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AUSTRIAN SPACE FORUM

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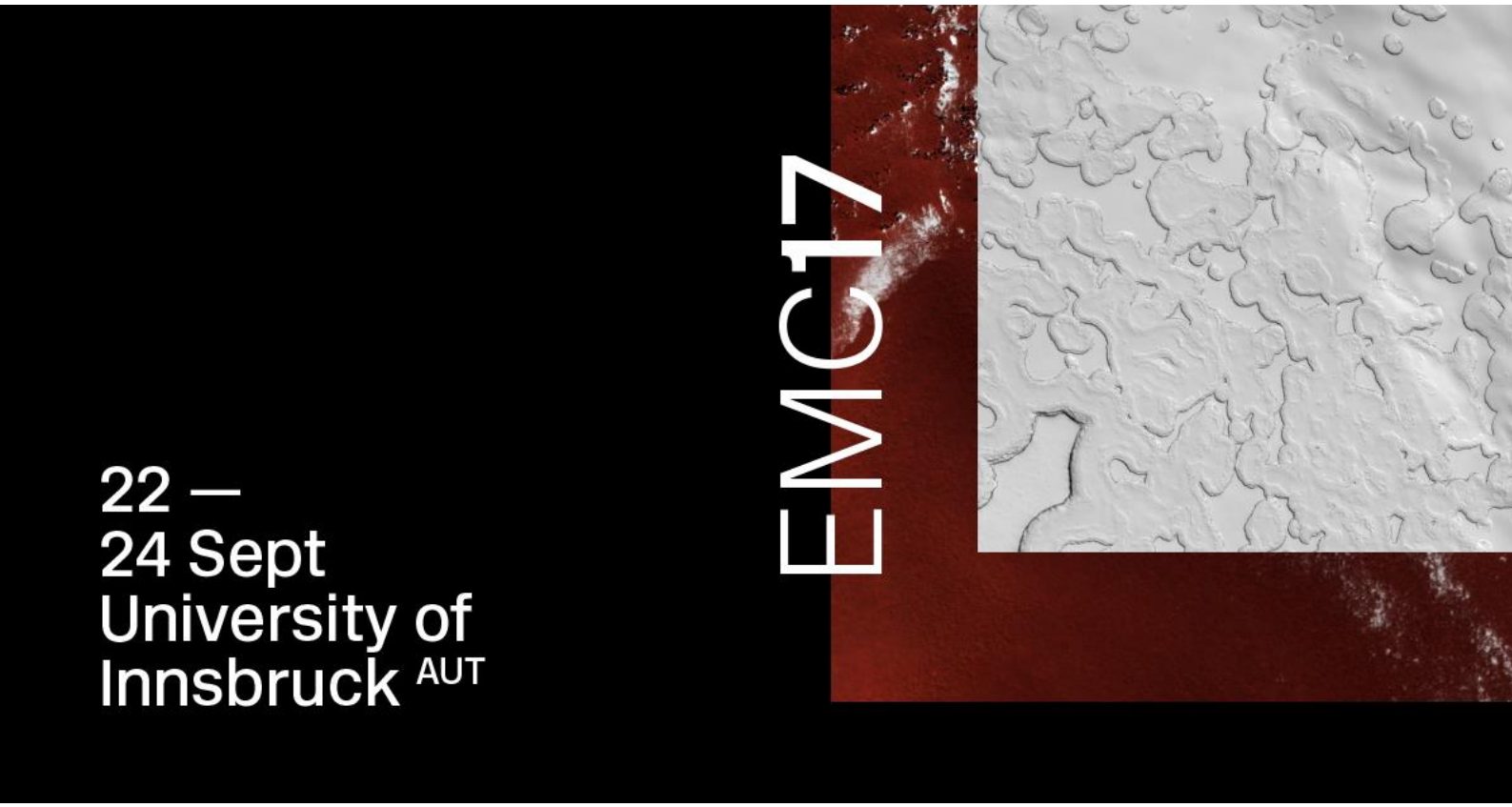
European Mars Conference 2017 (EMC17)-Project Report



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About the Austrian Space Forum
The Austrian Space Forum (Österreichisches Weltraum Forum, OeWF) is a national network for aerospace engineers, scientists and people with a passion for space. The citizen-science organization is involved in cutting-edge space exploration research and serves as a communication and networking platform between the space sector, industry, academia and the public.
www.oewf.org

The European Mars Conference 2017 in a nutshell

From 22 to 24 September, the Austrian Space Forum (OeWF) in cooperation with the University of Innsbruck, hosted the 17th European Mars Conference (EMC17). The EMC17 is the annual meeting of the European Mars Societies focusing on human and robotic exploration of the Red Planet.

The 17th EMC offered a communication and discussion platform for disciplines ranging from engineering, science, mission programmatics and space operations, space policy and arts. As in the past years scientists and people with a passion for Mars exploration were meeting in order to learn more about Mars and exchange experience, information and views. This year's highlights included: a key note from ExoMars Project Scientist Dr. Jorge Vago, an expert panel with Dr. Gernot Grömer (OeWF), Artemis Westenberg (Explore Mars) and Lukasz Wilczyński **(**European Space Foundation), a Student Forum and the science and operations behind the major international Mars analog simulation AMADEE-18 in Oman.

Student Forum

Photo: participants of the Student Forum (left) next to the jury © OeWF (Florian Voggeneder)

For the first time, a Student Forum was held prior to the main conference on 22Sep2017. That dedicated forum offered a platform for high school and undergraduate students between 15-25 years to present their ideas about Mars exploration to an international audience. The presented topics ranged from the applications of latest technologies, engineering and natural sciences.

