Astrosociological Insights
Newsletter of the Astrosociology Research Institute
Volume 4, Issue 2 - November 2015

Collaborating Towards the Future!

Notes from the CEO

The Astrosociology Research Institute continues to make strides in fulfilling its mission to advance astrosociology as an academic field. Here's what we're doing:

- Our ***Astrosociology in the Classroom*** program continues to move forward with the goal of attracting students of all ages to the study of astrosocial phenomena. Space education and research from a human perspective is the hallmark of the Astrosociology Research Institute.

- The Call for Papers for the next volume of ***The Journal of Astrosociology*** is out. We have extended the deadline for the submission of manuscripts to January 4, 2016. We encourage student submissions, and our virtual library at astrosociology.org is available to you. Our philosophy in developing astrosociology remains dedicated to involving the next generation of astrosociologists in our efforts. Work on the newsletter and journal has delayed our book project to the first quarter of 2016. However, it will be worth the wait!

- ARI is dedicated to expanding the presence of astrosociology in the space community. One key way to do this is attend space conferences. I was able to attend two conferences recently. First, I represented our Institute at the **AIAA Space 2015** in Pasadena, CA (August 31 – September 2). I presented a paper focused on issues involving astrosociology and the planning of space ecosystems. Second, the **100 Year Starship 2015 Symposium** in Santa Clara, CA (October 29 – November 1) had the theme of "Finding Earth 2.0" and included my presentation on deviance in space as well as Michael Waltemathe's four presentations regarding astrotheology issues. Kathleen Toerpe served as co-chair of the "Becoming an Interstellar Civilization Track." It is gratifying that space organizations that traditionally focused mostly on STEM-related issues have embraced the social sciences generally and astrosociology specifically. Collaboration is the key to the successful migration of humankind into space!

Jim Pass, PhD

Chief Executive Officer

Astrosociology Research Institute

Left to right: Incoming ARI Officer, Michael Waltemathe, with Juan Pablo Marrufo, SJ, and ARI CEO Jim Pass at recent 100 Year Starship 2015 Symposium in Santa Clara, CA.

Notes from the CEO: Collaborating Towards the Future! (cont.)

Albert Harrison, PhD
1940 – 2015

ARI will be creating an archive of Dr. Albert Harrison's materials, recently donated to us by his widow, Mary Harrison. I would personally like to thank Mrs. Harrison for her decision to donate these materials to ARI and for her warm hospitality. His collection will become a permanent part of our future ARI library and we are honored to forward the astrosociological research of one of ARI's founding supporters and our original Advisor.

An exciting program for 2016 involves the creation of a college scholarship fund in tribute to Al Harrison. Details will follow in the coming months, but this program both honors Dr. Harrison and encourages students in the social and behavioral sciences, humanities, and the arts to further explore the human dimension of space exploration.

- Our Institute continues to evolve and we have some news about pending changes. First of all, we would like to thank Katrina Jackson who is leaving us for serving as one of our deputy CEOs and assistant editor for the first issue of our journal. Her assistance on the first issue was invaluable and we wish her good luck in all of her future endeavors. Michael Waltemathe is joining our officers as Deputy CEO – Outreach and Education for Europe and on the Editorial Board of the *Journal of Astrosociology*. He currently lives in Germany. Our current deputy CEO, Renato Rivera Rusca, who serves as officer for international outreach and education will concentrate most attentively on Asia. Additionally, Nathan Johnson will be joining ARI's Board of Advisors and the Editorial Board of the *Journal* as well. Mat Vidmar has replaced Katrina as Assistant Editor for the *Journal*. Welcome to all!

As always, best regards,

Jim

Kathleen D. Toerpe, PhD

Editor

Astrosociological Insights

In this Issue

This issue spotlights articles on any research topic relevant to astrosociology, and encouraged authors to emphasize areas of interdisciplinary collaboration among the physical/biological sciences, the social sciences, the humanities, as well as the literary, performing, and visual arts. We also encouraged authors to pinpoint how they used the investigative methodologies of their individual disciplines in their astrosociological research. Our prompting questions focused on collaboration and methodology:

Collaboration

What type(s) of collaboration did you pursue in your research project?
What were some of challenges (personal, institutional, etc.) in researching this topic from a multi- or interdisciplinary perspective?
What were the advantages of undertaking a collaborative approach or interdisciplinary perspective for this project?

- Were drawbacks or hindrances did you find in collaboration? What lessons did you learn in the process?
- What kind(s) of collaboration models or structures is most useful for astrosociological research?

Methodology

- What investigative methodologies did you utilize in your research project?
- Did you need to adapt your discipline's standard methodology to fit an astrosociological research topic? Was the adaptation successful?
- Did collaborating with others outside your discipline create methodological challenges?
- How does astrosociological research rely on traditional academic and scientific investigative methodologies?
- How might astrosociological research efforts require the creation or development of new or hybrid investigative methodologies?

Space research as a whole, and astrosociology in particular, is a collective and cumulative endeavor that transcends individual disciplines and methodologies. It is our hope that this issue sheds light on some of the challenges and rewards of engaging in this interdisciplinary approach and it elicits questions for further dialogue and research.

