International Astronautical Federation - International Programme/Project Management Committee

IAF-IPMC

Young Professionals Workshop 2014

Workshop Results Report

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Group photo of the 2014 International Programme / Project Management Committee Young Professionals Workshop delegates on September 26, 2014.

Contents

1. Executive Summary

On September 26, 2014, a group of 30 young professionals – working in space agencies, companies and professional organisations located in fifteen countries and six continents – met to participate in a workshop organised by the International Program/Project Management Committee (IPMC) of the International Astronautical Federation. The Young Professionals Workshop was planned by a team of young professionals working in collaboration with the IPMC. It was held at the Metro Toronto Convention Centre in Toronto, Canada in connection with the 65th International Astronautical Congress.

The Young Professionals Workshop – the third in a series of annual workshops organised by the IPMC – sought to gather ideas and suggestions from early career employees in the international space community and provide the IPMC and IAF member organisations with greater knowledge, insights, and perspectives that can help them better develop and empower the next generation of space program employees. The IPMC was supported in this effort by a group of young professionals who participated in a previous workshop and agreed to serve on a Workshop Organising Committee to manage the overall process and finalise preparation of a workshop report.

The workshop itself represented the culmination of an initiative begun in mid-2014 with the nomination and selection of workshop participants who were divided into working groups focusing on five discussion topics. Over the ensuing period these groups discussed – through virtual on-line discussion sessions – and investigated the topics and reached preliminary conclusions. The groups then met face to face for the first time at the workshop, finalised their recommendations, and presented a preliminary report to the entire workshop along with several representatives of the IPMC.

Following the workshop, the Workshop Organising Committee prepared this final report that elaborates on the results of the discussion group deliberations. The five topics considered during the 2014 IPMC Young Professionals Workshop along with the participants' observations and recommendations are discussed below.

Starting a Career in Aerospace

The workshop discussion group on 'entering into and growing in the aerospace sector' reviewed the differing aspects of pursuing aerospace careers in academia, industry and government. The group also considered several national practices utilised to attract, recruit and help train early career employees.

The discussion group members noted the crucial role played by supervisors in paving the way for early career employees. Supervisors who successfully manage and advise young professional employees can have a significant impact on the success and growth of the young employees in the sector. The group believes that supervisors of early career employees ***should:***

- Serve as role models,
- Allow early career employees to manage their own 'brand,'

- Trust young professionals, and
- Challenge them.

On the other hand the discussion group believes that supervisors ***should not***:

- Micromanage talents of young professionals,
- Question their intentions,
- Marginalise them, and
- Seek to define them.

The discussion group noted that young professionals whose bosses are interactive, social, experienced, and sympathetic feel more comfortable and are more successful in their work environment.

Competences and Skills for the Space Sector

The 'key competencies and skills' discussion group determined that communication, system thinking, and interdisciplinary depth were key areas for necessary skills and competencies required by current and future young professionals to work in such a complex, interdisciplinary, and international environment. The workshop discussion group has the following observations and recommendations (discussed in greater detail in Section 4.2 below):

- Young professionals should have opportunities to take communication courses as part of their professional development.

- When appropriate, young professionals should be encouraged to participate in conferences, virtual and in person presentations, and other opportunities for internal and external exposure where they can exercise oral presentation skills.

- To encourage use of new technologies, young professionals should be given opportunities to create an evaluation report, prepare a lessons learned assessment and make recommendations to the company on use of technology.

- Networking can help young professionals learn from experience and can also result in teaching the teacher.

- Young professionals should be able and encouraged to give an 'Elevator Speech' to a range of audiences (general to specific).

- Systems thinking education should be initiated at the youngest possible ages to help train the next generation of systems engineers sooner.

- The IAF IPMC or one of its member organisations should consider holding a workshop to address the following topics:
    - How can future systems engineers be better identified earlier?
    - How do senior systems engineers develop?
    - What organisational and technical environments create better systems engineers?

- To increase the interdisciplinary breadth of knowledge of young professionals the IAF and its member organisations should consider initiatives that increase YP exposure to articles, papers, blogs, videos and podcasts and workshops on topics that span beyond their core specialty.

- Space project proposal writing competitions could be used to encourage students and young professionals to write proposals on new space project ideas, allowing them to apply skills from various disciplines.

- The IAF and its member organisations should also consider 'specialist exchanges', where a professional working in one discipline presents on their area of expertise to a group of professionals in another profession.

Relevant Tools and Methods for Innovation

The discussion group considering 'which tools and methods are most relevant and efficient for young professionals to ensure innovation' across their organisations offered several observations and recommendations:

- Maintain existing formal innovation programs and complement them with new tools, while giving ample attention to informal tools and methods. Inspiration for inclusion of new formal and informal innovation tools can be found in the 'high tech' sector. Possible steps include:

    - Increasing use of concurrent design facilities to foster interdisciplinary teamwork,
    - Establishing short term innovation programs with specific product-driven goals,
    - Embracing employee participation in less structured events like 'SpaceUp, unconferences,' and
    - Encouraging diversity of thought and welcoming opportunities to bring together individuals with diverse expertise and backgrounds.

- Enable more flexible use of the latest IT tools in space sector organisations and foster their use internally so that the available tools are effectively implemented.

- Use to the fullest advantage both the competition and the collaboration paradigms to strengthen innovation throughout space-faring organisations. Both paradigms have merits. In the discussion group's opinion the future may lie in pursuing a combination of both.

Management Practices to Boost Performance

The workshop discussion group examining 'which management approaches could be more efficient to enable collaboration and competition within organisations to boost performance' had the following observations and recommendations:

- While both collaboration and competition can be successfully employed to boost productivity, collaboration appears to produce the most positive outcomes both at the individual and at the corporate level. Collaboration, however, often takes time to be effective, but as an African proverb says: "If you want to go fast, go alone. If you want to go far, go together."

- Competition as a driver of performance can be either beneficial or detrimental in the highly competitive environment of the aerospace industry with overall performance being affected by management practices. Managers should identify carefully the environment in which they are working in before determining the amount of internal competition needed to have a beneficial impact on their workforce.

- One attractive approach involves generating internal competition through prizes with groups collaborating to win the prize. In this way, both cooperation and competition can be enabled at the same time. To achieve this, organisations need to create an environment that is receptive to idea sharing, innovation, collaboration and teaming to propose new ideas to management. One possible implementation could be to create a platform for proposing ideas for challenges/innovation inside the organisation that are selected based on corporate priorities. The senior managers would then be the "champion" for this process, taking the burden of ensuring everyone involved is on board and behind the ultimate success of the project.

- To promote successful collaboration among young professionals, management and human resources support is fundamental. Early career employees performance should be measured not only on personal achievement but also on the ability to collaborate successfully. In addition employees should be allowed time on a regular basis to team with colleagues to discuss and develop new concepts that can be proposed to management.

Evolution of Professional Relationships

The discussion group participants considering 'methods for YPs to engage and interact with more senior professionals in their working environment' identified several observations and recommendations:

- Organisations that do not already have early career programs should consider establishing groups and mechanisms for newer employees to network, collaborate and grow in their careers. Such efforts should ensure that early career employees have a clear perception of potential career pathways.

- Young professionals can be 'tapped' to help create and help conduct early career networking activities.

- Mid-level managers may not always be receptive to facilitating opportunities for younger professionals. Senior management should ensure that mid-level managers understand and promote the importance of early career activities.

- The following factors are associated with successful relationships between early career and more senior relationships:

    - Trust building and veracity in thoughts and actions
    - Establishment of mutual respect
    - Creation and maintenance of collegial atmosphere
    - Openness to diversity
    - Increased commitment
    - Clear perception career pathway
    - Higher chances of career success
    - More job satisfaction

This workshop report discusses the perspectives, interests and recommendations of the participating young professionals in the hope that interested management officials in IAF member organisations will take note of the ideas presented and begin a dialogue that leads to better understanding and promotes both individual and organisational needs. The perspectives

presented by the 2014 Workshop participants are also intended to promote greater discussion within the community of early career space program employees.