The students presented their work in front of an international jury. Each presentation was also made public on Facebook via live stream, to further reach out to the general public and the community behind Mars exploration. After each presentation, the students had to answer questions from the audience and the jury. That Q&A session was then followed by a qualitative feedback from the jury, on which the final score was based. Each juror could award up to 10 points in the categories originality, scientific or engineering soundness and presentation style. Following the last presentation, the jurors Dr. Gernot Grömer (OeWF), Artemis Westenberg (Explore Mars), Dr. Michaela Musilova (Slovak Organisation for Space Activities) and Dr. Silvia

Prock (Univ. of Innsbruck) have conferred to decide who should win the Student Forum competition.
Sophie Gruber was announced as winner of the student contest for her presentation on “Stability of Martian subsurface ice in caves”. Runners-up winners were Arno Passeron and Thibault Paris for their project on a 3D-printed spacesuit for Mars. Special mention was extended to Teresa Treichl, Astrid Pflügler and Patricia Friedl from BG/BORG St. Johann for their concept for settling in caves on Mars.

The EMC17 team

Host: Austrian Space Forum (OeWF) in cooperation with the University of Innsbruck

Conveners:

Gernot Grömer (OeWF)

Thomas Ußmüller (Univ. of Innsbruck)

Silvia Prock (Univ. of Innsbruck)

Sophie Gruber (OeWF)

The conveners of the EMC17 want to extend their gratitude to the volunteers and helping hands for their outstanding support during the conference!

Programme

Freitag, 22Sep2017

Time	Event	Location
09:00-10:30	Opening of the EMC17 student forum **Searching for Life on Mars**, Michaela Musilova/Slovak Organization for Space Activities Student Forum session 1 • **Testing 3D-printing technology,** Michael Müller/Austrian Space Forum, PMAS 2017 • **Spelunca–settlements in Martian caves,** T. Treichl, A. Pflügler, P. Friedl, BG/BORG St. Johann 	
10:30-11:00	Coffee break	
11:00-12:30	Student Forum session 2 • **Stability of Martian subsurface ice in caves**, Sophie Gruber/Austrian Space Forum & Univ of Innsbruck • **Chasing NASA- an introduction to propellers,** Benedikt Stingl/ TU Munich	
12:30-14:00	Lunch break	
14:00-18:00	General EMC17 Registration	
14:00-15:30	Student Forum session 3 • **Project X-1,** Thibault Paris, Arno Passeron/École polytechnique, Association Planète Mars **European Rover Challenge,** Lukasz Wilczyński, European Space Foundation	
15:30-16:00	Jury meeting (closed meeting)	
16:00-17:30	OeWF Suitlab Tour ***Group 1***	OeWF Suitlab

		
18:00	• Opening ceremony of the EMC17 and Announcement of best student contributions • **The Mars Analog Missions of the Austrian Space Forum,** Gernot Grömer/Austrian Space Forum	
19:00	City tour	Innsbruck, Oldtown

Samstag, 23Sep2017

Time	Event	Location
09:00-10:30	Morning opening statements Technical session 1 • Keynote address by **Armando Azua-Bustos**/ Centro de Astrobiología, Spain  • **The AMADEE-18 mission**	
10:30-11:00	Coffee break	
11:00-12:30	Technical session 2 • **Melanoma or Mars?** Tricia L. Larose, Mary Van Baalan/International Space University	

	• **#simulateMars - Social media in space communications**, Olivia Haider/Austrian Space Forum • **Space weather monitoring for a Virtual Reality Simulation of a Martian Settlement,** N. Narayanan, A. del Mastro, G. Bruno, H., Planet Mars, Italy	
12:30-14:00	Lunch break	
14:00-15:30	Technical session 3 • **Preparing a lunar rover,** Tibor Pacher, Matyas Hazadi/Team Puli Space • **Underactuated scout robot**, Łukasz Wiśniewski, Space Research Centre, Warsaw University of Technology • **Presentation of the student forum winner/ Stability of Martian subsurface ice in caves**, Sophie Gruber/Austrian Space Forum & Univ of Innsbruck	
15:30-16:00	Coffee break	
16:00-17:30	Technical session 4 • **Impact of human safety on the design of space systems,** Jürgen Herholz/German Mars Society • **The Poland Mars simulation**, Reinhard Tlustos, Sebastian Hettrich/Space Generation Advisory Council (SGAC) **Keynote address** by **Robert Zubrin**/The Mars Society 	
17:30-17:45	Conference group photo	
18:30-22:00	Conference dinner	Villa Blanka, Weiherburggasse 8

Time	Event	Location
09:00-11:00	Technical session 5 **Keynote address: The ESA ExoMars Mission**, Jorge Vago/European Space Agency • **Exploring Mars for Life**, Pierre Brisson/Mars Society Switzerland • **Miriam-2 parabolic flight test**, Tanja Lehmann, Klaus Bayler/German Mars Society • **Co-designing a Martian community**, Federico Monaco, Irene Lia/University of Parma	
11:00-11:30	Coffee break	
11:30-13:00	Technical session 6 **Keynote address: Policy initiatives of Explore Mars,** Artemis Westenberg/Explore Mars **Panel discussion** ***"Going Red: Mars exploration, space advocacy, citizen science and policy as allies or adversaries? "*** • Robert Zubrin, Mars Society • Artemis Westenberg, Explore Mars • Gernot Groemer, Austrian Space Forum Conference Closing	
13:15-14:30	European Mars Society Chapters Meeting (invitation only session)	University of Innsbruck (Seminar room)
13:15-14:30	OeWF Suitlab Tour ***Group 2***	OeWF Suitlab Innsbruck

The conference in numbers

Photo: Group picture in front of the University of Innsbruck © OeWF (Florian Voggeneder)

Programme item	No. participants
Conference participants	72
OeWF Suitlab tour group 1	23
OeWF Suitlab tour group 2	13
OeWF Suitlab tour group 3	4
Conference dinner	36

The number of participants in the conference also included **36 students**, who had the opportunity to gain substantial insights on Mars exploration, extend their network and get in touch with their peers. In the course of the conference, a total of **18 scientific presentations** were held, additionally to 5 contributions from the Student Forum. Furthermore, over **400.000 impressions** could be generated on the most common social media channels via #EMC17.

