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ENCOURAGING LEGAL AWARENESS IN STEM GRADUATES: LESSONS LEARNED FROM SPACE GENERATION CONGRESS 2014

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An ongoing challenge in the aerospace sector is the need for STEM graduates to familiarize themselves with the legal and political realities that will permeate their careers. At the recent Space Generation Congress, students and young professionals were challenged by a role-playing exercise as they examined the legal and regulatory framework surrounding on-orbit servicing – itself a topical field of study. This paper will present lessons learned from this innovative approach to workforce development.

I. INTRODUCTION

An ongoing challenge in the aerospace sector is the need for students from the Science, Technology, Engineering, and Mathematics (STEM) fields to familiarize themselves with the legal and political realities that will permeate their careers. A business plan for a successful project encompasses and must address not just programmatic, engineering, financing, and other risks, but it must also consider the legal and political challenges which might impact the project. Taking into account the legal and regulatory hurdles for space projects should be included in any project, as well as understanding the political and administrative context of any project.

In an ongoing effort to meet this challenge, the Secure World Foundation has sponsored working groups at the yearly Space Generation Congress (SGC) since 2009. The Secure World Foundation (SWF) is a private, endowed operating foundation dedicated to the secure and sustainable use of space for the benefit of Earth and all its peoples.[*] By contributing their expertise to the young space professionals at SGC, SWF acts on its belief that bringing awareness of the legal and political dimensions of space activities to those from the STEM fields is an integral part of assuring space sustainability in the years to come.

At SGC 2014, SWF continued their support of SGC by organizing a working group discussing on-orbit servicing (OOS), itself a topical field of study. In a change from previous years, the OOS working group was challenged to examine their topic through a role-playing exercise, a first for SGC and for SWF. The exercise sought to enhance the perspective of the participants and to further their understanding of the complexities of the legal framework surrounding space activities.

This paper will introduce SGC and the role-playing exercise undertaken by the OOS working group. Next, the specific benefits of education-through-simulation

[*] Secure World Foundation, http://swfound.org/.

will be highlighted using examples from the Congress experience. As a test of this educational tool's ability to generate valid research results, a critical examination of the resulting recommendations will be presented using perspectives from the project's industry and agency advisors. Finally, observations from the organizers will be provided for future applications of this tool for the development of the global space workforce.

II. THE ON-ORBIT SERVICING SIMULATION AT SPACE GENERATION CONGRESS 2014

The Space Generation Congress (SGC) is the annual meeting of the Space Generation Advisory Council (SGAC) held in conjunction with the International Astronautical Congress. Participants are highly qualified young professionals and top performing university students. Endorsed by United Nations Office of Outer Space Affairs, the SGC aims to unify and promote the voice of the next generation of space leaders on international space development.

II.I The Role of Working Groups at SGC

The SGC is designed to facilitate the discussion on current and prominent issues within the space community. To allow for this, the congress is split into several working groups covering the areas of entrepreneurship, satellite communications, commercial space, (human) space exploration and Earth observation. Over three days, the STEM students and young professionals collaborate to develop opinions and recommendations on these topics.

The typical structure of the working groups involves a moderator who oversees and directs the discussion and is responsible for the content and specific focus of the group. The moderator is accompanied by one or more subject matter experts (SME), who generally are experienced industry professionals. The SME act in an advisory role to monitor the discussion and provide insights into their part of the space industry.

Over the course of three days, the working groups are split into smaller sub-groups that have a more specific focus within the broader topic under consideration. Discussions continue and various sub-groups collaborate to obtain a cohesive set of recommendations. These recommendations are the principal output of the SGC and mainly focus on the development of new national or international policies. They should always voice the opinion and vision of the next generation of space professionals.

II.II Our Approach: A Simulated Hearing

During the 2014 SGC, one working group examined the legal and regulatory framework surrounding the on-orbit servicing (OOS) missions. This working group consisted of twenty-four university students and young professionals drawn from fourteen countries involved in space activities.[†]

To better familiarize the participants with legal and political procedures, the group moderator and SME facilitated a role-playing exercise. Participants were assigned a major stakeholder relevant to the industrial and regulatory aspects of OOS activities. Small-group discussions were carried out amongst the allocated stakeholder groups. The full-group discussion was carried out as a series of simulated hearings between the domestic regulators (of some fictional country) and the rest of the stakeholders.