2. Introduction

The IPMC Young Professional Workshop is an annual initiative of the International Program/ Project Management Committee (IPMC) of the International Astronautical Federation (IAF). The IPMC – which brings together representatives from more than twenty IAF member space agencies, companies and professional organisations – meets semi-annually to exchange experiences, best practices and to collaborate on projects that nurture the global space workforce.

The IPMC's Young Professionals Workshop is held just before the IAF's International Astronautical Congress (IAC). The IPMC selects a small group of young professionals who previously participated in a Young Professionals Workshop to serve as the Workshop Organising Committee and help the IPMC organise and manage the event. For the 2014 Young Professionals Workshop, the Workshop Organising Committee members were:

- Jessica Culler – San Jose State University,
- Birgit Hartman – European Space Agency,
- Amalio Monzón – Airbus, and
- Kevin Shortt – German Aerospace Centre.

The Workshop Organising Committee members were also asked to lead the development of the discussion topics, guide the discussion group deliberations, and prepare this final report.

Following discussions with the IPMC the topics selected by the Workshop Organising Committee for the 2014 Young Professionals Workshop were:

- Starting a career in aerospace
- Competences and skills for the space sector
- Relevant tools and methods for innovation
- Management practices to boost performance
- Evolution of professional relationships

The 2014 IPMC Young Professionals Workshop attracted over thirty early career employees from government, industry, research and professional organisations throughout the world. Each of the participants was nominated by an IAF member organisation to attend the workshop in response to a call for nominations issued in May 2014. To facilitate in-depth discussions, the workshop participants selected one of the five discussion topics and continued their discussions in smaller discussion groups that met virtually during a two-month period prior to the actual workshop session. (Please see Section 2: Virtual Session Collaboration and Pre-Workshop Activities, below.) The groups further discussed their topics in face-to-face working group and plenary sessions during the September 26th Workshop that also involved exchanges with representatives of the IPMC.

The results of these investigations and deliberations and associated observations and recommendations are presented in this report. The ideas and views expressed herein are those

of the participants as individuals and do not necessarily reflect the views or positions of the IPMC, the IAF or its member organisations.

3. Virtual Session Collaboration and Pre-Workshop Activities

Since the Young Professionals Workshop is only a one-day event, the Workshop Organising Committee (WOC) felt it was necessary to establish foundational relationships among the delegates who would attend through virtual tools in advance of the event. With a globally distributed and diverse group, the WOC elected to encourage use of online social and collaborative tools, such as Skype, Facebook and Google Docs and the scheduling tool Doodle, to facilitate "breaking the ice" and initiate group conversations around the chosen discussion topics.

After the delegates were selected, the Organising Committee administered a survey to obtain information including individual delegate profiles for the workshop handbook, along with their preferred social networking tools and capabilities. This information helped establish a basis for grouping the delegates into the various topics.

The participating Young Professionals each expressed particular interest in one of the proposed topics. In addition to their topic interest the participants could express their desire to function as either a team leader or a rapporteur.

The WOC then organised a first meeting via Skype for each group to introduce the Statement of Work (SOW) and explain in detail the expectations, goals, timelines and deliverables. This was also a good time for the delegates to ask any questions, and to share their initial thoughts and ideas.

Each group selected a topic leader and a rapporteur. The topic leaders were responsible for producing requested deliverables and for managing other related discussion group tasks. The topic leaders were also the main point of contact for the WOC. The rapporteurs were asked to document the discussions and the progress made. These documents were helpful to ensure all of team members understood the status of the deliberations.

The virtual session process began in August 2014. From August until the workshop in late September, the delegates were asked to work on their individual topics. Discussion group meetings were facilitated via Skype and scheduled mostly through Doodle, which allowed delegates to self-organise times when they were willing to be available. Documents, such as memoranda of meetings, mid-term reports and project execution plans were all saved and shared under folders in Google Docs. This proved to be a very helpful and reliable tool and was easily accessible by delegates around the world. The teams then conducted in depth investigations, held various interviews, and shared their own day-to-day experiences working in the space industry as young professionals.

As a tool for collaboration among thirty participants from diverse locations globally, the virtual sessions worked well as a means to bring the delegates together prior to meeting in person for the first time at the workshop. The virtual collaboration sessions also enhanced the overall workshop experience and outcome.

4. Discussion Group Results

During the 2014 IPMC Young Professionals Workshop the five discussion groups met face-to-face for the first time, finalised the results of their discussions and presented their findings to the other groups along with several IPMC representatives. The reports prepared by the five groups, along with each group's concluding observations and recommendations, are presented below.

Topic 4.1: "How do YPs enter and grow into the aerospace sector?"

Background

Entering into and growing successfully in the aerospace sector is one of the key challenges facing young professional employees. The discussion group examined the situation encountered by young space professionals in three segments of the sector: academia, industry and government. The discussion group members also shared personal observations and agreed on several observations and conclusions.

Comparing Academia, Industry and Government

Understanding and comparing the differing work environments and career options in academia, industry and government is an important first step for those pursuing careers in aerospace.

Careers in academia allow young professionals intellectual freedom. Research projects can involve computations, design concepts, process improvement, and systems engineering. Teaching experiences provide opportunities to gain advanced communication skills. Independent research abilities and individual decision-making and mentoring skills are additional potential competencies to be gained. Potential opportunities to train future generations can be rewarding. Those involved in graduate programs also frequently have close contacts with industry that can result in alternate career options.

Working in industry allows young professionals an opportunity to gain experience from a commercial perspective. Regardless of their academic background, YPs can gain experience with systems engineering and project management. Industry also can provide 'bridging opportunities' to gain experience from the university and government sectors. Setting up a bridge requires awareness of the sector and the challenges of working with different sectors. For instance an understanding of government budget considerations, government rules and regulations, potential contracting and documentation issues, and government interactions with international corporations can be critical considerations for success for some companies in the private sector. In addition, working in industry often calls for flexibility that can be valuable asset for young professionals in a dynamic and changing field. Smaller companies often offer a greater chance for more responsibility early in a young professional's career. On the other hand, larger companies generally have more corporate management structure and balanced work distribution; this can result in less responsibility. It is very important to determine and choose right sector and company for the future career.

Working in the government sector is a career experience that can vary from country to country. Many government aerospace jobs involve high-level oversight and review of various satellite and aircraft programs, component designs and testing, and determining which technology is the best for the country.

One advantage of a government job is that it can involve increased responsibility and access to hands-on work with new technologies (an area of interest of most countries). Young professionals working in the government sector may also have opportunities to work on joint government-industry programs or programs involving several government agencies. Government positions at national laboratories that partner with private industry and academia to develop and test new technologies can also be attractive.

Observations

Becoming a young professional in the aerospace sector is difficult whether in industry, in academia, or in government. This may in part be because the number of employees in those sectors has not significantly changed over the past decade. Please see Figure-1 below. At the same time, the number of students studying in aerospace is increasing though the numbers of Japanese students shown on Figure-2 below reflect a gradual leveling off in recent years. The discussion group noted that while the supply for workforce appears to be increasing the demand is not keeping up. If this observation proves to be valid in other countries, it could be a significant concern for those students pursuing aerospace careers. On the other hand, some students in aerospace may find opportunities in new fields – such as those associated with remote sensing technology – that are expanding as a result of space technology.