Impressions-This was the European Mars Conference 2017

Blog article by Olivia Haider

Opening ceremony

Gernot Grömer, EMC host opened the conference with a lecture on the OeWF Mars Analog Missions. All started back in 2003 when Groemer was selected as crew member of Crew 11 at the Mars Desert Research Station (MDRS) in Utah. The first OeWF Mars Analog Mission followed in 2006 with an all-Austrian MDRS crew “AustroMars”, which led then to implementation of PolAres program and development of the Aouda spacesuit simulator. In 2009 something small

and bad happened, which was a true game changer in how we work – Safety must stand above all other interests.

Photo: Gernot Groemer with small device who changed our thinking. (c) OeWF (Florian Voggeneder)

This was a very important lesson for us, but improved the quality of our work and led to 11 successful Mars Analog field campaigns.

Saturday 23 Sep 2017

Technical session 1: Life without water and AMADEE-18 Mars simulation
The morning started with a keynote address on Astrobiology by Armando Azua-Bustos from the Centro de Astrobiología in Spain. He explained us why the Atacama Desert in Chile is an extremely dry place. Therefore, it makes sense to look for life in this desert as water is extremely rare. Moreover, this makes it a perfect Mars Analog. As an example, Mr. Azua-Bustos showed us an alga living on spider-nets in the Atacama, to use the morning dew on the net.

The key take away from this fantastic lecture: **Life adapts. If we want to look for life on Mars, we might should consider looking for life in a different way than we know if from Earth.**
Summing up the morning session, Gernot Grömer introduced the “Next Big One” -> AMADEE-18. In February 2018, the Austrian Space Forum will conduct a 4-week Mars Simulation in the Sultanate of Oman. The mission framework also includes several innovative concepts, such as the **Analog Mission Performance (AMP)** metric – to measure the success of Mars simulations from different aspects as well as it can serve as a benchmarking tool for analog research.

Technical Session 2: Space Ethics, Social Media, Space Weather in Virtual Reality
Tricia Larose challenged the audience with ethical questions about the human journey to Mars. Although it was a controversial topic, Tricia Larose pointed out various aspects of crewed space flight we would have to consider before thinking about going to Mars. Speaking about cloning,

she left the audience with a sentence, which for sure was keeping some minds busy: We cannot only make people, we can also make parts for people.

OeWF Social Media Team Lead Olivia Haider then summarized the best practices and lessons learned from previous #simulateMars missions and explained that social media is a perfect science communication tool, as you can reach more than 10,000 people with one tweet if you write in a precise and understandable way. She invited the audience to get active on Social Media and promote #simulateMars as important step to prepare humans for Mars. Antonio del Mastro then concluded the 2nd tech session with a concept to integrate space weather forecast into their virtual reality mars station “Mars City”.

Photo: Audience (c) OeWF (Florian Voggender)

Technical Session 3: Innovative rover concepts & physics of ice sublimation

Innovative rover #1: Tibor Pacher from PuliSpace team introduce us to their rover, who works with wags instead of wheels (wags stand for wheels & legs). PuliSpace team came to life with the Google Lunar XPrize about 7 years ago. In 2013 they went with us to #simulateMars in Morocco to proof that the rover can move on rough terrain and moreover can be successfully controlled by a Mission Control Center in Budapest. The biggest challenge came later in 2013 when they went to Mauna Key, Hawaii, were the nearly lost the rover. Despite PuliSpace is not within the final 5 within GLXP, they continue to work on the rover to bring a piece of Hungary to the Moon.

Innovative rover #2: Łukasz Wiśniewski then introduced us to HOPTER, a hopping robot concept. HOPTER is an example of a low mass (10 kg) underactuated robot, who can do jumps up to 3-4 m. The session was closed by yesterday’s student contest winner Sophie Gruber on “Stability of Martian subsurface ice caves”.

Technical session 4: Space Safety, PMAS & keynote lecture by Robert Zubrin

Jürgen Herholz from the German Mars Society focused in his talk on how to ensure human safety in spaceflight and mentioned also recent example of how space hardware can fail & bring humans

in danger (e.g. spacesuit incident of Luca Parmitano where he nearly drowned). To ensure safety of humans for Mars its necessary to adapt design and documentation with provision of redundancies, oversizing, inspections & much more.

The Poland Mars Analog Simulation (PMAS) who was recently conducted in Pila and Torun in Poland was then summarized by PMAS flight director Reinhard Tlustos. Six analogue astronauts conducted experiments during 2-weeks in a newly habitat – the Modular Analogue Research Station (M.A.R.S.) provided by Space Garden Company. Fun fact: The same company who built the M.A.R.S habitat build the habitat for the movie "The Martian".

Robert Zubrin founder and president of The Mars Society concluded the day with his keynote lecture via Skype. He also challenged us with some interesting hypothesis, as he thinks that SpaceX like companies will be established soon in Europe, India and China. The audience doubted this, but he mentioned Virgin Galactic as European example. Besides that he pointed out his disregard concerning the Curiosity landing side. Why did we not send this expensive rover not to an interesting part on Mars, were water is supposed? There are too many rules for going to Mars.