- Kathleen D. Toerpe

Want to know more about astrosociology or the Astrosociology Research Institute? Interested in submitting an article to this newsletter or our peer-reviewed *Journal of Astrosociology*?

Drop an email to ktoerpe@astrosociology.org and we will add you to our contact list.

Michael P. Oman-Reagan, PhD student

Department of Anthropology

Memorial University of Newfoundland

The Social Lives of Plants, in Space

When I first came across NASA Astronaut Mike Hopkins' Twitter account in 2013, he was frequently posting photos from the International Space Station, his home at the time, and had an active community of 39,000 followers. [1] The photos he shared were a unique view into his life on the ISS. Many were of Earth from above - overlooking deserts, city lights, aurora, and spectra of refractions across our atmosphere. Hopkins also tweeted about other phenomenal encounters, his excited captions transmitting awe from each of his new experiences. Along with a photo of his space walk he tweeted: "*Wow…can't believe that is me yesterday. Wish I could find the words to describe the experience, truly amazing.*" Reflecting on a view of the Sahara he wrote: "*I never thought the desert could be so beautiful.*"

His posts on Twitter revealed insights into these otherworldly encounters, such as this tweet on September 30, 2013: "*Did you know space has a smell? Before ISS hatch to Cygnus was opened, small area between vehicles was at vacuum which left a distinct odor.*" Who wouldn't be in awe of such an experience? As his follower on Twitter, it was inspiring to share in discoveries like this – I never imagined I would receive a first-hand report on the *smell* of outer space. I began following Hopkins on Twitter as part of my exploratory fieldwork in the anthropology of space, the topic of my doctoral work. I was especially fascinated to find that by following Hopkins online I was able to watch him engage not only with his fellow ISS residents and fans down here on Earth, but also with *plants* in space. As social scientists ostensibly studying humans in space, I wondered, how might we account for these engagements with plants and with other non-human life in our research? And what questions arise from considering these relationships?

Multispecies Relations

Since arriving on the station, Hopkins had grown sunflower and pumpkin seeds, and posted updates on the results. In one update he tweeted: "*New life on ISS. A sunflower sprout is now 2 days old. Another few days at this growth rate & it will need a new home.*" *(Image 1)*

Starting out in Ziploc bags, like elementary school science experiments, these sprouts were later photographed after being transferred into more complex containers, modules designed specifically for plants growing in space. But these tubes didn't *contain* the plants – the roots reached out, leaving the containers, looking for more. Hopkins tweeted "*It took a little help, but the sunflower finally broke free from its shell! Freedom at last.*" *(Image 2)*

Image 1: Plant seeds sprouting in a plastic bag.

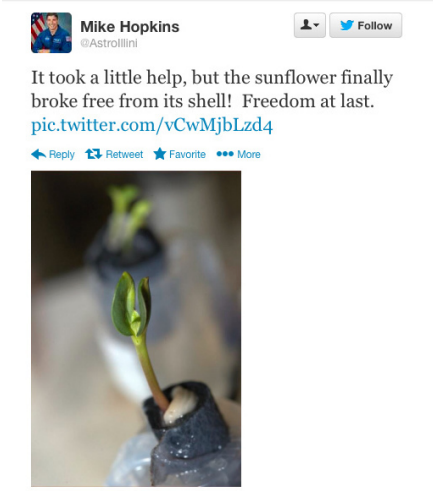

Image 2: Plant sprout growing up out of container.

The Social Lives of Plants, In Space (cont.)

The 1977 NASA publication "Space Settlements: A Design Study" discusses possible roles for plants in a speculative future of human space habitation. Chapter 3, "Human Needs in Space – Appendix A: Psychological and Cultural Considerations," describes plants as a necessary component for the psychological health of humans living in space, especially in preventing the dream-like state of "solipsism syndrome." Plants are important in this regard, the authors argue, because they are to some degree outside the control of humans; they do things that are unexpected, and they require care:

> ### The Solipsism Syndrome in Artificial Environment
>
> Some environments are conducive to the state of mind in which a person feels that everything is a dream and is not real. This state of mind occurs, for example, in the Arctic winter when it is night 24 hr a day. […]
>
> This state of mind can be easily produced in an environment where everything is artificial, where everything is like a theater stage, where every wish can be fulfilled by a push-button, and where there is nothing beyond the theater stage and beyond an individual's control.
>
> There are several means to alleviate the tendency toward the solipsism syndrome in the extraterrestrial communities: […] 3. Something must exist which grows. […] It is important for each person to feel able to contribute personally to something which grows, that the reality often goes in a direction different from expectation, and finally that what each person takes care of may possess increased wisdom, and may grow into something beyond the individual in control […] it is important personally to raise children, and to grow vegetables and trees with personal care, not by mechanical means. It is also desirable to see plants and animals grow, which is facilitated by a long line of sight." [2]

Hopkins' documentation of his plants and sharing of his experience on Twitter demonstrated this dimension of unexpected reality. One form this took was the failure of plants to survive: "*End of the road for my pumpkins. Not sure the cause of death, but I'll try again. Sunflower still growing, but slow.*" *(Image 3)*

Image 3. Plant with a few leaves, withering.