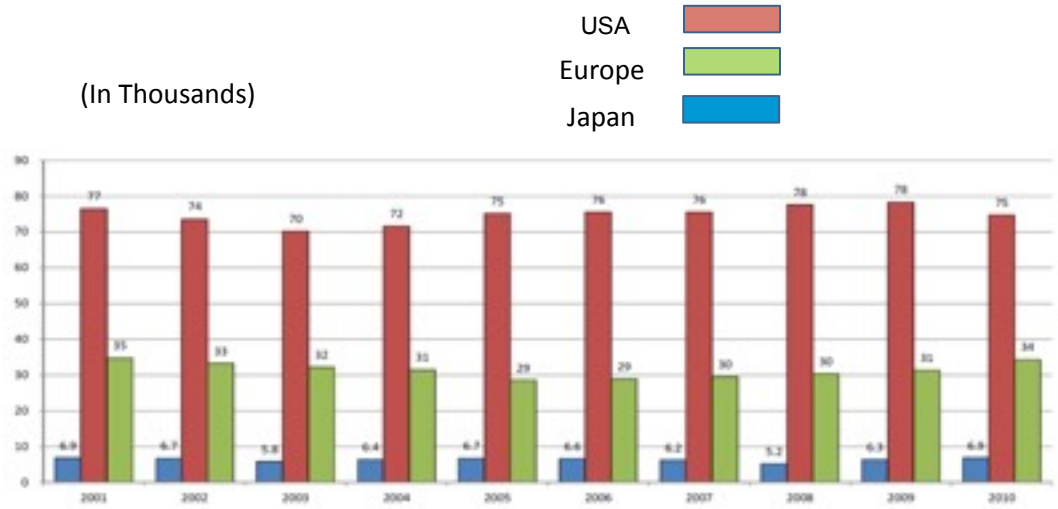

Figure-1: The number of employees in the aerospace industry in the USA, EU and Japan1. ***There has been little change over the past ten years.***

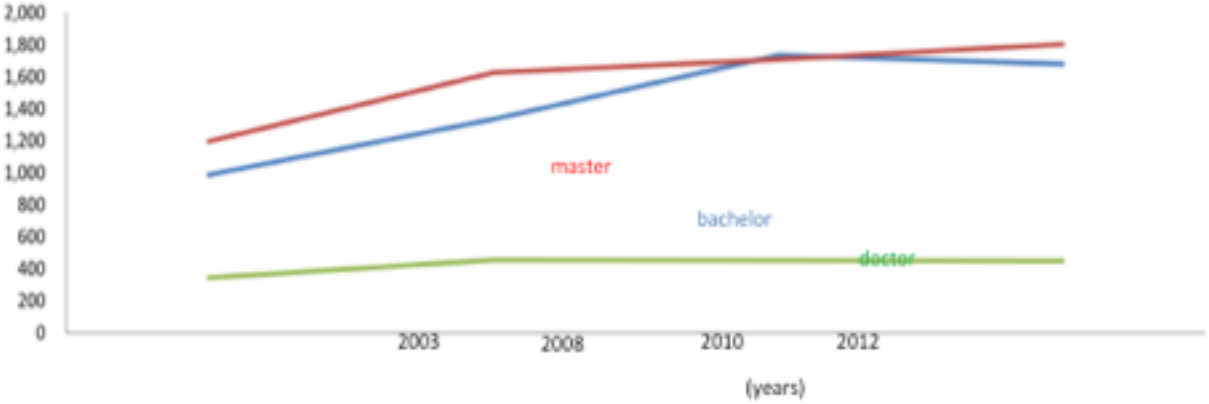

Figure-2: The number of students studying in aerospace fields in Japan2.

1 "2011 Data book of aerospace industry" by The Society of Japanese Aerospace Companies
http://www8.cao.go.jp/space/comittee/dai6/siryou8-2.pdf

2 "2011 Data book of aerospace industry" by The Society of Japanese Aerospace Companies

In Germany, a number of opportunities exist that encourage students to pursue space careers including: (1) a student competition called "CanSat" which is sponsored by ESA, (2) a project called "BEXUS" which uses sounding rockets that is sponsored by DLR, (3) a World Space Week student competition organised through the UN, (4) a SpaceLab prize offered by Airbus DS and (4) a student scholarship to attend the annual International Astronautical Congress funded by DLR. In addition, Airbus DS sponsors a Young Professional Recruitment Program and provides language courses, space engineering courses and diverse engineering courses that help pave the way for young professionals to grow into the sector.

In Japan, job hunting and recruitment of employees are performed simultaneously in sessions organised as students are preparing to graduate from their universities. JAXA takes part in such sessions to recruit its staff. As a part of the hiring process, students take an examination for their profession and they have several interviews. After starting their career at JAXA the new employees are assigned to a work group by the Human Resources Department. The assignment is based on the new employee's field of specialisation and career path. JAXA also has a department that is similar in structure to a university. Some post doctorate graduates are employed by JAXA to work in this department. This activity is similar to an internship, but the student can also obtain credits and pursue a degree though the assignment.

As in other sectors, early career employees in aerospace sometimes suffer from a mismatch between their technical training and the task assigned to them. On-the-Job training (OJT) is one way to help young professionals meet this challenge. Such training can involve working with a leader who knows how to do the task. An OJT arrangement can involve risks when the young professional is dependent on the leader who has an otherwise busy workload. Accordingly it may be best – depending on the specific task – for the young professional to maintain overall responsibility for the task. In cases where the task is unusually challenging or an unexpected problem arises, the OJT may not succeed. In such cases, the young professional employee can benefit significantly from also being given responsibility for developing the solution.

Observations and Recommendations:

The discussion group on 'entering into and growing in the aerospace sector' reviewed the differing aspects of pursuing aerospace careers in academia, industry and government. The group also considered several national practices utilised to attract, recruit and help train early career employees.

The discussion group members noted the crucial role played by supervisors in paving the way for early career employees. Supervisors who successfully manage and advise young professional employees can have a significant impact on the success and growth of the young employees in the sector. The group believes that supervisors of early career employees ***should:***

- Serve as role models,
- Allow early career employees to manage their own 'brand,'
- Trust young professionals, and
- Challenge them.

On the other hand the discussion group believes that supervisors ***should not***:

- Micromanage talents of young professionals,
- Question their intentions,
- Marginalise them, and
- Seek to define them.

The discussion group noted that young professionals whose bosses are interactive, social, experienced, and sympathetic feel more comfortable and are more successful in their work environment.

Topic 4.2 : "What are the key competencies and skills that YPs consider necessary to strengthen the aerospace sector?"

Background

The aerospace sector is an immensely complex environment involving technologically and scientifically challenging efforts undertaken in a legally challenging international setting.

While exploring what skills and competences are necessary for young professionals hoping to navigate such a complex and multidisciplinary field, the discussion group for this topic decided early on to focus on three distinct areas. These were **effective communication, systems thinking and interdisciplinary depth**.

- The ability to work collaboratively with colleagues in complex projects is enabled by **effective communication**. Language skills, proficiency in communication technologies, oral presentation and writing skills, as well as regular networking, are not just key to project success but often also influence professional opportunities for young professionals.

- The complexity of modern aerospace projects requires solutions to be viewed as systems, rather than isolated components, in order to better understand the broader context. **Systems thinking** fosters this mind-set and should be introduced to young professionals in both technical and nontechnical disciplines in order to encourage broader thinking.

- Space is a scientifically, legally and politically complex environment. The success of a space project requires the consideration of number of **technical and non-technical disciplines**. Exposing young professionals to an increased breadth of knowledge can allow them to consider disciplines other than their own and tailor their work to be better integrated into the broader system.

These topic areas were chosen by the working group as building skill sets to better equip early career employees to face the main initiatives that the sector is targeting in the coming decades. The working group came up with a number of recommendations to promote skills and competences within these areas for current and future young professionals.

Effective Communication:

Language and Communication Skills: Language skills that are valued in aerospace professions include verbal and writing skills in a variety of settings: internal and external, professional publications and presentations, and public outreach, among others. This reflects a more general shift in the professional skills that are valued in the 21st Century.

