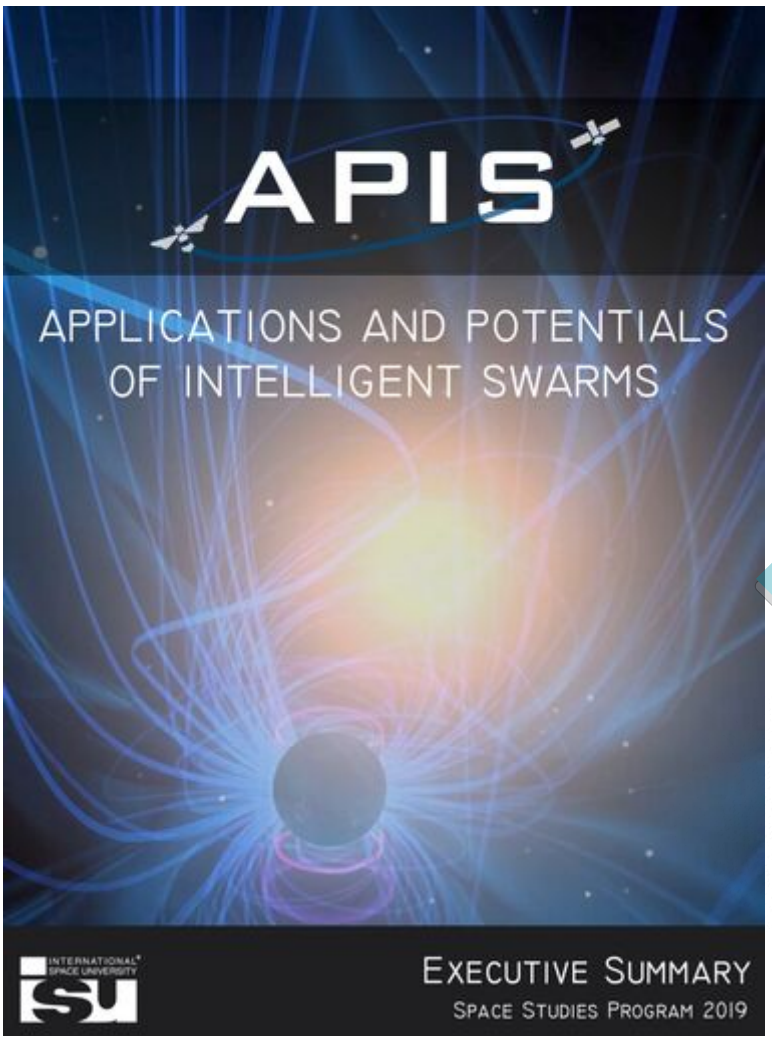
Cities are economic development and innovation hubs: they support and benefit from the development and application of space technologies. Data sets from Landsat and MODIS (Moderate Resolution Imaging Spectro-radiometer) programs, Sentinel constellation satellites, and global navigation satellite systems (GNSS), are already routinely utilized to monitor land, water, and urban infrastructure, and to complement emergency and rescue systems.

More opportunities exist to integrate space technologies into Earth-based infrastructure: passive thermal control systems, developed to regulate the temperatures of spacecraft components, have been tested on Earth to reduce building energy consumption. When innovation in polymeric film technology and photo-voltaic cells brings down their production costs, their application as thermal insulators and power storage devices will become part of the mix of solutions tosave energy and reduce the carbon footprint of cities.
The decreasing availability of resources can be addressed by imaginative solutions: for example, water scarcity can be managed by the realization of infrastructure modeled after natural water cycles, with its components consisting of natural and artificial reservoirs, monitored through ground-based and space-based sensors,controlled through intelligent systems run by programs initially developed for space. Implementation of space solutions in urban planning depends on levels of national development: urban planners in least developed countries have different priorities than those working in the developed world.

Climate change and conflicts causing new waves of mass migration will globalize challenges, however, and urban planners all over the world will need to adapt to the resulting increased levels of socioeconomic inequalities. This report focuses on urban planning challenges depending on global scale factors, i.e. those that are more effectively incorporated into the future space agenda. The team's vision is that the urban planning process of addressing global challenges will transform cities into fundamental nodes of Earth-space integration.