Hopkins tried again, starting a new seed: "*A new pumpkin is on its way! It took a week to reach this point from when I first put water on the seed.*"

As his follower on Twitter, I received Hopkins' public updates about these plants in space. I saw his photos of them sprouting, struggling to break through the seed shell, fighting to grow and thrive, or not. I watched his followers respond to the growth and death of the plants with sensitivity and shared concern. Watching this unfold, I couldn't shake the feeling that there was something both heroic and sad about these plants - small packages of life from Earth, brought into the vacuum of space, just barely protected in the ISS, where they seemingly have no long-term future. Looking at the images on Twitter I first thought how hopeless the plants appeared, tricked into emerging as if there would be sun and soil to grow in, pollinators to visit their flowers someday, animals to spread their seeds, fooled into living in a place they don't belong. And if they did thrive, I wondered, how long could they grow on the ISS? Would they be cared for? Would they be allowed to live? *(Image 4)*

The Social Lives of Plants, In Space (cont.)

In my own home at the time, an apartment in New York City, I also had plants that I cared for. These plants, isolated in pots of soil within my apartment, many floors above the ground, in the concrete canyons of Manhattan – were, in some ways, not that different from those in the space station. Both were disconnected from the Earth, the complex ecosystem of the soil, but still dependent on that idea of soil, and on Earthly products from the ground below, on light approximating our sun. Many of my plants were also cuttings from friends or colleagues – so they were continuations of plants that had been in workplaces or homes under the care of others. They may never have known anything more than potting soil. Could the same thing happen in space? Assuming the plants Hopkins was growing could thrive, would they be accounted for in the atmosphere of the station? Would they take up or contribute resources? I wondered: How big could they get? Would they be in the way or a welcome change to the built environment of the ISS?

Image 4. Sprout with seed still attached growing out of metal container.

These ISS seedlings seemed to have the same precarious relationship with survival that house and office plants do, they depend on our care, on human attention for survival – but they are also threatened by it as we control their growth and reproduction – decide whether to care for them or not, where they will be, how long they will live. Were Hopkins' space plants going to live or die? Online followers of space science were recently able to watch live as NASA streamed the first harvesting and consumption of plants grown for eating on the ISS. Watching this live-streamed event, I wondered what human relationships with plants in space might become in the future.

Interdisciplinary Futures

Colin Milburn describes science fiction as a "repository of modifiable futures" for science. [3] Keeping this idea in mind, I turn to the speculation of the sci-fi repository to consider questions about human (and plant) futures in space. Recently plants have played a central role in human survival in speculative fiction, appearing as oxygen gardens for long term space voyage in the film *Sunshine* (2007), and as a cyborg-forest-oxygen-factory in spaceships on the television series *Doctor Who* (2010). (*Image 5)*

Image 5. Cyborg factory and oxygen forest. ***(Doctor Who)***

In today's actual world of tentative steps toward longer-term space habitation, the roles of humans and plants are somewhat reversed. Humans care for plants and the plants live or die in our hands – much like those under the care of a space dwelling botanist in the 1972 film *Silent Running*. On a small station such as the ISS, I wonder: what role might these plants play aside from that as subject in scientific experiments? How do the crew experience the plants? How are they considered? Cared for? Are they part of the crew?

Despite not being intended as an "oxygen garden" the plants on the ISS are still exchanging carbon dioxide for oxygen, they are still engaged in an intimate relationship of the breath with the humans on the space station. What about other life that may have hitched a ride on the ISS? Are there microbes living on the seeds, the leaves, or in the roots, or on the humans? Perhaps there must be, in order for the plants and people to survive. Can plants survive in the

long-term without the microbial ecosystems and networks of fungi that make up our Earthly soil? If they do, what kind of life, what kind of experience is it for a plant to be disconnected from the Earth and the soil, the insect, fungus, and microbial communities of the Earth? What kind of experience is it for a human to be disconnected from these same fungal and microbial worlds? *(Image 6)*

Image 6. Tending the biodome ecosystem. (*Silent Running*)

In *Silent Running*, space freighters carry biodomes full of plants. The plant arks and their precious cargo are cared for by a live-in ecologist with the help of robot companions. In this imagined future, all plant life on Earth is extinct and these plants are preserved to later repopulate Earth. In the film, however, orders come from Earth to destroy the plants and put the freighters back into service transporting commercial goods. Disobeying the orders, the hero botanist sets out into deep space to continue caring for the plants. These themes from *Silent Running* re-appear in *WALL-E* (2008), an animated film in which a waste disposal robot discovers a sprout growing on the long-abandoned Earth. The discovery of this sprout means the planet may once again be suitable for humans after a previous generation's consumerism made it uninhabitable. *(Image 7)*