In a survey of adult skills conducted in 2013, researchers found that "in addition to mastering occupation—specific skills, workers in the 21st century must also have a stock of information—processing skills, including literacy, numeracy and problem solving, and 'generic' skills, such as interpersonal communication…" (OECD, 2013)3. This dynamic is evident in the aerospace community, where employers value effective communication skills. This is the case even when employee's position or job function is primarily technical.

When asked to reflect on the skills needed to ensure the quality of the aerospace engineering workforce in Europe, leaders from two leading aerospace companies, Airbus and Pegasus, highlighted social and presentation skills and intercultural skills (European Commission News, 2004)4. In a sample of 10 job applications for a variety of aerospace positions around the world, "strong," "excellent" and "outstanding" oral and written communication skills are described as "essential," "desirable," and "expected."

The globalised nature of the aerospace field also drives an emphasis on intercultural communication and foreign language skills. Employees are often required to work with colleagues from different cultural backgrounds, in a secondary language, while remaining mindful of different practices in the workplace. For example, the salinity measuring Earth science mission Aquarius/SAC-D, launched in 2011, involved international collaboration among no fewer than six countries. The mission's main partners, Argentina and the United States, built the primary instruments and integrated the satellite with other sensors provided by Canada, Italy, and France, before it was tested in Brazil ahead of its launch. Space missions involving multiple international partners are increasingly common and involve a cadre of scientists, engineers, managers, public outreach professionals, and more, all of whom benefit from multiple languages and other communication skills for effective mission planning and implementation. With this in mind, positions available at governmental and private sector organisations – such as NASA, Arianespace, and Surrey Satellite Technology – highlight teamwork and the ability to collaborate with colleagues within and outside the institution.

[3] OECD Skills Outlook 2013: First Results from the Survey of Adult Skills The Skills Needed for the 21st Century (2013) OECD http://skills.oecd.org/skillsoutlook.html

[4] The future aerospace workforce — ACARE considers university education at Berlin Air Show (2004) European Commission News http://ec.europa.eu/research/transport/news/items/the_future_aerospace_workforce versity_education_at_berlin_air_show_en.htm

Use of technology

Communication has always evolved with technology, from early cave drawings, to the printing press, and now in the digital age with nearly instant access to the world's knowledge in the palm of our hands. Digital literacy includes the ability to use software tools to communicate ideas ranging from presentations (such as PowerPoint, Prezi, and Keynote) to modelling concepts (such as AutoDesk, CAD, and 3D visualisation tools). This is further extended by the creation of rapid prototypes from 3D printing, including moving parts demonstrating actual application. Tech savvy YPs use these tools. Senior management should "play to their strengths" (Forbes, 2012)5 and encourage expanding the baseline practices of the company.

Virtual education offers opportunities for continued education and increasing skills in the workforce. Programs can be used to fill knowledge gaps or keep employees at the leading edge of their field. In 2013, more than 2,800 academic organisations were surveyed in the USA, and students taking at least one online course surpassed 7.1 million. This represents 33% of all higher education students (21.3 million) (The Best Schools, 2014 / Babson, 2013)6. The rapidly increasing numbers reflect the changing culture and opportunities for education in the workforce, where anyone with a laptop and Internet connection can learn. Similarly, online presentations and events are used for training and conferences, as are live streaming keynote events.

Networking

Networking can be subdivided into two types of interactions, online and face-to-face. Social media has created an open source cloud of intelligent and unintelligent information. The constant activity between users has been referred to as "promiscuous networking" (Career Trends, 2010)7. Young professional employees raised on the internet have developed a personal brand of "give them the tools, and support the work environment they require to fit and feel relevant." This can support these individuals' growth as social entrepreneurs "naturally wired to innovate and [a] desire to change the world" (Forbes, 2012)8. Young Professionals are often scrutinised for their use of social media (such as LinkedIn, Twitter, Facebook, and Google +), but essentially these are the medium used for news and faster communications to maintain work momentum.

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[5] Glenn Llopis 5 Ways Young Professionals Want to Be Led (12 March 2012) Forbes http://www.forbes.com/sites/glennllopis/2012/03/12/5waysyoungprofessionalswanttobeled/

[6] 2013 Survey of Online Learning Report (2013) Babson Survey Research Group http://onlinelearningconsortium.org/publications/survey/gradechange2013

[7] Career Trends: Building Relationships (2010) AAAS/ Science Business Office. http://sciencecareers.sciencemag.org/sites/default/files/building_relationships.pdf

[8] Glenn Llopis 5 Ways Young Professionals Want to Be Led (12 March 2012) Forbes http://www.forbes.com/sites/glennllopis/2012/03/12/5waysyoungprofessionalswanttobeled/

Face-to-face networking in this era has been highlighted by one skill in particular, the 'elevator speech': In under a minute, the length of a short elevator ride, the young employee should be able to explain what they are working on and why they think it's relevant. Demonstrating this 'elevator speech' skill shows focus, drive, and pride in ones' work. The speech should be "clear, crisp, accurate, interesting, informative, pleasant, friendly, optimistic, articulate, and succinct all in a single, relaxed burst of speech measured in seconds, not minutes" (Career Trends 2010)9. Young professionals need to know their audience, and a general rule of thumb is to be able to give an elevator speech to a range of audiences, from an elderly family member with no prior knowledge in the topic area, to the professor that gives the final signature on a PhD, or to the Chief Scientist of a space agency. Another important aspect of face-to-face networking is respecting the culture of the company and/or the country of origin of the other party. This leads to clear communication practices and is often a learned skill.

Communication Recommendations

The discussion group believes that young professionals should have opportunities to take communication courses as part of their professional development. With in-person and online course offerings, young professionals can practice written and oral communication skills, as well as learn how to use online collaboration platforms.

When appropriate, young professionals should be encouraged to participate in conferences, virtual and in person presentations, and other opportunities for internal and external exposure where they can exercise oral presentation skills.

To encourage use of new technologies, young professionals should be given opportunities to create an evaluation report, prepare a lessons learned assessment and make recommendations to the company on use of technology. Managers should let young professionals "tune in" to virtual events and courses or risk YPs falling behind.

Networking can help young professionals learn from experience and can also result in teaching the teacher. Early career employees should be allowed to dive deeper than their comfort zone into social media (and report findings to senior management). Time should be allocated for mentoring young professionals on cultural aspects of company business such as at social events.

Young professionals should be able and encouraged to give an 'Elevator Speech' to a range of audiences (general to specific). The organisation , for its part, should develop sample text and let young professionals know it's available for them to reference when they describe company activities.

Systems Thinking:

Broadly defined as 'big picture' thinking, Systems Thinking is a necessary skill for aerospace systems design. In response to the growing complexity of its products, it is important to provide a link between the purely analytic side of engineering and the creative design side. Systems thinking is, therefore, a critical skill for communicating between design and analysis, ensuring the final product delivers the desired functionality, identifying and managing interfaces (social

[9] Career Trends: Building Relationships (2010) AAAS/ Science Business Office. http://sciencecareers.sciencemag.org/sites/default/files/building_relationships.pdf

and technical), and brokering effective design trade-offs (Lamb, 200910 / Davidz, 200611).

However, there is an industry shortage in Systems Thinking competences. There are not enough experienced systems engineers within government and industry to meet current and future program needs (Davidz, 2006)12. It also is known that the aerospace industry workforce is getting old and "going gray:" The average age for an American aerospace and defence worker is 45, 47 for an aeronautical engineer, compared to the median age of 42 for all workers in the United States. (Zillman, 2013)13

In addition to that, some systems leaders believe it may take more than twenty years to develop fully a senior systems engineer. Altogether, this means that accelerating and improving the development process of space systems engineers is an immediate concern. Systems Thinking should, therefore, be introduced to young aerospace professionals, in both technical and nontechnical disciplines, in order to address the problem while encouraging a broader thinking and a holistic mind set.