The major stakeholders considered in the exercise were the following:

- **OOS service provider:** executive members of a fictional company owning the intellectual property for *Canadarm*, who also have access to a modular spacecraft bus and a spaceplane platform.
- **OOS customer:** executive members of a dominant telecommunications satellite service provider for Europe and Asia Pacific; seeking economic benefits from the lifetime extension and upgrading of existing satellites.
- **Prospective angel investor:** individual with the capability of investing up to two billion US dollars into the OOS industry.
- **Domestic regulators:** an intergovernmental panel consisting of members from the Foreign Ministry, Executive Office of Science and Technology Policy and the Ministry of Aviation.
- **Domestic military liaison:** highly ranked military officials with responsibility in the classified reconnaissance and Earth observation areas; main concerns lie in the potential of the weaponization of space assets.
- **Allied country delegation:** Foreign Ministry of an allied state seeking to license and regulate OOS.
- **Non-allied country delegation with military attaché:** permanent delegation members of the United Nations from a non-allied country; main concerns are with potentially hostile capabilities of OOS spacecraft.

Over the course of the SGC three hearings were held, with small-group discussion before and after each session. The main objective of each sub-group was to represent their stakeholder in the best possible way,

[†] Working group participants: Laura Bettiol, Daniel Brack, Emma Braegen, George Calder-Potts, Joyeeta Chatterjee, Kathleen Coderre, Roxanne Côté-Bigras, Matthew Driedger, Caitlin Egen, Emilie Froeliger, Eren Gorur, Jacob Hacker, Weston Hankins, Alaa Hussein, Ilji Jang, Martin Losekamm, Matthew Noyes, Lyle Roberts, Nikita Sardesai, Bruno Sarli, Thomas Sinn, Anne Wen, Eric Wille

such that the regulatory board would include their concerns and requirements into its decision-making process. The board was tasked with attempting to find a political solution to the problem of a missing regulatory framework. Each group was asked to give a brief presentation about their point of view, followed by a period of questions by the board.

II.III Our Results

One of the main questions arising during the hearing was: Who is liable for any future damage caused by mission-related debris from OOS missions and over what time frame is this liability maintained? In conjunction with this issue, it was noted that the ultimate liability of launching states, as currently defined in the Outer Space Treaty‡ and the Liability Convention, may not be economically feasible for extensive OOS activities. Additionally, launching states issuing national licensing regulations could build upon international policies, if they existed.

Another important aspect discussed during the hearings was the prevention of the weaponization of space, i.e. how to create the necessary transparency for all stakeholders to be able to assess the non-hostile character of planned operations. Trade embargos and restrictions might interfere with creating transparency and with OOS activities in general.

Based on the results of the discussions, the following recommendations were formulated:

1. Extend the Outer Space Treaty to cover on-orbit servicing and active debris removal activities.
2. Initiate the monitoring and licensing of on-orbit servicing and active debris removal activities by national government agencies.
3. Create governmental support and demand for the on-orbit servicing and active debris removal industry.
4. Create sufficient transparency to prevent the weaponization of space.
5. Initiate a global debris removal initiative.
6. Initiate the creation of global regulations for limiting debris creation and active debris removal.

III. OBSERVED BENEFITS OF EDUCATION-THROUGH-SIMULATION

When examining the OOS working group as an educational tool, a number of benefits were realized when compared to the typical structure of an SGC working group. These benefits are highlighted in this section as indicative of the larger benefits of education through simulation.

Experience of intense research and preparation. In a traditional working group, a great deal of time is spent in open discussion exploring the topic from many angles. By assigning small groups a specific role motivated by a tangible stakeholder profile, the simulation permitted the examination of this topic from the viewpoint of seven different stakeholders. The working group delegates embraced this opportunity by sequestering themselves in various parts of the conference venue for focused research and discussion.