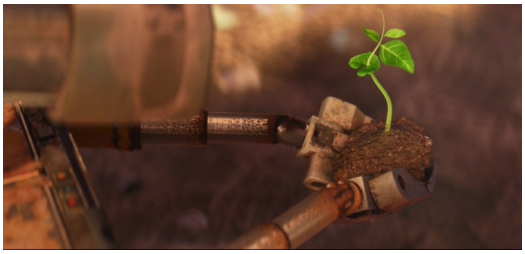

Image 7. The robot finds a sprout. *(WALL-E)*

It was unlikely that astronaut Mike Hopkins' adventure with his plants would end as *Silent Running* does, with Hopkins setting out into deep space to protect his seedlings. Hopefully our current era of anthropogenic climate change and environmental destruction won't end as the film *WALL-E* begins, with the Earth made uninhabitable. There is, however, a similarly intimate multispecies relationship in Hopkins' plant posts on Twitter – he cares about these plants, shares something with them and this is something worth attending to. In the future, such care – the acts and experiences of plant caretaking – may become central to human lives as we move into space and onto other worlds. Social scientific research on human futures in space can benefit from the inclusion of recent interdisciplinary scholarship on plant sensoria [4] and multispecies engagements.[5] Considering life of all kinds in our work ensures we conduct research in terms of the full range of experiences implicated in being here on Earth while remaining open to possible encounters and existences elsewhere.

A proposal from NASA Ames in 2013 describes the first Lunar plant experiment in which a self-contained seed germination test unit would be placed on Earth's moon. The project would rely on corporate ventures, hitching a ride on a Google sponsored Lunar X-Prize trip. Such plant experiments could provide valuable data about whether plants can grow in the radiation on the moon, but they also serve as analogs for human experience across several registers: "As seedlings, [plants] can be as sensitive as humans to environmental conditions, sometimes even more so".[6] Aside from fighting solipsism syndrome, cleaning our air, or serving as salad ingredients – perhaps plants, with their many sensitivities, will also be sympathetic companions for humans living in space who, like them, are coping with life in a hostile new environment – far from home.

Notes

1. https://twitter.com/AstroIllini

2. Johnson, Richard D. "Space Settlements: A Design Study. NASA SP-413." *NASA Special Publication* 413 (1977), 29.

3. Milburn, Colin. "Modifiable Futures: Science Fiction at the Bench." *Isis* 101, no. 3 (September 1, 2010), 568.

4. Myers, Natasha. "Conversations on Plant Sensing: Notes from the Field." *NatureCulture*, no. 3 (Forthcoming).

5. Kirksey, S. Eben, and Stefan Helmreich. "The Emergence of Multispecies Ethnography." *Cultural Anthropology* 25, no. 4 (November 2010): 545–76.

6. NASA. "LPX First Flight of Lunar Plant Growth Experiment." *NASA*, June 7, 2013.

How to Engage Space Community Partners on Research Projects

Alan Steinberg, PhD

Center for Civic Leadership

Rice University

As a social scientist working on space related issues, the data I analyze comes from the decisions of government, the opinions of people, and the actions of space-related organizations. Often to get at these sources, I have to engage with people and organizations in the space community. Such engagement is not always quick or easy. Cold calling a space organization and asking for help on a research project is not likely to get you what you need. Instead, you must form relationships within the space community so that you are not just taking, but also giving back. While this can be done in various ways, I will share my experiences and some of the trials and tribulations I have encountered including discussing two research projects that involved extensive space community partnerships, though in different ways.

I see my relationship to the space community as one of give-and-take; whereby, I need access to data for the purpose of providing valuable insight. My relationship is also a little more interlaced than a typical researcher (if such a thing even exists), as I am also part of the space community through my volunteer work with various space organizations including Yuri's Night, the Space Generation Advisory Council, and the Moon Society. In addition, as I work with partners on research, I get pulled into the community even further. This provides me with both an insider perspective and an expanding network of people with whom to work. The insider perspective allows me to understand the wants and desires of the space community, but it may also complicate the objectivity of the research. The network provides a greater reach to different data sources, but means that at times I have to be mindful of what I write as it may cause rifts among some of the nodes in the network.

Part of the goal behind my research is to provide stakeholders in the space community with research and analysis that will help their endeavors. Therefore, I attempt to partner with space organizations at various stages of the research process and to differing degrees in order to gain stakeholder buy-in and build a spirit of collaboration. This helps ensure that the work has the highest possible value to the space community and opens doors to future projects.

In my research, working with community partners has taken on two different models. On the one hand, members of the organization can take an active role in the project; on the other, the organization provides support or data for a project with which they are not directly involved. The best way to explain these two methods of interaction is by describing two projects that demonstrate the need for connections and highlight the various ways of working with space community partners.

Projects

One of the first projects I worked on that involved engaging partners in the space community was a recently published article in the *Journal of Astrosociology* [1] whereby I worked as an insider with other members of Yuri's Night to analyze their use of social media and draw conclusions about what styles and methods of web 2.0 communication were providing the best value to the organization. Access to some of the data in this analysis would not have been possible without having Yuri's Night involved; and having members of the organization actively involved with the project allowed for a deeper understanding of the organization's reasoning for particular actions. In addition, having Yuri's Night's buy-in with the project ensured that my work was going to be of value to that organization. The paper provided insight to social media usage that space organizations as a whole can learn from and has provided a starting point for another project.