Photo: Robert Zubrin via live link (c) OeWF (Florian Voggender)

Sunday Sep 24 Sep 2017

Technical Session 5 & 6: ExoMars, Life on Mars, Mars Balloon

Jorge Vago, project scientist of the European ExoMars waked us up with the newest insights of the mission. ExoMars rover is a little bit smaller than Curiosity (300 kg vs. 900 kg), but equipped with the most expensive experiment ESA ever built the MOMA (Mars Organics Molecule Analyser). This experiment will have a key role in detecting life.
He also pointed out that getting the right side to drill is important as it takes several days to conduct a drill.

Pierre Brisson from the Mars Society Switzerland continued with an intriguing topic: "Exploring Mars to know more about the process of leading to life". Is it possible that on Mars complex organic molecules developed? The answer to this question is to go there and look for it. Brisson also criticize that rules like from COSPAR (Committee of Space Research) prevents us from sending rover & humans to the really interesting sites on Mars.

An update on the flag ship project “Miriam-2” of the German Mars Society was giving then by Tanja Lehmann. In their last parabolic flight campaign in 2015 they discovered some issues with deployment mechanism and are currently improving it to test it again in the next ESA parabolic flight campaign.

A different approach in designing a Martian outpost presented Federico Monaco from the University of Parma. He and his team suggest a Co-design approach to involve people outside the space community similar to what citizen-science organisation are doing. Very interesting approach.

Artemis Westenberg, co-founder of Explore Mars concluded the morning session with a very interesting talk on policy initiatives of Explore Mars and how the “Human To Mars” summit was born. Moreover, she pointed out that we need to get in the process of how NASA gets money (via US congress) and ensure that Mars is part of this money.

The EMC17 then was concluded with an interesting panel discussion on: “Going Red: Mars exploration, space advocacy, citizen science and policy as allies or adversaries?” Panelist Gernot Grömer, Artemis Westenberg and Lukasz Wilczyński, discussed different aspects of how get people & politicians interested in sending humans to Mars.

Abstracts

CO-DESIGNING A MARTIAN OUTPOST COMMUNITY: ANALOGIES AND SIMULATIONS

Federico Monaco[1]c, Irene Lia, Schlacht[2], Amir Notea[3], Antonio Del Mastro[4]

The design of a martian outpost implies not only engineering, technical and scientific inputs, but also experiences and knowledge of heterogeneous complexity given by social and cultural issues in extreme conditions. Therefore, an approach open to different ideas and perspectives might be taken in account to solve tensions and biases. Such a co-design approach can display better salients, factors and potentialities at the light of the possible emergency, complexity and heterogeneity of a community on Mars. Architectonical structures, infrastructures, public life as private life organization processes, might be openly designed by the wide interaction of participants to accommodate such large community. A wide, open and seamless project would be useful to design spaces for working and living according to possible users' needs and practices.

Key words: Mars community, design, architecture, social life, extreme conditions

1. Case studies as analogies

A further step to a Mars human mission is certainly the building of an outpost aimed to make human life sustainable in extreme conditions. Experiments are conducted on Earth by simulations (MDRS, Mars 500, Cave, Simulation in South Pole like in Concordia, etc…) and by the research of analogies in terms of communities in extreme conditions like kibbutzim model, and concrete examples like the Muruntau gold mine, in Uzbekistan, or the Kupol gold mine in Chukotka region. Such case studies represent valuable and complex experiences about practices of living together and adopting practical solutions in extreme conditions. Although, such communities cannot be directly compared to a martian context, they can be of reference in sketching categories and parameters for further analysis and as examples in design processes that might include not only engineers, but different experts such as designers, anthropologists, sociologists, managers, but moreover other experts and users.

2. Communities designing communities

Co-design (also called participatory design) means designing together with the user as a basilar principle for all good projects. In the space context it is already very clear the importance of astronaut involvements in the projects to support the user needs, increasing therefore performance and safety [1,2]. Co-design applied to a community means to explore and research together a new vision on design, more collaborative, sustainable and resilient. A successful community design consists in learning from the community, putting people at the center of the design as a commitment and a common interest, to open opportunities for all and foster new, inclusive ways of living [3]. This concept is fundamental for a successful community design in extreme conditions, such as those on Mars. Simulations are needed at the moment to explore possible scenarios of community living on Mars to understand risks, possible developments and solutions by designed sustainable ecosystems for human life for the benefit of possible future pioneers on Mars.

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3 Israeli Mars Society, Israel
4 Mars Planet, Italy

EXPLORING MARS TO KNOW MORE ABOUT THE PROCESS LEADING TO LIFE

Pierre Brisson[1]

Since the Viking experiments carried out in 1976, there is a doubt about life on Mars. Most likely no breakthrough will be made before the 2020 missions (NASA Mars2020 and ESA ExoMars). We can nevertheless express an opinion about the possibilities of Life, the places where we could find it and the form it could present.

Key words: Martian life, Viking, Mars-2020, ExoMars

1. The problematic of Life on Mars

The problem stems from the presence of organic molecules in Space on the one hand and from Life on Earth on the other hand. Mars which presented many similarities with Earth during several hundred million years at the beginning of its history, down to the time when Life appeared on Earth, should logically have processed those organic molecules along the same prebiotic path. “How far?” remains an open question. No clear evidence of such evolution has been yet established through the research lead by the various Mars missions. However, both Viking landers did find “something” although what seemed to be positive results have been rapidly denied. Unfortunately, no other missions were clearly dedicated to the search for Life (Curiosity has been mostly looking for habitability). However apart the intriguing Viking experiment results, many indices within the Martian meteorites found on Earth (“SNC”) and some observations made on the surface of Mars, hint at the possibility of past Life. The 2020 exploration missions are assigned biological objectives. They will have the capacity to make important progress on the subject, all the more than ExoMars will also explore the underground where life could have found shelter after appearing on the surface of the planet.