Systems Thinking Recommendations

In order to address the issues identified, the workshop discussion group has the following set of recommendations:

- Early exposure to Systems Thinking could help train the next generation of systems engineers sooner. Broadening the scope of Systems Thinking education at the youngest possible age is very important, as it helps to shape the right mind set for approaching these problems when people are most impressionable. This approach can be used for students at high school, or potentially even younger students.

- Organisations need to study and understand both their organisational and technical structures, as well as interactions between the two. Each organisation and each technology has its own structure and functional areas. Understanding the implications that changing one part of the system has for the rest of the parts can promote a deeper understanding of the 'big picture'. Additionally, perceiving the relationships between organisational and technical design allows for a broader view of the overall system. Such measures need to be emphasised by senior management to develop the culture of understanding these sorts of connections.

There is a need to implement better methods for evaluating implications of different systems approaches. If we implement changes to a system, we need to be able to evaluate the broader implications of these changes.

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[10] Caroline Marie Twomey Lamb, Collaborative Systems Thinking: An exploration of the mechanisms enabling team systems thinking (2009) http://seari.mit.edu/documents/theses/PHD_LAMB.pdf

[11] Heidi Leoti Davidz, Enabling Systems Thinking to accelerate the development of senior systems engineers (2006) http://esd.mit.edupeople//dissertations/davidz.pdf

[12] Heidi Leoti Davidz, Enabling Systems Thinking to accelerate the development of senior systems engineers (2006) http://esd.mit.edupeople//dissertations/davidz.pdf

[13] Claire Zillman, America's defense industry is going gray (2013) http://fortune.com/2013/11/12/americasdefenseindustryisgoinggray/

Understanding the multiple layers of a system is important because it promotes a view that shows how impacting a subsystem affects the overall issues. Furthermore, understanding how changes to a system affect other systems at the same level is important in the same vein. Combining these two ideas together provides a clearer overall picture of what connections exist and how changes to one part influence all of the other parts.

These recommendations are focused towards educational institutions and actors within the space industry. These actors should play an active role in convincing such educational institutions to adopt ways to promote systems thinking at a younger age.

Finally, given that these issues have been identified as key drivers, there is a need to understand where efforts must be focused for further consideration. For that, the working group has identified a set of pertinent questions to move forward with. The working group proposes these as questions that could be addressed at future workshops organised by the IPMC or one of its member organisations:

- How can future systems engineers be better identified earlier?
- How do senior systems engineers develop?
- What organisational and technical environments create better systems engineers?

Interdisciplinary Breadth of Knowledge:

Space is an inherently complex environment in a legal and political as well as scientific sense. Successful systems require a wide range of technical disciplines to be considered in order for the system to successfully operate. Additionally, neglecting the non-technological aspects of space projects can hamper the success of a system due to budgetary, political, or legal issues. Space sector projects as well as the professionals involved in them can thus benefit from exposure to a wide range of disciplines beyond their core specialty. The knowledge gained from such exposure can be defined as interdisciplinary breadth.

Increasing the level of breadth of non-technical knowledge will allow YP engineers and scientists to better appreciate systems aspects beyond their area of expertise. Similarly, exposing non-technical young professionals to technological aspects will allow them to better develop policy to match existing technology. Professionals who consider project aspects beyond their core specialty when conducting work will create output that more smoothly integrates into the greater system context. Encouraging an interdisciplinary breadth of knowledge in young professionals will allow them to better navigate such a multidisciplinary industry.

The Need for Interdisciplinary Breadth in the Space Sector

In the current state of the space sector, large government and private entities can no longer afford to ignore the benefit of interdisciplinary breadth. In the past, it was possible for entities to spend a tremendous amount of money on a dedicated project, the prime example being the Apollo project, the estimated cost of which was $109 billion in 2010 dollars (Lafleur, 2010)14

A similar undertaking would be unlikely, if not impossible, in the current economic climate. Additionally, international and inter-organisational collaboration has become increasingly

[14] Claude Lafleur, Costs of US piloted programs (2010), The Space Review http://www.thespacereview.com/article/1579/1

common through multilateral space and aerospace projects such as the International Space Station (ISS) program. As a result, engineers and technical staff are required to integrate political, cooperative, and intercultural components into their technical work in order to successfully complete a project.

The recent trend of smaller space projects such as cubesats and nanosats, and the increase in space start-ups, has led to the space sector no longer be limited to being the domain of large and well-resourced government and private entities. A multidisciplinary breadth of knowledge increases the effectiveness of small teams that do not have access to the extensive knowledge base of a large project or company. An interdisciplinary mind-set makes for more flexible teams, who are more likely to consider project factors beyond their area of expertise.

Research into NASA systems engineering guidelines has shown the steps organisations like NASA have taken to introduce systems engineers to non-technological project aspects, such as legal restrictions, must also be considered in space project development (NASA, 2007)15. An example of non-technical project aspects requiring consideration is the power system of the Cassini-Huygens Mission, the Radioisotope Thermoelectric Generator (RTG), which raised public concerns about environmental impact.

Assessment was required to consider alternative options for the power source and the various mission-related and non-technical impacts these alternatives had (Jet Propulsion Laboratory, 1994)16. Additionally, the International Space Exploration Coordination Group's Global Exploration Roadmap has outlined space sector goals that require non-technical expertise, such as international communication and the effective management of publicly funded budgets.

Educational institutions across the globe have also understood the need for young professionals to develop interdisciplinary skills as early as possible, and these institutions have started to add content from other disciplines into their technical programs. In addition to standard engineering disciplines, schools should provide young professionals with a basic knowledge in various non-technical fields such as space law and policy, business and management skills, and geopolitics. Several schools are already implementing such an approach, such as the International Space University and the "Institut supérieur de l'aéronautique et de l'espace." By doing so, they are better preparing future young professional for work in international and interdisciplinary projects.

Interdisciplinary breadth is a key competence for current young professionals, as well as those entering the workforce in the coming decades. For this reason, it is important to expose students and young professionals in the industry to disciplines besides their own.

Interdisciplinary Breadth Recommendations

The recommendations made by the discussion group to increase interdisciplinary breadth within the knowledge of young professionals all revolve around increasing exposure to different disciplines and skill sets. The discussion group believes that the first four recommendations can be implemented relatively quickly and easily.

- At the most basic level, current and future young professionals can increase exposure

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[15] NASA, Systems Engineering Handbook (2007) http://foiaelibrary.gsfc.nasa.gov/_assets/doclibBidder/tech_docs/5.%20NASA%20SP6105%20Rev%201%2 0%28Sys%20Eng%20Handbook%29.pdf

[16] Jet Propulsion Laboratory, Cassini Program Environmental Impact Statement Supporting Study. Volume 2: Alternate Mission and Power Study (1994) http://saturn.jpl.nasa.gov/spacecraft/safety/eisss2.pdf

by accessing articles and papers on topics that span beyond their core specialty. The International Astronautical Federation (IAF) could facilitate this through a blog or an email newsletter that includes such articles, or by collaborating with existing space industry media to give greater access to students and young professionals. The IAF could also implement information exchanges through an interdisciplinary space forum or a mailing list for international collaboration to facilitate professional exchange.

- For effective and broad exposure, the IAF could facilitate the development of media, such as a series of short online videos or podcasts, of young professionals from a wide range of disciplines describing the facets and challenges of their specialty. These video or podcast episodes should be 'bite-sized', lasting only a few minutes, to make them easily accessible and easy to create, while also allowing them to provide a quick introduction to other disciplines. Participants representing various disciplines in the next IPMC workshop could create examples of such videos.

- Workshops and gatherings focussing on space topics such as the Space Generation Congress, Space Generation Fusion Forum, SpaceUp or ISU, Singularity University provide an excellent opportunity for students and young professionals to be exposed to disciplines and subject areas they are not traditionally involved with. The short time span of such events suit a focus on the discussion of space policy and have allowed many engineers and other technical professionals to spend some time considering space issues from a non-technical standpoint. The continued support of the IAF and other organisations in the space sector for such events promotes the exposure of young professionals to various disciplines.