The next project involves comparing the social media usage of multiple space community groups. In order to get the data necessary to do this analysis, I needed their cooperation, as the data being used is not publically available. Over the course of the last six months, I have been able to connect with over a dozen organizations to gather data for a project entitled "Reaching for the Stars: A Study of Facebook Use by Space NGOs." The project will be exploring the Facebook use of non-profit organizations whose mission includes advancing or influencing space policy, engaging in space advocacy, and/or raising awareness or interest in space among the public. Getting space organizations to agree to participate required a mix of connections within the space community, a solid reputation as an academic, and showing the value of the research to the organizations that would be involved. Unlike the previous project, this one will not have a focus on any particular space organization and will not have the direct involvement of these organizations beyond the data they have provided.

These are but two examples of how a researcher can engage with a space community partner to varying degrees. In these examples I have briefly highlighted the need for networking, solid academic skills, and providing value for the stakeholders in order to get buy-in from the space organizations. There are other examples where working with partners is necessary, be it to help spread a survey, to write about the history of space organizations, [2] to interview members of the space community [3] or even just to get access to data.

Challenges

It should be noted that working with partners could also bring with them unique challenges. In my own work I have often had to assuage fears of privacy when dealing with survey research or social media information. For me this has been a relatively small hurdle often solved through discussion of the partners' concerns. However, other projects may involve more complex issues ranging from technical issues like software incompatibilities to information security issues like proprietary and legally restricted information. These hurdles are not necessarily insurmountable, but will add time, cost, and complexity to any research project. It is critical to respect the wishes of those space community partners. One slip with publishing data that an organization did

not want public, and instead of just losing access to that data source you may find many doors with other members of the space community now closed to you as well.

To those academics out there who want to connect with space community partners, focus on building your network and doing solid work. Your network will be an invaluable point of access, and your background will help open the door. Decide if you want to try to remain an objective outsider or if you want to try to walk the difficult line of being an unbiased insider. I feel that being an insider is worth the costs. My interest and passion for space does not prevent me from doing unbiased research and presenting thorough analysis; rather these factors are what propelled me to pursue space policy as a research topic in the first place. Regardless of the choices you make, the key to successful collaborative research is understanding the needs of the potential community partner and working to address those needs. This will allow for greater involvement by stakeholders and reduce potential barriers to cooperation.

Notes

1. Alan Steinberg, Jeffrey Alles, & Ryan L. Kobrick. "Exploring How Social Media Can Be Used to Promote Space Awareness: A Case Study of the Yuri's Night Web 2.0 Strategy." *Journal of Astrosociology* 1 (2015): 31-54. Available at http://www.astrosociology.org/Library/PDF/Journal/JOA-Final/JournalOfAstrosociology-Vol1.pdf.

2. Michael Michaud, *Reaching for the High Frontier: The American Pro-Space Movement, 1972-84* (Santa Barbara, CA: Praeger, 1986)

3. John Logsdon. *John F. Kennedy and the Race to the Moon* (London: Palgrave Macmillan, 2013). John Logsdon. *After Apollo?: Richard Nixon and the American Space Program* (London: Palgrave Macmillan, 2015).

Norah Patten, PhD

International Space University

The Only Way is Up: Ireland's First Secondary School Experiment on the ISS

At the tender age of 11, I visited NASA in Cleveland and have been fascinated by space exploration ever since. I spent many years focused on my studies and developing my own space career. I had the opportunity of going to NASA on several occasions and now I work at the International Space University. It was time to bring something back to the younger generation at home in Ireland.

In 2013, I created The Only Way is Up project while working at the Irish Centre for Composites Research. Ireland is a country without a space agency and yet through a partnership with NanoRacks, a commercial space company, it was possible to send the first Irish high school experiment to the International Space Station (ISS). I raised the necessary funding for the project through a number of different sources, including writing a successful grant application to the Irish government, to fund one NanoRacks Mixstix.*(Image 1)* The Only Way is Up was announced to schools in Ireland in September 2013, which allowed transition year students to submit ideas for experiments they would like to send to the ISS. *(Image 2)*

The Only Way is Up (cont.)

Image 1. NanoRacks Mixstix device for delivering student projects to the ISS.

Image 2. Norah Patten at the Next Generation Plenary at the 2015 International Astronautical Congress conference.

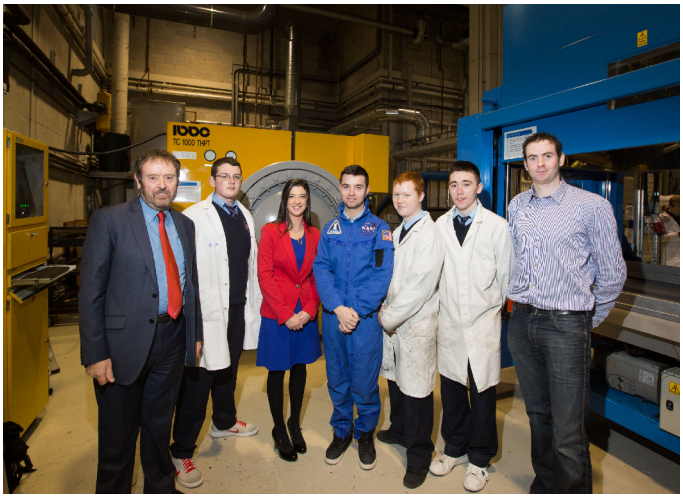

Image 3. University of Limerick Space Experiment: Dr. Terry McGrail (Irish Centre for Composites Research Director and Technology Leader) and Dr. Norah Patten (The Only Way is Up project coordinator) with Jamie O'Connell, Jonathon Roche, Kevin Hanley and Jason Hannon (students) and Mr. Gavin Doyle (teacher) who developed the winning experiment. (Photo credit Sean Curtin)