2. Biological research instruments aboard Mars missions scheduled for 2020.

Mars 2020 will carry seven instruments among which two are precisely dedicated to the identification of Life signatures: PIXL, an X-ray fluorescence spectrometer; SHERLOC, a spectrometer that will contain a high-resolution imager to determine the fine scale elemental composition of surface material. ExoMars will carry eight instruments apart from a drill which will allow to reach a depth of 2000 mm underground where most radiations are stopped and where humidity may (have) provide(d) a hospitable environment to Life. Three of its eight instruments are more precisely dedicated to the identification of Life signatures: MOMA “Mars Organic Molecules Analyzer” is a composite suite made of (a) a Gas Chromatograph - Mass spectrometer and (b) a Laser Desorption - Mass Spectrometer. RSL is a Raman spectrometer. Its purpose is to establish mineralogical composition and identify organic particles. The CLUPI camera to be operated on surface,will search morphological biosignatures (thrombolytics, biofilms) on outcrops. In addition, we are still hoping for some analysis to be made inside the nine wet cups of the SAM Curiosity laboratory, as heating obviously hindered the analysis in the dry cups of the samples contaminated by surface perchlorates.

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[1] Pierre Brisson, President of The Mars Society Switzerland and board member of Association Planète Mars

PLANNING AND OPERATING A COST EFFECTIVE MOON-MARS ANALOGUE MISSION - THE MODEL OF THE POLAND MARS ANALOGUE SIMULATION 2017 WITH EARLY RESULTS

Reinhard Tlustos[1], Sebastian Hettrich[1], Tajana Lučić[1], Hady Ghassabian[1]

Key words: Mars, Moon, Analogue Mission, time-delayed operation

Mars analogue missions allow to develop optimal procedures for a real Mars mission, and act as a testbed for the implementation of new technologies for the future of space exploration. By closely observing the human and technological components of such a mission, scientists can test existing hardware, software, and procedures, as well as troubleshoot pitfalls and potential crises. For this purpose, the Space Exploration Project Group, a subgroup of the Space Generation Advisory Council (SGAC), decided to plan and operate an analogue mission focusing on the scientific value and try to make it as cost effective as possible: The Poland Mars Analogue Simulation (PMAS). This mission was held from July 31st to August 14th 2017 where six analogue astronauts faced isolation for two weeks performing tasks and scientific experiments. The location of the Habitat is in Pila, Poland while the Mission Control Centre is located in Torun, Poland. The mission was divided in two parts throughout its duration: the first days were performed in Lunar-mode without time delay in communications, while the rest of the mission was in Mars-mode operating with a 15-minute time delay in both directions. This decision has been made considering that most Mars mission architecture designed by space agencies use cis-lunar space as an outpost and as a stepping-stone for future space exploration scenarios. PMAS is set apart from other analogue missions by its diverse and international group of students and young professionals, by its cost effectiveness and its solely scientific driven purpose involving researchers from all around the globe; In this presentation, we will explain the planning and operating part of this mission and present the early results gained from the preparation phase, as well as results from the isolation phase of the mission. Both infrastructure and human factors were considered in the process. The Poland Mars Analogue Simulation is a good case for planning future analogue missions, furthermore, the lesson learned from this mission are useful for similar activities in the European panorama.

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IMPACT OF HUMAN SAFETY ON THE DESIGN OF SPACE SYSTEMS
FROM APOLLO TO MANNED MARS MISSIONS

Dipl.Ing. Jürgen Herholz[1]

Up to 1967, when the first Apollo crew died in the Apollo1 disaster during a ground test, no systematic approach was taken to systematically analyze human safety related issues and translating them into requirements. The process of "man-rating" a space system started afterwards and reached first a certain maturity for the Shuttle / Spacelab program. The ISS was the first system where most of the today known safety related criteria and requirements have reached a satisfying standard. Since then safety related criteria and requirements have constantly been updated based upon experience.

Key words: Apollo, NASA, Mars Direct, von Braun, Elon Musk, Robert Zubrin, Shuttle, ISS, Spacelab, ATV

For satellite systems, mainly the reliability of functions and elements down to parts level under worst case mission conditions are considered, resulting in design measures such as redundancies, parts selection, shielding, automatic failure detection and isolation, system safing until failure elimination etc. Man-rating a system or component drives the system and component design and required documentation to a much higher level. High reliability alone is not necessarily an answer to more safety! Design for safety requires a systematic step-by-step analysis, definition, design and documentation approach taking human presence in the space system into account requiring a variety of different project activities. This includes:

- setting a safety goal
- identifying all possible safety risks
- analyzing different operations scenarios
- performing operational analyses with view on human safety
- considering safety risks associated with every possible operational scenario
- providing detailed operations planning meeting safety requirements
- taking human error into account
- considering crew safing and rescue options
- deriving a safety concept and related requirements
- identifying and tailoring all related design requirements
- analyzing possible failure of components
- performing reliability and life limitations analyses down to parts level under all possible operational and environmental conditions

The resulting design and documentation implications are summarized below:

- provision of redundancies
- load limitations
- oversizing
- timely replacement of limited-life components
- inhibiting unsafe or forbidden operations
- regular inspections
- sophisticated automatic failure detection and prevention measures
- identifying and treating safety relevant elements of the system with specific attention
- documenting all safety related findings and solutions and their implementation
- performing specific safety related reviews
- etc.

The presentation will address these specific safety related issues and give examples of their implementation during the system development process, considering also long mission durations such as a Mars mission.