Realization of tension between simulation stakeholders. As working group delegates assumed their stakeholder roles, natural collaborations and confrontations arose. The delegates took it upon themselves to consult with their natural allies and took care to prepare their defences against competing interests. This tension was most tangible in the late stages of the hearing preparatory work and had a noticeable motivating effect on the delegates.

Exposure to dynamic nature of real-world relations and regulatory hearings. As discussed in the previous section, a traditional working group divides into subgroups which focus on distinct subsets of the larger topic. The working group recommendations are then an agglomeration of the recommendations from the subgroups. In contrast, the simulation forced delegates to defend their stance as their concerns and requests were examined in turn by the domestic regulators. As an added benefit, the delegates were forced to defend themselves orally and publicly – skills not often developed by traditional STEM education.

The encouragement of debate between STEM graduates on topics of law & policy. By design, the simulation scenario forced delegates to advocate for and against solutions based on legal and policy grounds. The delegates with a STEM background – which constituted a majority of the working group – were therefore forced to operate outside their area of expertise as they debated the ideal regulatory environment for future on-orbit servicing activities. Thus, the simulation succeed in its ultimate goal: fostering a deeper understanding of the importance of the legal and political realities critical to on-orbit servicing and space activities as a whole.

IV. EXAMINATION OF RESULTS

As a test of this educational tool's ability to generate valid research results, a critical examination of the methodology and resulting recommendations is presented in this section, using perspectives from the working group's three Subject Matter Experts (SMEs).

‡ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]; The Convention on International Liability for Damage Caused by Space Objects, Mar.29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].

IV.I Industry Perspective

Robert Bell, the Executive Director of the Society of Satellite Professionals International, served as the Industry SME for the working group. He provided the following evaluation of the working group methodology and recommendations:

This report validates my first conclusion about simulation-as-education as I witnessed it at the 2014 SGC: the seriousness and good preparation evidenced by the members of the working group. As a subject-matter expert, I fielded many good questions and had the opportunity to brief the group on the current commercial realities of the satellite business and the emerging commercial OOS sector. I appreciated the opportunity because, as is usually the case, these young space enthusiasts knew little or nothing about the only industry so far that does business and generates revenue in space.

The recommendations emerging from the group are cogent, reasonable and well directed to the challenges uncovered in the group's deliberations. I do believe, however, that there is a missing piece that could be better addressed in future simulations.

Since the beginning of commercial space operations with the launch of Intelsat 1, governance and regulation of the sector has responded to commercial developments more than they have shaped those developments. Businesses innovate and, in the process, stretch the boundaries of current policy; policy makers then work to fill gaps and adjust to new capabilities. The current moment is a dramatic example, with several new global LEO constellations proposed, small sat companies delivering earth observation services that were once the exclusive province of LandSat, and the MEO system O3B achieving sustainable commercial success. OOS is yet another example.

I recommend that future SGC simulation sessions work to attract more commercial executives to brief the teams and better inform their deliberations. There may even be value in developing a standard briefing on the commercial space sector to bring the group up to speed on global developments, so that the recommendations reflect the real-world challenges faced by the biggest investors and actors in the space sector. I would also like to see recommendations coming from the working group that promote business-government consultation and collaboration on initiatives. An advisory process that focuses on creating recommendations for the United Nations naturally stresses policy and regulatory action. But the recommendations will ultimately carry greater weight if they recognize the seminal role of the commercial sector.

IV.II Agency Perspective

Daniel Rey, the Head of Space Exploration Systems Engineering at the Canadian Space Agency, served as the Agency SME for the working group. He provided the following evaluation of the working group methodology and recommendations:

As an invited guest speaker at an SGAC 2014 plenary, my role was to provide a backgrounder on the growing problem of on-orbit debris and on the feasibility of debris removal and the emerging commercial market for on-orbit servicing of existing space assets. For the OOS working group I had the pleasure of providing some insight into the perspectives of various stakeholders and was able to observe and comment on the very dynamic simulation.

My professional background is space systems engineering, management and space robotics. So, with no legal background, I was well placed to share my experiences with the STEM participants on the very real and important role of policy, regulatory and legal considerations that technical staff must be aware of. The simulation scenario chosen by the working group chairs was an excellent case in point. Many of the issues raised by the simulation resembled those of multi-organization due diligence assessments that I had participated in, particularly for innovative space services.