TEAM PROJECT:
NEXT GENERATION SPACE SYSTEMS - SWARMS

Chair: Jacob Cohen
Associate Chair: Andrew Simon-Butler
Assistant Chair: Anh N. Nguyen



Electronic copies of the Final Report and the Executive Summary can be downloaded from the ISU Library website at http://isulibrary.isunet.edu/

ABSTRACT:

Satellite Swarms are developing as a high-capability and robust mission architecture. The APIS team analyzed satellite swarm technology and applications regarding science, law, and the commercial market. Based on the results, we designed a swarm mission for heliophysics. From nature, such as bees, we can mimic natural swarm systems.

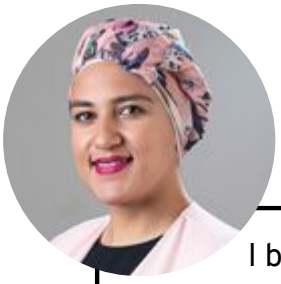
This report presents an analysis of the strengths and weaknesses of satellite swarms, as well as the opportunities and threats they face. Our analysis is the result of research and discussion from the perspectives of science, applications, engineering, human performance in space, humanities, management and business, and policy, economics, and law. Building on our SWOT analysis, we propose a swarm-based heliophysics mission to meet the scientific requirements set out by our APIS team.

The mission is designed to carry out radio tomography in Earth's magnetosphere at various scales, thereby addressing two of the four key science goals in the National Research Council's Decadal Survey. The swarm architecture enables both large-scale and high-resolution tomographic imaging, gathering critical data that traditional constellations are not able to collect because of their inability to respond autonomously to changes in their environment. This report presents an interdisciplinary summary of the analysis and mission concept, with particular emphasis on scientific motivation, engineering, operational design, and commercial and legal challenges.

WORKSHOPS

SSP19 had eight sessions of elective workshops providing participants an opportunity to either expand their knowledge in their chosen department discipline or explore new fields in space. Elective workshops also helped participants gain further knowledge and insight in the topic of their team projects.

WHAT DID PARTICIPANTS SAY ABOUT WORKSHOPS?



I believe the best way of learning is through hands-on experience. Workshops at ISU provided me with the hands-on experience to understand each discipline better, from satellites to artificial intelligence, to the concept of New Space. These workshops provided me with the technical background I needed to combine with my business knowledge. - Lilly Hayder - Participant

In my opinion, the workshop is a unique element of SSP19. It gave us a lot of different choices, not only let us know the knowledge of different fields but also let us have more opportunities to participate in the team activities that we are interested in. - Cheng Cheng - Participant

SSP19 workshops were designed to complement ISU's 3I concept. They captivated, nurtured and flourished the space interoperability insights of the participants from diverse nationalities, cultures, and disciplines. This will benefit from bridging gaps between different space realms.
Rushanka Pramod - Participant

LIST OF ELECTIVE WORKSHOPS

EWS 1A - The Space Shuttle's last mission. (Paul Wohrer)
EWS 1B Space Debris (Rudi Jehn, Jeffrey Apeldoorn)
EWS 1C - Spacecraft Sensing and Instrumentation (Justin Karl)
EWS 1D - Space, a new frontier for ethical interrogation (Jacques Arnould)
EWS 1E - Media training and Crisis Communication (Juan de Dalmau)

EWS 2A - Robotics I (Kazuya Yoshida)
EWS 2B - Smarter Program & Project Management (Angie Bukley, Martha Hess, Stratis Catacalos, Justin Hornback)
EWS 2C - Artificial Gravity (Gilles Clément)
EWS 2D - Astronomy and Civilization: A Look Through Time and Space (Miles Bengtson)
EWS 2E - Space Business Coo-petition (Cooperation + Competition) (Hugo André Costa, Tahir Merali, Halit Mirahmetoglu)

EWS 3A - Robotics II (Kazuya Yoshida)
EWS 3B - Visit to l'Observatoire de Strasbourg and l'École et observatoire des sciences de la terre (EOST) (Hugh Hill, Margot Loubiere)
EWS 3C - Business Model Canvas (Krzysztof Kanawka)
EWS 3D - Simulations and Perturbations (Thomas Mueller, Dillon O'Reilly, Hashmita Koka)