[1] Board Member – German Mars Society

PREPARING A LUNAR ROVER MISSION IN THE FRAMEWORK OF ANALOG PLANETARY RESEARCH

Tibor Pacher[1], Matyas Hazadi[2], Koppany Juhasz[3], Miklos Pathy[4]

We report on our analogue field test experiences in testing the Puli rover. Their possible implications on further hardware and software development as well as on operational procedures will be discussed.

Key words: APR, field test, lunar mission, education

Testing of hardware in space analog environments is a powerful tool in space exploration. Analog Planetary Research (APR) is a relatively new and rapidly growing topic in this field: APR is about development of equipment, methodologies and strategies for future human and robotic planetary exploration [1],[2]. It involves studying mission planning, operational procedures as well as hardware testing (prototypes/engineering models) still on Earth, but under environmental conditions as similar as possible to that of the targeted planetary body.

The results of APR missions can be used to detect possible conceptual deficiencies, software and hardware bugs and other physical faults. These can be evaluated and fixed in an early stage of development, prior to launching the real mission. APR is not only a valuable tool for mission planning validation, but also a cost-effective testing opportunity for operational and hardware concepts.

Team Puli Space participated in various APR missions to test its mission planning and operational procedures as well as mission hardware prototypes and its Mission Control Software. These APR missions took place in various planetary-analog environments, such as a Mars analog field simulation in Morocco (OeWF MARS2013), the PISCES testing site in Hawaii (Puli Mission Maunacast), and on Kaunertal Rock Glacier in Austria ("Puli Rocks" in the OeWF AMADEE-15 mission).

Team Puli conducted and tested area selection, rover health check, mapping, and mission control procedures, and other tasks regarding the requirements of the Google Lunar XPIZE contest and the planned lunar mission itself. Based on the results of these APR missions, designing and building of Puli's space-grade lunar rover is currently underway.

This is a publication of Team Puli Space.

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SCIENCE COMMUNICATION AND SOCIAL MEDIA-A PERFECT MATCH FOR #SIMULATEMARS

Olivia Haider[1]

The Austrian Space Forum (OeWF) is one of the leading organizations in Europe to conduct international & multidisciplinary Mars analog simulations. These Mars analog simulations are excellent tools to gain and improve operational experience as well as learn about advantages and limitations of remote science operations on planet Mars. Moreover, these simulations also serve as outreach platform to generate enthusiasm towards the idea of sending humans to Mars, whilst communicating the necessity of planetary analog research in preparation for future crewed missions to Mars. In this presentation, I will outline why using social media as science communication and show best practice examples from previous #simulateMars campaigns.

Key words: Science communication, social media, Mars analog simulation, #simulateMars

1. Why Social Media?

Social media is a worldwide phenomenon, there are currently more than 2.7 billion active social media users [1] of more than 3.7 billion internet users [1]. That means a total penetration of 37% of Earth's population [1] are using social media. Using social media as organization or as brand opens the possibility to engage in a direct way with your community or customers. In our case, these are people who are generally open for space exploration or people who are fascinated by space topics. Social media also opens a direct channel for these interested people to interact with their Space Agency, their favorite space mission and even talk via social media to their favorite astronaut. This direct communication channel can be used for an organization to inform, engage and share the passion for space exploration or in our case used for science communication about Mars analog simulations.

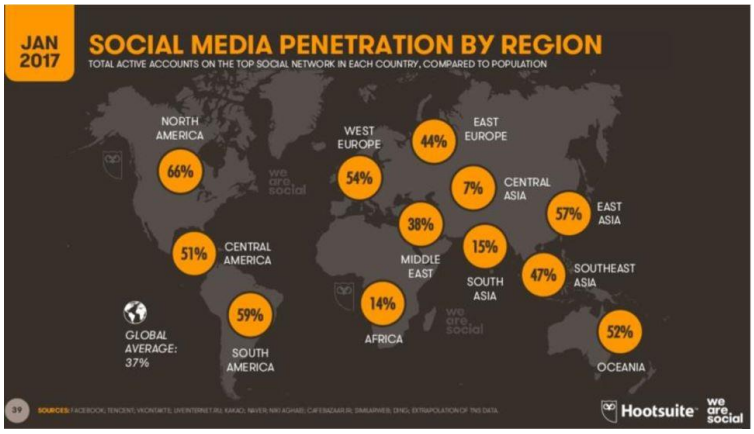

Figure 1: Worldwide Social Media penetration [1]

2. #SIMULATEMARS Best Practice

The OeWF is using social media since 2008. For all major Mars analog simulation, social media was used to communicate the ongoing analog missions and its science results to the public. Moreover, the OeWF experimented with new formats of space communication and organized the first MarsTweetup worldwide [2]. Before the MARS2013 analog mission in Morocco each Mars simulation was communicated through a different hashtag e.g. #riotinto11, #dachstein12, #MarsTweetup. Since 2013 the OeWF is using the #simulateMars hashtag for all its planetary Mars analog activities. In my presentation at the European Mars Conference, I will summarize the best practices of the OeWF social media activities since the start in 2008 and give an outlook to the planned activities for the upcoming AMADEE-18 simulation in Oman/February 2018.

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SPACE WEATHER MONITORING FOR A VIRTUAL REALITY SIMULATION OF A MARTIAN SETTLEMENT

Nived Narayanan[1,2], Antonio del Mastro[1], Giovanni Bruno[1,3], Hitesh Paul[1,4]

Key words: radiation on Mars, space weather, machine learning, python.

High-energy particles accelerated by the Sun during Coronal Mass Ejections (CME) are a major concern for a manned mission to Mars. On the Earth surface, these particles are shielded by the Earth's magnetic field. On Mars, where the magnetic field is much weaker, CME pose a radiation threat to the health of astronauts. Understanding space weather is a requirement for future manned space missions in order to properly protect the astronauts from the radiation environment. Several methods for space weather monitoring are currently developed by the scientific community and public forecasts are already available online.