Throughout the project, we spoke to hundreds of students from around Ireland about the importance of microgravity, research, space exploration, and the utilisation of the ISS. The students had many questions about space and were given an opportunity to research space related topics for themselves. They worked in groups to develop ideas of what research they would like to send to the ISS. For the first time in Ireland, second level students had an opportunity to send their research to the International Space Station. They watched YouTube™ videos of Chris Hadfield, began to think about space research, and asked questions about the importance of space.

In the words of one of the students, "If we get an opportunity to do this, then maybe they'll see that we need something like this and students want something like this." This was an opportunity I would have absolutely loved to have had when I was in school, and now I was able to bring it to students in Ireland.

In all, over 140 students submitted ideas for space projects and the winning experiment - investigating the effects of microgravity on reinforced concrete from students at the University of Limerick - was selected in February 2014. We spent several weeks preparing the experiment for the Mixstix and it flew to the ISS on board the Orb-2 resupply mission in July 2014. (*Image 3)* Measuring the impact of a project like this is difficult, but if it results in students being inspired and dreaming a dream bigger than before, then it was worthwhile.

Commercial space has opened up many avenues to inspire the next generation. Companies like NanoRacks have made it possible for countries without space agencies, like Ireland, to send experiments designed by teenagers to the ISS. But projects like this need people like us to pull them off – people who love space and exploration and understand the need to engage with and inspire the next generation. Success takes many shapes and forms; it is the accomplishment of an aim or purpose. We need to ask ourselves: what is our aim or purpose in life, and how can we succeed?

Chris Welch, PhD

International Space University

Worldship Society

Introduction

Between September 2014 and the end of August 2015, the International Space University (ISU) MSc in Space Studies (MSS) brought together graduate students and space professionals from all over the world to form the MSS15 class. The MSS15 students were immersed in an intensive interdisciplinary, intercultural, and international (3i) space curriculum. A key part of the MSS is the 3i team project. One of the MSS15 3i team projects – later named *Astra Planeta* (ISU 2015) - was focused on the possibility of human interstellar travel by a multigenerational slower-than-light worldship and the development of an interdisciplinary roadmap to enable the launch of such a craft within a nominal one hundred year timeframe. The *Astra Planeta* project was executed by a team of twenty-two students from eleven countries. It evaluated the current level of understanding of interstellar flight with specific reference to worldships - craft carrying populations of 100,000 people at slower-than-light speeds - with journey times of hundreds to thousands of years. It identified disciplinary and interdisciplinary knowledge gaps in the field and defined potential technical and non-technical solutions for closing them. These were then integrated into the overall roadmap leading to a future worldship launch for a mission consisting of a single worldship directly travelling to a single stellar system within 25 light years for the Solar System. In particular, as part of the project the team examined a range of societal aspects of life on a worldship. Their findings are summarized hereunder but can be found more fully described in *Astra Planeta* (ISU 2015).

Population

One possible approach would be to use the smallest initial population possible concomitant with ensuring genetic diversity and then allow the population to expand. At the same time, the age distribution needs careful consideration. The first crew might have the same age distribution as that of the general population. Alternatively, it could also be comprised of an educated set of the youngest individuals possible. A smaller homogeneous initial population might lead to a less confrontational society, but would increase the measures needed to maintain genetic diversity, while a more heterogeneous population would negate the latter but increase the number of possible inter-group confrontations.

Culture

Deciding the culture of the worldship - if, indeed, this is possible - will be affected by conditions prior to its launch. Whether a monocultural society or a multicultural one is best for a worldship is by no means clear, let alone which of the many cultures possible. Irrespective of this, however, the worldship's own culture(s) will develop over time, forming identities separate from those of Earth.

Ethics

There are many ethical considerations. One of these is the treatment of the deceased. The ship will not be able afford the cumulative mass loss of 'burial at sea.' All bodies would have to be recycled back into

the ecosystem in some manner. Another consideration relates to what actions may be considered ethical on-board – cut-off from any direct assistance from the rest of humanity – which would not be considered ethical on Earth.

Religion

A significant amount of political and financial power follows religion. Might a worldship be a religious undertaking and what would be the implications of this? Alternatively, would a worldship population be required to be multifaith or atheist? In either of these cases, might new religions emerge in deep space between the stars?

Language

Similar to other psychological and cultural issues of in-group and out-group biases, language could potentially divide the population and create problems, especially between those groups whose languages do not have etiological links. A common language would aid collaboration and cohesion. In all these cases, though, the languages would evolve after departure from the Solar System. As long as communication with Earth occurs, this might be mitigated. However, with time the worldship language(s) will likely evolve into something incomprehensible to those not born on-board.

Education

Effective educational systems will be essential to produce a competent and effective population. As the worldship travels beyond the Solar System and communication with the Earth decreases and takes longer, the population will need to be increasingly self-reliant. Since their survival will depend on their capability to repair, recycle, and reuse the resources available, a deep understanding of worldship operations will be necessary at all levels.