EWS 4A - Human Performance in Space Research (Andrée-Anne Parent)
EWS 4B - Regulations for Space Activities: Satellite Launch Considerations (Lulu Makapela-Bontsi)
EWS 4C - AI for Satellite Imagery (Liad Yosef)
EWS 4D - Radar Image Processing Workshop (Su-Yin Tan)
EWS 4E - Weather Factors Affecting Space Launch Operations (Rajasekhar Meka)

EWS 5A - Updating space international cooperation tools in the context of NEW SPACE (Philippe Clerc)
EWS 5B - Management, Leadership, and the Future of Governance (Adil Jafry)
EWS 5C - CubeSat Workshop #1 (Masahiko Yamazaki, Taiga Zengo, Rei Kawashima, Haruki Momose)
EWS 5D - Future of Healthcare in Space I (Anna Wojdecka, Max Fagin)
EWS 5E - Ethics for a Sustainable Space (Roberta Gregori)
EWS 5F - Getting Around on Another World - An Introduction to Rover Systems Design (Ewan Reid)
EWS 5G - Military Space Applications (Ofer Lapid)
EWS 5H - Ground Truth Field Trip-I (Taiwo Tejumola, Jerome Maxant)
EWS 5I - Holistic Work Systems Thinking (Egemen Ozalp)

EWS 6A - Saving the World 101: A Planetary Defense Simulation (Alissa Haddaji)
EWS 6B - On-Orbit Services : Challenges on International and National Space Law (Philippe Clerc)
EWS 6C - NASA Deep Space Gateway - Pathway to the Lunar Surface (Kim Ellis, Tracy Gill, Michael Johansen)
EWS 6D - CubeSat Workshop #2 (Taiga Zengo, Masahiko Yamazaki)
EWS 6E - LeadAship - Launch your team to success! (Rhonda O'Sullivan)
EWS 6F - Space and the Arts: Take Your Creativity to New Heights! (Steve Brody)
EWS 6G - The Politics of Space Mining – Futuristic Simulation Game (Danna Linn Barnett)
EWS 6H - Ground Truth Field Trip-II (Taiwo Tejumola, Jerome Maxant)

EWS 7A - Small group dynamics and interactions in intercultural environment (Pierre Evellin)
EWS 7B - Stars Navigation ISU Style (Oshri Rozenheck)
EWS 7C - Career Management Strategies (Neta Vizel
EWS 7D - Build your own Satellite Structure (Alev Sonmez)
EWS 7E - Holistic Work Systems Thinking (Egemen Ozalp)
EWS 7F - KOSMICA After Federov: New Narratives for Space Exploration (Nahum Romero Zamora)
EWS 7G - Space Radiation and Cancer (Daniela Trani)