We present a Python-based project which leverages on state-of-the art knowledge by monitoring three space weather web portals: NOAA [1], FORSPEF [2], and PREDICCS [3]. Our software combines the near-term forecast of CME and a real-time propagation model of energetic particles throughout the inner Solar System and through the Martian atmosphere. It recovers probabilities for CME directed to the Earth and their propagation velocity. This way, it extrapolates days-to-hours forecasts for the radiation dose astronauts on Mars would be exposed to under the protection of different shielding materials.The system raises an alert signal when the incoming radiation dose exceeds the security levels defined by the International Commission on Radiological Protection [4], which the main space agencies adopt as a reference.

We plan to implement a machine learning approach which combines the forecasts and models from the different websites, and to compare its performance with such a "deterministic" method. This project is meant to be integrated in a virtual reality simulation of a human settlement on the surface of Mars (Mars City Project), which is currently under development at Mars Planet.

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MELANOMA OR MARS? FOLLOW YOUR MORAL COMPASS

Tricia L. Larose PhD[1,2], Mary Van Baalan PhD[3], Ruth McAvinia MSc[2], Petter Skanke[2], Anderson Wilder MSc[2] , Ana Diaz Artiles PhD [2,4]

This oral presentation summarizes discourse from, "Follow Your Moral Compass", a space ethics activity delivered at the International Space University's 30th Space Studies Program in Cork, Ireland on 04Aug2017.

Key words: Mars, space exploration, cancer, space ethics, moral compass

Space exploration – an ethical dilemma?

Imagine that you have been granted a large sum of money. With this large sum of money comes a choice – you must choose to use this money to cure melanoma, or to send a human crew to Mars. You cannot divide the money between these two options, nor can you invest the money to gain dividends. You must choose. Melanoma or Mars? Where does your moral compass point? What direction will you take? Which decision will you make? And why?

Most certainly, strong arguments can be made for choosing to cure melanoma over sending a crew to Mars, or for choosing Mars over melanoma. Likewise, a number of strong critiques can be put forth for choosing one option over the other. In this example, and the examples that follow, the line of demarcation is not set. Personal perspectives and biases have an impact on our behaviors and choices. As a consequence, there is not always a straightforward path to finding the correct answer – if indeed, there *is* a correct answer. Is it not our human destiny to explore – can we not advance medical technologies, including potential cures for and/or prevention of cancer by stretching the limits of our knowledge through space exploration [1]?

Ethical dilemmas related to space exploration are not limited to health policy and economics versus space policy and economics, as outlined above. There are a number of other scenarios we ought to consider, such as the sustainability of our own home planet. For example, ought we consider Earth as inherited from our ancestors, or borrowed from future generations [2]?

Furthermore, if we are willing to admit that space exploration may be the next phase of human evolution, can we agree that we have the right to select-out space exploration candidates based on certain attributes so as to select-in a homogeneous population for the betterment of science or mission success? How can we be certain that the discriminative selection process will be based on individual attributes and not the group, class, or category to which the person is perceived to belong [3]?

Moreover, when we do send our first humans to Mars, what shall their job description be? Ought we consider these first Mars explorers to be a vulnerable population at risk of coercion? Or ought it be their responsibility to meet every deliverable and engage in every task that is demanded of them, no matter the risk, regardless of an individual's level of apprehension [4]?

What of space colonies in the far future? Is there justification for "manufacturing" biological organs or whole "human beings" to restore crew-based resources [5]? Will resources be bought and sold? Will commercialization, industry and the free market find their way to the cosmos [6]? If so, at what cost to humanity? At what cost to Earth? At what cost to one's moral compass? This oral presentation will reflect upon these important ethical implications in the context of space exploration in the near and far future.

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4. Tânia Amorim, Lisa Drudi, Marcel Kaufmann, Chandra Prakash Kotwal, Annette Parks
5. Paola Belingheri, Bryan Chan, Michael Johansen, Daisuke Kawamura, Roberto Ubidia.
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***Intellectual content from cited sources provided by participants from Human Performance in Space and Space Humanities Departments who actively engaged in the joint departmental activity, "Follow Your Moral Compass", as part of the 30th Space Studies Program, International Space University, Cork Ireland on 04 August 2017.

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MIRIAM-2 Parabolic Flight Test

Dipl.-Ing. (FH) Tanja Lehmann[1], Dipl.-Ing. (FH) Klaus Bayler[1]

The MIRIAM-24 parabolic flight test is the main test at system level in preparation of the MIRIAM-2 Spaceflight sounding rocket test campaign planned for end 2018.

Key words: ARCHIMEDES Mars Balloon Probe, MIRIAM-2, parabolic flight, Mars Society Deutschland e.V.

MIRIAM-2 is a spaceflight vehicle mission prepared in cooperation with the University of the Armed Forces in Neubiberg and the German Space Agency DLR and shall verify the ARCHIMEDES balloon design and manufacturing methodologies as well as the design of the systems for folding, packing, storing, deploying, inflating and releasing the balloon. The balloon itself and all its associated systems will therefore be similar to the ones foreseen for the ARCHIMEDES Mars mission to the extent as possible on a 1:2,5 reduced scale (the Mars balloon has 10 m diameter, the MIRIAM-2 balloon 4 m). The scientific payload of MIRIAM-2 is similar to the one for ARCHIMEDES. In addition to the test of the balloon and its associated systems the behaviour of the balloon at entry into the earth atmosphere shall be simulated at an air density similar to the Mars atmosphere. The MIRIAM-2 mission is planned for end 2018, the flight vehicle being transported into an altitude of more than 200 km on-board a sounding rocket.