- Space project proposal writing competitions could be used to encourage students and young professionals to write proposals on new space project ideas, allowing them to apply skills from various disciplines. Clear guidelines should be given for the competition to list out the questions to be answered and topics to be covered. These could include scientific motivation, engineering feasibility and cost, budget estimation, legal issues, public concerns, and social impact. Requiring students to address such a broad range of topics would drive them to consider multiple disciplines in their work.

Additionally, interdisciplinary exposure can also be promoted through longer term and more involved efforts.

- The IAF could facilitate and promote a 'specialist exchange', where a professional working in one discipline presents on their area of expertise to a group of professionals in another profession. For example, a satellite operation engineer could present on how spacecraft are operated to an audience of engineers who specialise in the design and construction of a satellite system. This could be tailored to provide expertise for specific projects or be conducted to provide general information.

- A focus on interdisciplinary breadth could be promoted in education through an interdisciplinary educational approach where multiple disciplines collaborate in the learning process. This would be done with the goal of fostering interdisciplinary interactions and could involve interdisciplinary exposure within the technical disciplines as well as between technical and non-technical professions. Such interdisciplinary education is based on mutual understanding and respect for the actual and potential contributions of the disciplines (multiple department education approach promoted, existing approach).

Measuring the Impact of Communication, Systems Thinking and Interdisciplinary Breadth Skills and Competences

Theoretically, promoting more effective communication should allow for improved collaboration within aerospace projects. Additionally, a systems mind-set, together with a broader knowledge base and awareness of issues beyond core specialties should reduce errors that occur during system integration and subsystem interface, while also reducing the amount of changes that need to be made to a system to adhere to legal or policy requirements. While communication, systems thinking and interdisciplinary breadth are intangible qualities, it may be possible to measure the benefit of exposing early career employees to these competencies. This could be done by comparing the time taken to conduct project reviews in the current state of the industry to project reviews within a project team comprised of professionals who have been trained in these competencies.

Observations and Recommendations:

The 'key competencies and skills' discussion group determined that communication, system thinking, and interdisciplinary depth were key areas for necessary skills and competencies required by current and future young professionals to work in such a complex, interdisciplinary, and international industry and environments. The discussion group has the following observations and recommendations (discussed in greater detail in the sections above):

- Young professionals should have opportunities to take communication courses as part of their professional development.

- When appropriate, young professionals should be encouraged to participate in conferences, virtual and in person presentations, and other opportunities for internal and external exposure where they can exercise oral presentation skills.

- To encourage use of new technologies, young professionals should be given opportunities to create an evaluation report, lessons learned assessment and make recommendations to the company on use of technology.

- Networking can help young professionals learn from experience and can also result in teaching the teacher.

- Young professionals should be able and encouraged to give an 'Elevator Speech' to a range of audiences (general to specific).

- Systems thinking education should be initiated at the youngest possible ages to help train the next generation of systems engineers sooner.

- The IAF IPMC or one of its member organisations should consider holding a workshop to address the following topics:
    - How can future systems engineers be better identified earlier?
    - How do senior systems engineers develop?
    - What organisational and technical environments create better systems engineers?

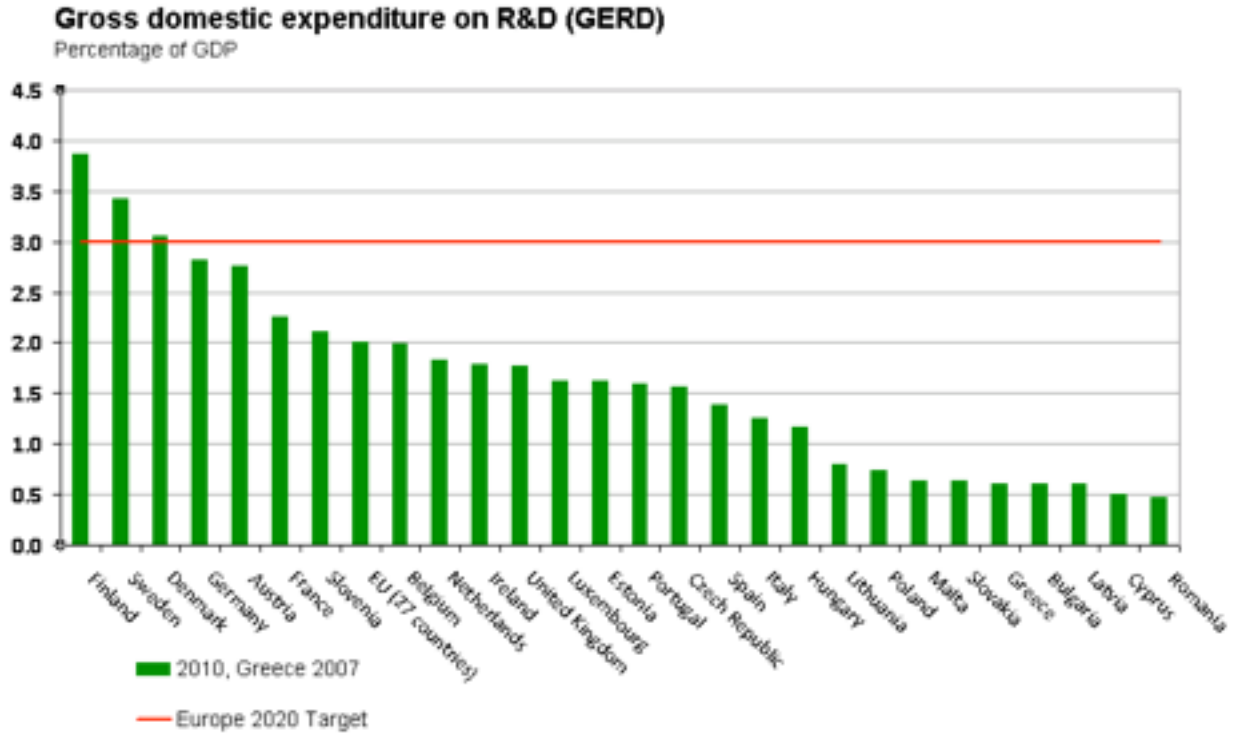
- To increase the interdisciplinary breadth of knowledge of young professionals, the IAF and its member organisations should consider initiatives that increase YP exposure to articles, papers, blogs, videos and podcasts and workshops on topics that span beyond their core specialty.

- Space project proposal writing competitions could be used to encourage students and young professionals to write proposals on new space project ideas, allowing them to apply skills from various disciplines.
- The IAF and its member organisations should also consider 'specialist exchanges', where a professional working in one discipline presents on their area of expertise to a group of professionals in another profession.

Topic 4.3: "Which tools and methods are considered most relevant and efficient for YPs to ensure innovation across their organisations?"

Background

Innovation is sometimes viewed as a cornerstone of economic growth. Empirical data suggests, however, that insufficient resources are being allocated to research and development (R&D), which can be a major contributor to innovation. This situation is illustrated in statistics (below) from the European Union where overall R&D expenditure expressed in the percentage of their Gross Domestic Product is, with three exceptions, lower than the 3% target expenditure set by the European Commission in its Europe 2020 Strategy.



Source: Eurostat (last visited 04/09/2014)

Space is a relatively small sector, a puzzle piece in the larger picture of global R&D and innovation efforts. Nevertheless space sparks the imagination of people. Space can be the

main driver for innovation, and innovative efforts, in turn, drive space.

The discussion group looked at tools and methodologies that – from the perspective of young professionals – can create and ensure innovation conducted its investigation through literature study and drawing on personal experiences gained through engaged organisations and extracurricular activities. The group examined drivers for innovation, discussed formal and informal methods and tools and considered two case studies. The discussion group also agreed on several observations and conclusions.