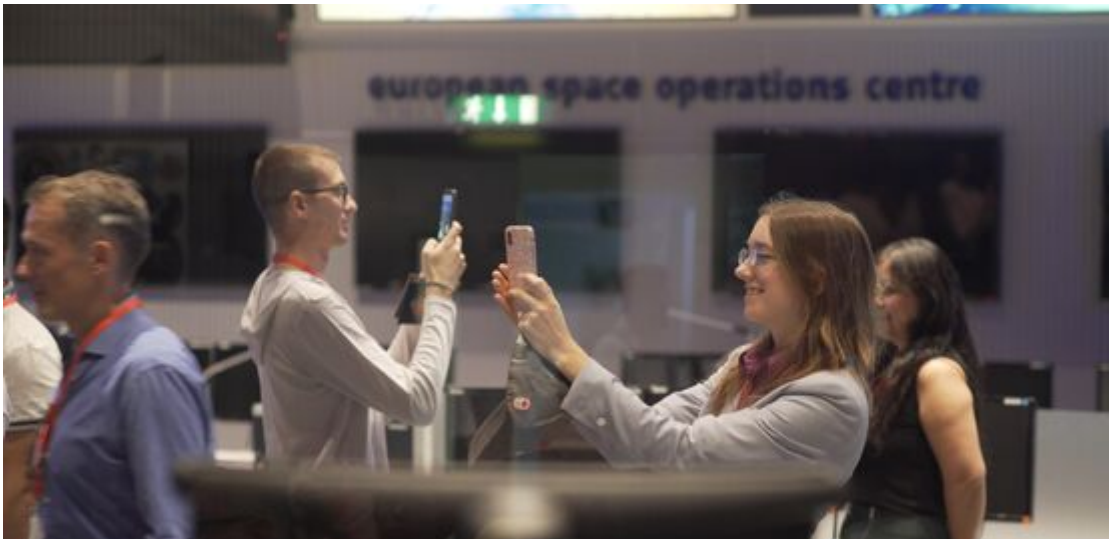
EWS 8A - Multi-Robot Systems for exploration: the Buzz programming language (Jacopo Panerati, Giovanni Beltrame, Marcel Kaufmann)
EWS 8B - Hurt on Mars? Doctor afar? Worry not! Treat on the spot! (Linda Dao)
EWS 8C - Introduction to Valispace Software and Demo Run (Stefan Siarov, Paolo Guardabasso)
EWS 8D - International Cooperation foundations in Global Space Market (Egemen Ozalp)
EWS 8E - Future of Healthcare in Space II (Anna Wojdecka, Max Fagin)
EWS 8F - AI in the Service of Space (Shirrel Assis, Liad Yosef)
EWS 8G - Cubesat Building and Testing Workshop with Open Cosmos (Daniel Sors Raurell, Remco Timmermans)
EWS 8H - Small Business Partnership Opportunities: Launch Your Innovation – Collaborating with NASA's SBIR/STTR Programs (Carlos Torrez, Indunil Ranaviraja)

PROFESSIONAL VISITS

VISIT TO CERN

EUMESAT

ESA - ESOC OPERATIONS CENTRE



PROFESSIONAL VISITS

OHB SYSTEM AG

EUROPEAN PARLIAMENT

ESA - EAC Astronaut Centre

PUBLIC EVENTS

Opening Ceremony

The opening ceremony was held at the European Parliament. The subjects of discussion, debate and the ideas put forward in the venue where we also received all the participants for this year carrying the different flags of their countries as the SSP tradition says.

Once We Went to the Moon

The United States between July 1969 and December 1972 sent twelve men to walk of the surface of the Moon. Then it stopped lunar voyages, and in the almost half-century since, no human has traveled beyond low Earth orbit. This talk by the author of John F. Kennedy and the Race to the Moon will discuss why the United States undertook Project Apollo, why that project was cut short, and whether there will be a return to the Moon in coming years.
Dr. John M. Logsdon is Professor Emeritus at George Washington University's Elliott School of International Affairs, where he was the founder and long-time director of GW's Space Policy Institute.

UAE'S JOURNEY TO MARS

The UAE Space Agency is working on developing a space exploration probe mission to Mars that is set for launch in 2020. The Hope Mars Mission also called Emirates Mars Mission will become the first mission to Mars by any Arab country. Dr. Al Ahbabi, the Director General of the Emirates Space Agency will give a talk describing the path being followed to achieve this highly challenging endeavor.

International Astronaut Panel

The International Astronaut panel is an annual highlight of each ISU session. ISU participants and the public will have the opportunity to interact with this outstanding group of astronauts who represent over 30 years of international spaceflight experience ranging from the Spacelab, to the Hubble Space Telescope and the International Space Station.

PUBLIC EVENTS

HEADS OF AGENCIES

Top managers from agencies around the world such as ESA, DLR, UAE, have lectured to the SSP participants and discussed the strategic, policy, and operational environment for space science and exploration activities in the years ahead.

ESA DIRECTOR GENERAL JAN WOERNER PRESENTS HIS VISION AND THE POLICIES FOR SPACE IN EUROPE, NEXT TO STRASBOURT EUROMETROPOLIS VP CATHERINE TRAUTMANN AND TO ISU DIRECTOR OMAR HATAMLEH.