Economy

If the worldship population is to live together peacefully, the exchange of ideas, goods and resources, and the ability of the population to benefit from these, seems essential. Any such interchange needs a system of regulation, though. Like current terrestrial societies, either a market or a controlled, mixed economy are most likely. Which of the options is optimum in a worldship is not straightforward, though, since these are inevitably also culturally and socially linked.

Conclusions

The topics outline above give a only a very broad idea of the societal areas of inquiry pursued by the *Astra Planeta* team members during their consideration of worldship society. For more detailed information on this – or aspects of the project – readers should consult the main report, which is referenced below.

References

International Space University (ISU), 2015: *Astra Planeta Final Report*, available at https://isulibrary.isunet.edu/opac/doc_num.php?explnum_id=731

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Australian Aboriginal Place Names in the Solar System

The International Astronomical Union (IAU) was established in 1919, and took on the task of administering the names of places and features in the solar system. The IAU maintains the Gazetteer of Planetary Nomenclature, in collaboration with the United States Geological Survey. Since the 1950s, spacecraft has replaced the telescope as the principal means of solar system exploration; and the number of identified places and features has increased dramatically with fly-by, orbiting, and surface missions to most planets and moons.

In general, names are drawn from a list of preferred sources, which includes collections of myths and legends, ethnographies, word lists, and atlases. More recently, crowdsourcing has been utilized to enable public participation in the naming process, facilitated by groups such as SETI and spacecraft mission teams.

The original rationale was to systematize naming for scientific purposes, so that astronomers and planetary scientists could be sure they were talking about the same feature. However, in keeping with the United Nation's *Vienna Declaration*, the IAU also aims to represent diverse cultures in the naming process, affirming that space is the common heritage of humanity. This can be particularly meaningful in the case of Indigenous cultures who have endured the ravages of European colonialism.

Of over 15,000 officially named places in the solar system (excluding Earth), approximately 0.3% are Australian Aboriginal words. They are found on three planets, Venus, Mars, and Pluto (although note that Pluto names are unofficial at this stage), four moons of Saturn, one moon of Uranus, and four asteroids. Most of the names are from Aboriginal ancestral beings related to the naming theme of the planet. The theme for Venus is love; accordingly there are eleven features named for Aboriginal female beings associated with fertility and creation. Some places, particularly on Mars and the asteroids, are named after similar features or relevant towns in Australia, which happen to have Aboriginal names.

While this research is very preliminary, the principal question raised is what the names connote in their new context. Across Australia, there are 'Dreaming' landscapes created by the same beings that are also featured in the Planetary Gazetteer – for example, the Wawilak (Wawalag) sisters on Venus. They are also the focus of major ceremonial cycles practiced by contemporary communities. The use of some words is subject to restrictions based on gender, age, grade, or moiety, while others refer to parts of the landscape for which there is specific knowledge, or custodianship. These are not forgotten 'gods and goddesses,' like many of the classical names so common in the solar system, but very potent symbols of continuing Aboriginal cultural practices against the formidable array of colonialist alienation technologies.

One set of names evokes a very particular landscape of northern Arnhem Land, in the country of Yolgnu people, particularly around Milingimbi Island. This is of additional interest because it relates to Aboriginal music on the Voyager Golden Records (Table 1).

Australian Aboriginal Place Names in the Solar System (cont.)

Location	Name	Feature type	Description
Venus	Banumbirr	Vallis	The planet Venus; also a ceremonial cycle.
	Miralaidj	Corona	A female Djangguwul sibling
	Madalait	Corona	A female Djangguwul sibling
Titan	Bralgu	Insulae	Also called Barralku, Island of the Dead; the Djangguwul siblings stopped there, and the Morning Star (Barnumbirr) rises behind it.
Pluto	Djangguwul	Fossae	The three siblings who travelled by canoe to the mainland via Barralku and created law, ceremony and landscape. Also sometimes the name of the male sibling
Voyager spacecraft	Moikoi	Song	About spirits who try to entice the newly dead away from Barralku
	Morning Star	Song	*Manikay* clan song, indicative of land ownership

Table 1. Names of Northern Arnhem Land.

These names refer to two major ceremonial cycles, the Barnumbirr and the Djungguwul; the ancestral beings who are the Djungguwul; distant places like the island of the dead and the land of the morning star, and to creation and death. The very brief story is that the two sisters and their brother came from the sea, via the island of Barralku, and when they landed on the mainland, they brought the landscape and humans into being. Barralku is the place where the spirits of the dead go from their own land, if they are not enticed away by the *morkoi* spirits before reaching it. Major versions of the Barnumbirr and Djangguwul ceremonies centre on Milingimbi Island off the coast of Arnhem Land, and it was also here that anthropologist Sandra Le Brun Holmes, in 1962, recorded the music that was later selected for the Voyager Golden Records.

This is an extraordinary cultural landscape. The terrestrial landscape shaped by the Djunggawul is that lived by Yolgnu people today, sustaining their law and culture. The colonialist structure of space exploration has translated these concepts and places into a new setting which spans the solar system. What it may mean to have key places and beings in a 'Dreaming' landscape extended to outer space is a question that only the communities concerned can answer.