My assessment of the simulation exercise format and methodology is very positive. I witnessed the following:

1. A simulation between peers is very effective in motivating participants to thoroughly prepare. The desire to perform well was evident in the up-to-date fact finding, interviews and other research performed beforehand.
2. Proper definition of context, scope and various roles of the simulation can ensure the discussions are couched in real elements of policy, legal and regulatory considerations. The simulation chairs did an excellent job in this respect.
3. Aspects of a simulation resemble a debate and learning is assured as the role playing participants naturally challenge each other with their different perspectives on key issues and considerations.

I hesitate to critically examine the validity of the final recommendations of the working group report since I consider the primary objective of the exercise to be learning the importance of policy, regulatory, and legal frameworks for STEM graduates. Clearly this objective was met, particularly in the context of international space activities and pioneering developments. The set of final recommendations is valid in that most of the key issues have been identified and a possible way forward is proposed. The recommendations are refreshing in that they are very ambitious and idealistic, but this reflects the very extraordinary nature of SGAC participants who are to be commended for their work.

IV.III Legal Perspective

Chris Johnson, a project manager with the Secure World Foundation, served as the legal SME for the working group. He provided the following evaluation of the working group methodology and recommendations:

By the end of the simulation, working group participants were able to ascertain some of the broad legal and political implications of On-Orbit Servicing, either as a purely governmental activity, or done in a commercial setting by a private company.

While OOS has some very promising commercial implications, because of the technological capabilities involved, many historical space powers, as well as emerging spacefaring States, see the underlying phenomena as potentially destabilizing. While all space technology, whether hardware or know-how, is dual-use technology, OOS capability is particularly unsettling to national governments contemplating the vulnerability of their space assets, which form a critical link to ground-based military capabilities. Additionally, disabling a military space asset – or even a commercial telecom satellite also used for military communications – is a relatively cheap and efficient way to disable a military's ground infrastructure (compared to traditional means of warfare)

The best way to convey this reality was to have participants discover it for themselves, as they stepped into the roles of governmental officials and their military officers and attaches. Consequently, governments might be hesitant to allow the development of this technology – even after considering the commercial industry's interest in seeing it happen. Participants had to balance security with commercial development in a way that wasn't clear-cut or easy. As regulators of the space industry, many governments are grappling with the same concerns.

V. LESSONS LEARNED FOR FUTURE SIMULATIONS

In addition to the specific benefits of education-through-simulation which were noted in Section III, the following observations were noted by the simulation organizers and are recorded here to guide future applications of this educational tool.

First, it is essential that the simulation is properly prepared for. Delegates perform best when they are provided with well-defined roles within a clear and constrained scenario. Ambiguities can result in a misalignment between stakeholder arguments as individual delegates arrive to the simulation unprepared to meet the questions of their rival stakeholders.

Next, it is essential that the simulation contain enough people for discussions within each stakeholder group. Exceptions can be made for exceptionally clear roles and capable delegates – notable in our simulation was the lone angel investor – but overall it is beneficial for stakeholder groups to present a clear position arrived-at after internal deliberation.

In a related vein, it is important to recognize the unique skills brought to the table by each delegate. Our simulation was enhanced by our lead regulator (a law student), our servicing provider (a robotics student), and our angel investor (a young business professional). All three individuals brought knowledge and capability which added to the realism of the simulation.

Finally, even the best delegates, roles, and scenario cannot replace a thorough legal education. It is therefore essential to have experts involved in the simulation who have deep experience in the topic at hand. These experts are able to brief the delegates, giving them essential tools and insights with which they can form their cases for the simulation at hand.

VI. CONCLUSION

This paper has presented the education-through-simulation experience from the On-Orbit Servicing working group at SGC 2014. Observed benefits of this educational methodology have been discussed; notably, simulation participants demonstrated a high level of engagement due to the tangible nature of the simulation experience. The recommendations resulting from this simulation have been validated through examination by expert advisors to the working group.

This paper has therefore demonstrated the validity of education-through-simulation as an effective teaching tool, both in and of itself and as a means to encourage STEM graduates to consider the implications of law and policy on current and future space activities.

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