ROCKET LAUNCH COMPETITION

Participants from ISU's Engineering department were divided into international teams of four to design, construct and fly a rocket that met a set of difficult requirements for altitude, payload, data capture, and design style.

TEDxISU

Under the theme of Exploration, ISU organized a TEDxISU event on 27 July gathering speakers from around the world who presented their "ideas worth spreading" on the exploration of the universe, the high mountains, the Earth from space, and even our inner minds or the world of innovative music. ISU's large Cosmos Auditorium was packed with participants and alumni, and many viewers followed the 4-hour event online.

SOCIAL ACTIVITIES

ALUMNI WEEKEND

Thanks to our generous sponsors, the extended ISU community enjoyed an energetic evening of reunions. Also we had the Gala dinner, Sponsored by Lockheed Martin where our more than 200 Alumni (record in the history of Alumni conference) enjoyed an evening full of memories and conversations about future collaborations.

SPACE MASQUERADE CONTEST

This year's SSP Space Masquerade Ball was masked in mystery as the participants donned their most creative space costumes! Held in conjunction with the ISU alumni conference, participants had a bit of healthy competition from the seasoned SSP alumni who were dressed to impress people from all ages.

SOCIAL ACTIVITIES

CULTURE NIGHTS

Every Friday night, participants from the represented countries shared their culture in a very entertaining and sometimes eccentric way! Interactive highlights included Chinese Hot Pot & Dumplings and the traditional SSP presentation of Canada's canoe.

TALENT NIGHT

On this special night participants showed their talent in different types of arts. Only one was the winner of the title "Most talented person at SSP19".

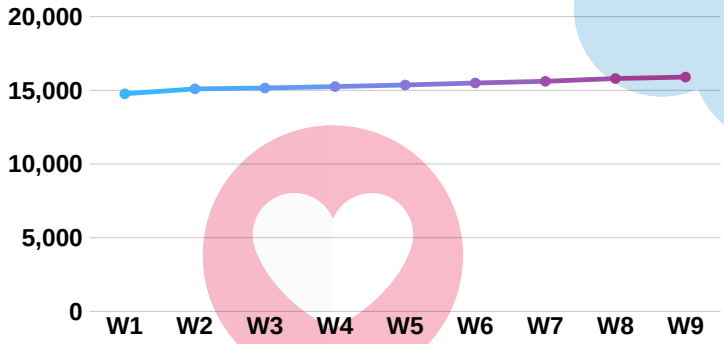
FOOTBALL GAME: ALUMNI vs SSP19

This years' Alumni vs Participants Football Game took a high stand in the favour of the Alumni. The preparation for the Staff was excellent and begun earlier in the program. After 5 years losing on a row, they went away with the 2019 Victory!

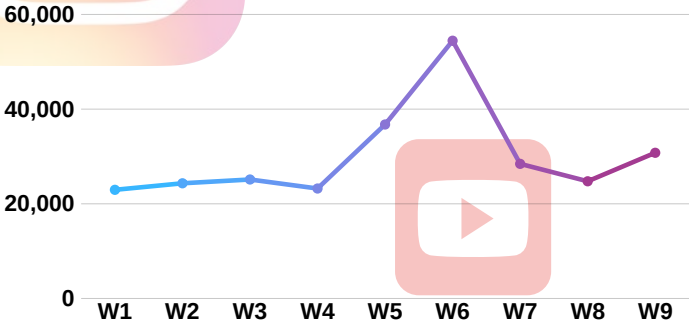
SOCIAL MEDIA & OUTREACH

Similar to previous SSPs, ISU ran a large scale social media campaign during the program. This year we majorly focused on Instagram and Twitter, also making use of Facebook and LinkedIn, as well as the SSP19 blog. In addition to social media, the program also featured extensively in local and international press, including traditional print and digital media.

Total Followers Overview: 15.899 Fw



Total Impacts Overview: 268.835



6 Weekly videos with 8.802 total views on our Facebook page and a final video release gathering the content of the whole SSP19

Connect with the ISU Community!