These names can do more than just represent Aboriginal people in space: there is the potential to contribute to sustaining culture in the present. Many projects in Australia today are repatriating objects and knowledge, in the form of artifacts, photographs, diaries, stories, administrative records, names and more, to the communities from which they were taken. There are numerous successful language revival projects which use colonial word lists to re-invigorate what has been lost. There's also a growing interest in Aboriginal astronomical knowledge, such as that relating to Venus.

A first step might be repatriation of the place names of the solar system. In the Djungguwul example, the IAU sources lead to detailed ethnographic accounts by anthropologists Ronald and Catherine Berndt, collected in the field from the 1950s to the 1970s. The communities, families – and perhaps some individuals - with whom the Berndts worked continue to live in the landscape of the Djunggawul. A next phase in this project would involve identification of all original sources used for Aboriginal names in the Planetary Gazetteer, identification of the contemporary communities to which they relate, and a process of consultation, perhaps leading to appropriate protocols for selecting and using Aboriginal language place names in the future.

Note: this research was originally presented at the Australian Places and Placenames Symposium, 25 September 2015, Flinders University, Adelaide

Student Perspectives

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Researching Mars Colonization: An Interdisciplinary Approach

Could you imagine living on Mars? Or being one of the first humans on Mars? The cool factor alone would be off the charts. Therefore, it is not hard to see why people want to get there within their lifetime. The question is, do we need to rush to get to Mars? If so, at what cost? What are space organizations telling the public? These are some of the questions that I examined within my research [1].

Methodologically, no theoretical framework was used. I did use a selective content analysis by searching several media outlets including promotional videos and news conferences for content that involved space colonization. The common themes of biological, colonial, and utopian narratives were ubiquitous. Moreover, potential candidates for the Mars One mission were also repeating many of those same narratives that space organizations were promoting. Therefore, I chose narratives that needed to be challenged.

Specifically, some space advocates express ideas of biological determinism that space exploration is in our genes, our nature, or our destiny [2]. However, my findings suggest that space exploration is based on culture and when we decide to venture out there, humans are making conscious decisions. I also challenge the rhetoric of the golden age of the explorers and suggest that men such as Columbus or Magellan are not people to hold up on a pedestal. We should, however, look towards more humanitarian examples of people who faced adversity and were courageous, such as the American Harriet Tubman. Mainly, my research focused on the use of fear messages and marketing ethics. The "colonize now or stagnate and die" [3] narratives may not be ethical and perhaps, especially to children, might be more anxiety inducing messages than inspirational.

Reflexively speaking, I come from both a psychology and anthropology background. Trying to marry the two disciplines has been difficult. Despite the fact that some may see science and the humanities like oil and water, I tend to see the interesting possibilities that they provide when they align. Since my research was informed by different disciplines, I ended up with a more balanced perspective on my topic. There was a license to be more fluid with the philosophical sections, adding scientific data into the mix gave me a nice theoretical cocktail.

The biggest methodological challenge was the writing. When I write psychology papers, I am told to cite more. When I write anthropology papers, I am told to cite less. Science writing requires you to back up everything you say, other than specific points of your novel research. Writing more philosophically, I am required to offer more about my own thoughts rather than citing many others.

I knew that I was going to submit my research to a mainly scientific journal as opposed to a humanities journal, so I cited as much as I could. The peer reviewers came from a scientific background and claimed that more of my paper needed to be backed up. When giving my manuscript to anthropologists, they said

that I should have had fewer citations. These views are deeply embedded within each discipline. Therefore, I don't see those points changing any time soon. However, if science and humanities researchers can see the pros and cons of each side, then collaboration between the two could focus more on the content of their ideas as opposed to nitpicking writing styles.

Here is one example of how I blended the two disciplines within my research. I compiled examples of the different arguments for rushing to Mars, which included discourse and scientific research on the idea of immortality. I included philosophical positions on immortality to contextualize and give rise to ideas that backed up my points. I also included more scientific, experimental ideas of immortality via research done on Terror Management Theory [4].

Patience is needed in order for interdisciplinary collaboration to work. Whether the discipline falls under science, social science or philosophy, we have much to gain by working together. At the beginning of human spaceflight, NASA was preoccupied with the mechanics of flight itself and failed to take into account mental health and behavioural issues. When communication problems arose between crewmates [5], officials began to think about psychological effects of astronauts in space. Many of those problems may have been avoided if the NASA team had more interdisciplinary-minded individuals.

If you are hesitant to embrace the interdisciplinary approach, there are a few points to consider. Firstly, gather some information on the discipline that you are not familiar with. Having some knowledge of what the field is about and how people research differently will give you insight as to how you may approach collaboration. Secondly, contact others who you think might be able to help you out. If they are in a field that you are unfamiliar with, then inquire if they would be interested in having a discussion. That way you aren't committing to a major research project. Simply talking to a fellow colleague will help inform you as to whether collaboration is a good idea, or they may be able to point you in the right direction. The possibilities are endless in regards to how different perspectives can open minds and offer new ways of approaching the challenges of space.

Notes

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