The Drivers for Innovation (from a Young Professional Point of View)

According to *Wikipedia*, "*Innovation is a new idea, device or process. Innovation can be viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. This is accomplished through more effective products, processes, services, technologies, or ideas that are readily available to markets, governments and society … Innovation differs from invention in that innovation refers to the use of a better and, as a result, novel idea or method, whereas invention refers more directly to the creation of the idea or method itself. Innovation differs from improvement in that innovation refers to the notion of doing something different rather than doing the same thing better*".

In this sense, Wikipedia, itself, is innovative. Is it has revolutionised the medium of the encyclopaedias by making its content virtually accessible to everyone while also allowing everyone to add to its content. The existence of Wikipedia is clearly innovative in that it creates "a better and, as a result, novel idea or method." The now widespread use of Wikipedia, for professional purposes, is a bold choice forward. It is, even if cited only to be argued against, a choice pushed by a new generation of young professionals.

For purposes of this investigation the discussion group focused the following aspects that it considers to be drivers of innovation:

- Diversity in discipline and expertise of the team in order to foster innovation (as in the philosophy of the International Space University), and

- Dichotomy of the values and outputs of open sourcing (as in the collaborative spirit) and the values and outputs of intellectual property (IP) protection (as in the competitive spirit).

Diversity: An article in the Harvard Business Review (HBR) identifies two kinds of diversity: 1) inherent and 2) acquired. Inherent diversity involves traits that someone is born with, such as gender, ethnicity, or age. Acquired diversity involves traits that one gains from experience, such as the type of education received or having lived in a different country or overall perspective. The HBR article also points out those companies whose leaders exhibit high levels of diversity out-innovate and out-perform other companies. A high level of diversity unlocks innovation by creating an environment where "outside the box" ideas are heard, and different points of view and methods of doing things are compared and synthesised to create something new.

The Dichotomy of IP Protection and Open Sourcing: Based on the group's investigation the most common tool adopted by the international community to incentivise and encourage innovation involves the use of intellectual property rights (IPR). Primary incentives embodied in IPR include incentives to invent in the first place: to disclose the invention once made; to invest the sums necessary to experiment (R&D), produce and market the invention; and to design around and improve upon earlier patents (R&D again).

In this sense, IPR hold a double function of protecting the intellectual investments and property of those engaged with inventions and thus encouraging innovative behaviour. Furthermore, patents facilitate the knowledge becoming common knowledge after a reasonable period, enabling greater availability of the societal benefits related to inventions and innovations.

However, the world of today, with its accelerated creation and adoption of technology, also now enjoys the emergence of Open Source initiatives. Starting with "open source" computer software, it has extended to the use and content of Wikipedia, the biggest free online encyclopaedia. Finally, even in profit-driven industry, leaders such as Tesla are sharing their intellectual property outputs to the market.

Methods and Tools for Innovative Outputs

Formal Methods and Tools – Case Study "ESA": The workshop discussion group examined, as a case study, the programs and practices employed by the European Space Agency to promote innovation and inventions. ESA has two main programs supporting new innovative ideas: 1) Technology Research Program (TRP), and 2) General Study Program (GSP). In addition, ESA has established an Advanced Concept Team (ACT) and a Technology Transfer Program Office (TTPO).

The main ESA technology research program is the TRP, which enables researchers to explore new ideas from the very earliest stages. Notable initiatives within the TRP include the so-called Star Tiger scheme, involving the rapid development and prototyping of advanced technology—typically 'spin-ins' from non-space sectors—in a timescale of months rather than years. The Innovation Triangle Initiative, which accepts unsolicited innovation proposals, focuses on using non-space technologies to solve space problems.

In its current activities, the TRP is making so-called disruptive innovations a special priority. These are technologies with the potential to transform the way space missions are designed and run. Examples include microsystems and nanotechnology and ultra-light materials. Success in any one of these projects could contribute to a dramatic reduction in the time and cost involved in space missions, and the mastered technologies would have multiple applications "on the ground" as well.

Another innovative program at ESA is the General Studies Program (GSP). This program is not only addressing technology, but it has a more general goal in the Agency as it investigates a remarkable diversity of topics such as:

- Contributing to the formulation of the overall ESA strategy,
- Studying feasibility for selection of new mission concepts,
- Preparing and demonstrating the case for approval and funding of new optional projects/ programs, and
- Supporting the evolution of ESA by analysing and testing new working methodologies.

This program helps identify tools of innovation in the ESA organisation not dedicated to technological systems or material but methods and strategies within processes, environments, and communities. GSP is organised around three domains: 1) mission assessment studies, 2) interdisciplinary activities, and 3) strategy studies. GSP also participates in the mission assessment studies conducted in ESA's Concurrent Design Facility.

ESA is actively involved in promoting science, technology, engineering, and mathematics (STEM) education by organising several student competitions, and supporting educational

programs in collaboration with national space agencies. The most recent opportunity published by the ESA Education Office in September 2014 is the opportunity for university students to perform a microgravity-related experiment using the ZARM drop tower in Germany.

Another opportunity to foster the imagination of university students is the Sentinel-1 Student Transponder Project. This new hands-on educational initiative is the first ESA student project to involve students directly in preparing for and then contributing to the ESA Earth Observation satellite, Sentinel-1, the first of the five satellites of the Copernicus Earth-monitoring program to be launched.

Although STEM is not necessarily a tool or methodology highly influencing the career of young professionals as such, the initiative is considered to be pivotal for the future and sustainability of the space sector. Secondly, STEM influences young professionals as well because efforts focusing on future generations should in any case incorporate YP inputs and outputs.

ESA grants the intellectual property developed under its contracts to the industrial players involved. Via this approach, industry R&D development is highly supported. ESA holds a license to exploit the IP for European space programs.

IT Tools: The most obvious – and for young professionals – natural topic concerning formal tools that are relevant and efficient for innovation involves the use of Information Technologies (IT). And this will be even stronger for the generation coming after the current young professionals.

Young professionals are often familiar with new software tools and can use them to provide added value for their organisation in terms of efficiency and communication. For example:

- Using the latest technology for connectivity: videoconference meetings, sharing and editing online documents, using cloud computing to manage document sharing;.
- Improving efficiency by changing the way everyday software is used in order to improve efficiency by facilitating the search and sharing of information. This might, for example, be achieved through classifying files, pictures and emails by tags and keywords rather than placing them in folders.
- Utilising new, powerful tools for data analyses – such as Tableau and Spotfire – that provide effective representation of data in different graphical views and facilitate analyses that can inspire new ideas.

Young professionals also are familiar with and able to use simple IT collaboration tools such as the toolkit provided on Google Drive. Unfortunately security protocols in many organisations limit the use of open source and other easily accessible online tools. The corporate alternatives are very expensive and not always easily accessible by to all young professional stakeholders.

While most space professionals utilise information technology tools, early career employees are often more aware of and comfortable with the latest IT tools. This familiarity can be harnessed to promote greater efficiency, stimulate innovation and help ensure mission success.

Informal Methods and Tools – Workspace to Enhance Innovation: Informal innovation is hard to measure and to define. This section will focus on two initiatives: 1) The ‘SpaceUp unconference events and 2) the ESA Concurrent Design Facility (CDF). These initiatives are considered informal because they allow engineer to think outside the box and because they provide an environment in which innovative thinking can be more easily pursued.

SpaceUp is an open attendance space exploration 'unconference' where participants decide the topics, schedule, and structure of the event. SpaceUp unconferences allow people from all backgrounds to gather and share ideas with no constraints. For example, a SpaceUp event in Bremen, Germany sought to gather:

- Young professionals working in the space industry in the greater Bremen area
- Students from the local universities (University of Bremen, Bremen University of Applied Sciences, Jacobs University, Technical University of Brunswig, University of Aachen)
- Space enthusiasts from inside and outside the space industry
- Anyone with a passion for space!