TWITTER: @ISU_SSP @ISUnet

INSTAGRAM: Spaceuniversity

FACEBOOK: ISU Space Studies Program

International Space University
Friends
International Space University
International Space University Alumni Association

LINKEDIN

YOUTUBE

SSP18 WEBSITE ssp18.isunet.edu

SSP18 BLOG POSTS
ssp18.isunet.edu/blog

→ 2.815.544 Twitter Potential Impacts

→ 5.676 Total Tweets

→ 1.568 Contributors

→ +3317 Followers

*Potential impacts - The potential number of times
*Potential reach - Number of unique users that could have seen the hashtag

SPONSORS

ISU SSP19 is supported at different levels by the following organizations:

Program Supported by:

Centre National d'Etudes Spatiales (CNES)
Chinese Academy of Sciences (CAS)
Chinese Aerospace Corporation (CASC)
China Satellite Launch and Tracking Control General (CLTC)
China Space Foundation (CSF)
European Space Agency (ESA)
Heinlein Prize Trust Ilan Ramon Foundation Indian Space Research Organisation (ISRO)
Israel Space Agency (ISA)
National Aeronautics and Space Administration (NASA)
Stichting Space Professionals Foundation (SSPF)
UK Space Agency (UKSA)
United Arab Emirates Space Agency

Host Institute:

The Space Studies Program (SSP) is hosted at ISU Central Campus, by the Eurometropolis of Strasbourg and the GrandEst Region.

Program Sponsored by:

Deutsches Zentrum fur Luft und Raumfahrt (DLR)
Eumetsat Eurometropolis of Strasbourg (EmS)
Federal Aviation Administration (FAA)
French Air Force
Japan Aerospace Exploration Agency (JAXA)
Lockheed Martin
Netherlands Space Office
Norwegian Space Agency
OHB System AG
Region Grand Est
SPIRE
The Aerospace Corporation

Program Supporters:

American Astronautical Society (AAS)
Argos
Association of Space Explorers (ASE)
ATG Europe
Ball Aerospace and Technologies Corp.
Belgian Science Policy Office (BELSPO)
Canadensys Aerospace Corporation
Canadian Armed Forces
Canadian Space Agency (CSA)
Conseil Départemental du Bas-Rhin

Program Supporters:

European Organization for Nuclear Research (CERN)
Canadian Foundation for the International Space University (CFISU)
CISCO
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Design & Data
Dr. Kalpana Chawla Scholarship
Project Embry-Riddle Aeronautical University
European Astronaut Centre (ESA-EAC)
European Parliament
Esri Canada
Harris Corporation
ispace Europe SA
Jardin des Sciences
Kyushu Institute of Technology (KIT)
LOC Precision Rocketry
ManSat Ltd
Massachusetts Institute of Technology (MIT)
Medtech Campus
Mission Control Space Services Inc.
Moon Express
MOONA - A Space for Change
NanoRacks LLC
Norwegian University of Science and Technology
Observatory of Strasbourg
Odyssey Space Research
ORBIT Communication Systems and Services
Orbital ATK
Parameter Space
Planetarium of Strasbourg
Rhinespace
Royal Australian Navy
Royal Military College of Canada
Secure World Foundation (SWF)
SES
Telesat
Tohoku University
United States Consulate in Strasbourg
Université de Strasbourg
University of Victoria
University of Waterloo
UrtheCast

Individual Sponsors:

Jim (and Lin) Burke
Carol Carnett
Michael Potter

INTERNATIONAL® SPACE UNIVERSITY

DISTINGUISHED PARTNERS

Grand Est
ALSACE CHAMPAGNE-ARDENNE LORRAINE

Strasbourg.eu
eurométropole

INSTITUTIONAL PARTNERS

European Parliament

Université de Strasbourg

PROGRAM PARTNERS

ERHINeSPACE BOOSTERS

Le Parc d'Innovation

INTERNATIONAL® SPACE UNIVERSITY

Space Studies Program

ISU Central Campus
Strasbourg, France

International Space University

Parc d'Innovation
1 rue de Jean-Dominique Cassini
67400 Illkirch - Graffenstaden
France

Tel: + 33 (0)3 88 65 54 30

ISUSSP

International Space University

ISU_SSP

Spaceuniversity

#SSP19
#SpaceOptimist