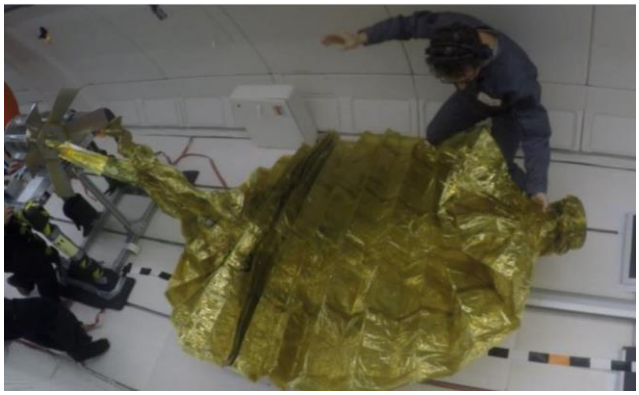

Figure 1: 4-m balloon after deployment

The parabolic flight test shall demonstrate that the balloon is being correctly deployed after being stored in a densely packed condition, using the balloon and the balloon packing, storage and release system of MIRIAM2. This system consists of the container itself and the associated fully automatic system for deploying the balloon. Inflation and release of the balloon is not subject of the test.

Technical description of the parabolic flight experiment A fully functional model of the MIRIAM-2 balloon deployment system is fixed in a test rig, which in turn is fixed to the aircraft. The balloon is packed into the container beforehand in a specific development facility using specific tools. Only one single test run is possible during the whole parabolic flight test campaign. A pyrotechnic cable cutter device opens the balloon container and releases the balloon, which then is pushed out by a spring mechanism. The balloon is expected to be fully released without being inflated.
Test Campaign in November 2015 The cable cutter was activated by the test operator approximately half-way into a flight parabola. The deployed balloon was supposed to be captured and safeguarded by a member of the test team. However, the balloon was not deployed as foreseen and needed an additional push by the operator to deploy. Therefore the test was considered not successful and will be repeated in December 2017 after the incorporation of some design changes into the balloon storage and release system.

The parabolic flight test is financially supported by ESA as part of their General Support Technology Programme.

[1] German Mars Society

UNDERACTUATED SCOUT ROBOT FOR PLANETARY EXPLORATION – MISSION CONCEPT, SYSTEM DESIGN AND EXPECTED PERFORMANCE

Łukasz Wiśniewski[1], Jerzy Grygorczuk[2,1], Piotr Węclewski[3], Daniel Mege[1,4], Joanna Gurgurewicz[5,1], Teresa Zielińska[6]

HOPTER hopping robot is presented as an example of a low-mass (10kg) underactuated scout robot for planetary exploration. Case study for Martian gravity is provided, where the robot is expected to perform jumps up to 3-4m above the surface. Robot determines its jump direction through independent actuation of three actuating legs driven by spring-load mechanisms located symmetrically around its main platform.

Key words: hopping robot, underactuated system, reduced gravity, planetary exploration, scout robot

HOPTER's system architecture comprises of three actuating legs arranged around a disc-shaped main body. The mechanism allows to store up to 50 J in each actuating leg which, given its mass of up to 10kg, should allow for jumps of several meters on Mars. Major subsystems of this horizontally symmetric are shown in Fig.1. Simulation and analysis of locomotion indicate relatively high efficiency (around 80%) of the system provided that the actuating legs remain as light as possible (0.6kg each in our case). This allows for wide coverage of surface areas, especially those that are not accessible for rovers. The system requires strong and reliable drive mechanism, which accumulates energy in drive springs by operation of a BLDC motor, a ball screw, latch system with an electromagnetic release. Each leg can be controlled separately to a different level of energy, which determines the jump direction. Applicability of the system to space missions is discussed, i.e. as an add-on to a rover scout or as an independent swarm of robots. Summary of work described in [1],[2] and [3] is provided.

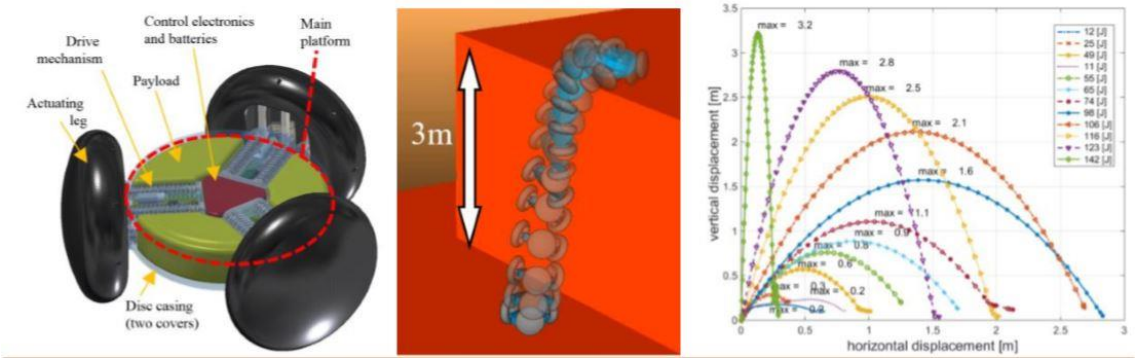

Figure 1: Left: design visualization of HOPTER, disc casing is semi-transparent to show interior arrangement; Middle): hopping sequence simulated in MSC.Adams (here jumping on a 3-meter cliff in Martian gravity); Right: Simulated HOPTER jump trajectories in Martian gravity (assumed overall mass 10 kg and mass ratio of actuating legs to main platform 1:9). [2]

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