SpaceUp Unconference events are very inclusive. There are no rules about registration and organisation, so many young people meet and share ideas in a relaxed, youthfully spirited atmosphere. Such events drive innovation because they offer a discussion platform with no peer review and no pressure of success. Young professionals can share ideas and test new methods of discussion. The driving force comes in part from the lack of structure and the absence of a formal methodology. While other events might work better for traditionally minded managers, from an informal young professional perspective, this lack of structure increases the potential for innovation.

The ESA Concurrent Design Facility (CDF) is a state-of-the-art facility equipped with a network of computers, multimedia devices, and software tools, which all allows a team of experts from several disciplines to apply concurrent engineering methods to the design of future space missions. CDF facilitates a fast and effective interaction among all disciplines involved, ensuring consistent and high-quality results in a much shorter time. The ESA CDF and similar concurrent design facilities17 employ the most up to date tools, for instance 3D printers.

CDFs belong more to the realm of formal tools and methodologies, as they are usually employed in an existing organisational structure. They are easy to control as a means to foster innovation throughout the organisation and/or collaborating/competing organisations. Yet, CDFs are also informal in the way they operate and promote successful missions. The approach CDFs follow is more difficult to grasp and to channel.

Informal innovation is innovation happening "off the road" and out of the box. In order to foster such processes, it is important to create physical places where individuals can meet and exchange such as events like the SpaceUp or a CDF.

In addition to the established programs driving innovation, informal tools and methods should complement the formal aspects.

Benchmarking

The Case of Google: Google's Advanced Technologies and Projects Group (ATAP) has emerged as something of a counterpart to Google X, the Google facility working on self-driving cars, glucose-detecting contact lenses, and other wonders.

ATAP initiatives start with identifying a project that demands a quantum leap in both scientific understanding and engineering capability. Once identified, a core team of experts at Google is assembled. But that team quickly casts a much wider net, tapping what are often a huge number of outside collaborators from across a mix of fields and disciplines in industry and

17 For example, the DLR, CEF: http://www.dlr.de/irs/en/desktopdefault.aspx/tabid-7174/11938_read-28186/.

academia. This expert sharing allows ATAP, with a staff of just 75 full-time members, to be far smaller and 'scrappier' than traditional research labs. Together with its partners, ATAP forms special-forces research teams.

ATAP projects must deliver a finished product. That goal works to inspire ingenuity in researchers and intensify their focus. Neil Gershenfeld, an MIT professor who directs MIT's Centre for Bits and Atoms and collaborates with ATAP on a modular phone, says the finished product focus helps ground his research. Many technical challenges can only truly be solved when a researcher builds not just a prototype but also a product made at scale.

The third piece of ATAP's formula is impatience. Projects are conducted on a two-year deadline so that they do not become open-ended research initiatives. If tangible results are not achieved quickly, they are shelved to make room for new ones18.

This way of working is diametrically opposed to what is often expected from large term space missions. The model of ATAP – a small compact team working on project basis – could be a viable way for advancing and reducing cost of space missions in the future. By making the time to implement and develop much shorter programs that involve fewer people in the process, significant cost reductions could be realised.

The Case of Elon Musk: Elon Musk was named Innovator of the Year by *The Wall Street Journal* in 2011. He is the creator of Paypal, SpaceX, Tesla Motor, and his most recent project, the Hyperloop. While he aims at finding solutions for some of humanity's challenges such as human exploration of space and the end of dependence on non-renewable energy sources, Elon Musk is also breaking many of the rules in the aerospace and energy industries.

While SpaceX did not innovate with ground breaking innovative technologies, the focus was to innovate with process and industrial structure. SpaceX and other Musk-owned companies also have been successful in attracting talented young employees with high salaries and the opportunity to participate in an innovative company.

Musk has also reportedly promoted long-term innovation though sharing information such as Tesla Motors patents19 and, in so doing, potentially accelerating progress in the electric car industry.

These initiatives make Elon Musk an example for young space professionals and for the younger generation in general.

Recommendations and Conclusions

While innovation is a widely shared objective, it appears (based on this discussion group's research) that though lip service is paid to the importance of innovation, sufficient funding and human resources are frequently not allocated to pursue this goal. The challenge involves more than money. The challenge involves changing a mind-set. Consideration should be given to

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18 Quoting Fortune, Google goes DARPA, 14 August 2014, http://fortune.com/2014/08/14/google-goes-darpa/ (last visited 04/09/2014); Forbes, Google Powered Up A Semi-Functional Project Ara Prototype Device at I/O, 27 June 2014, http://www.forbes.com/sites/marcochiappetta/2014/06/27/google-powered-up-a-semi-functional-project-ara-prototype-device-at-io/

19 http://www.teslamotors.com/blog/all-our-patent-are-belong-you; http://www.theguardian.com/sustainable-business/competition-collaboration-push-forward-sustainability

utilising new formal and informal tools and methods, to promoting greater diversity in the workforce and workplace all of which can help promote innovation in the space sector.

With this observation in mind the workshop discussion group on tools and methods recommends the following steps to better empower the next generation workforce as young professionals rise through and innovate in their organisations:

- Maintain existing formal innovation programs and complement them with new tools, while giving ample attention to informal tools and methods. Inspiration for inclusion of new formal and informal innovation tools can be found in the 'high tech' sector. Possible steps include:

    - Increasing use of concurrent design facilities to foster interdisciplinary teamwork
    - Establishing short term innovation programs with specific product-driven goals
    - Embracing employee participation in less structured events like 'SpaceUp unconferences'
    - Encouraging diversity of thought and welcoming opportunities to bring together individuals with diverse expertise and backgrounds

- Enable more flexible use of the latest IT tools in space sector organisations and foster their use internally so that the available tools are effectively implemented.

- Use to the fullest advantage both the competition and the collaboration paradigms to strengthen innovation throughout space-faring organisations. Both paradigms have merits. In the discussion group's opinion the future may lie in pursuing a combination of both.

Many tools and innovative methods are in place or readily available for young professionals in the space sector to advance their careers and promote the objectives of their organisation. The challenge facing young space professionals today is to capture the innovative spirit, share these tools and methods with peers and apply them to the organisation's challenges. The challenge is also to develop new tools and methods that promote innovation for future generations.

Topic 4.4: "What management approaches could be more efficient to enable collaboration and competition within the organisations to boost performance?"

Background

Within organisations, young professionals are often motivated by a drive for success, promotional incentives, personal interest, and recognition. These motivations can drive a young professional if approached correctly leading to increases in performance and streamlining the work process. Young professionals can provide new outlooks, an understanding of new technology, and energy to pursue aerospace projects that result in innovation.

In a collaborative environment, young professionals can find ways of networking, gaining recognition, and developing new strengths in previously unknown areas. This can strengthen a young employee's base knowledge while helping the organisation in future innovation and development. A competitive environment can allow young professionals to explore new roles pushing the boundaries of their understanding and limits. Competition has the potential provide recognition and allows young employees to pursue more personal interests.

The discussion group considered the overall subject of collaborative and competitive performance boosting management approaches in order to better understand the advantages and disadvantages of each. The investigation identified a number of successful collaborative and competitive programs including several that focus on or involve early career employees.

After reviewing the results of its investigation, the discussion group developed several observations and recommendations.

Collaboration for Performance Enhancement

The discussion group noted that several types of collaboration methods exist within and among organisations. These methods can be classified according to structure of the cooperation and can be divided into three categories: vertical, horizontal, and global collaboration.

a) Vertical collaboration can determine the success of a company. Some companies are now using or experimenting with "idea management" software applications that allow an employee to suggest to his/her management possible innovations or improvements within the organisation.

b) Horizontal collaboration can also be used to help to improve end-to-end processes by eliminating physical boundaries between people working on shared objectives but located in different sites/countries.

c) Global collaboration can help large, dispersed organisations to know who the experts are and utilise them more effectively. Some organisations are beginning to address this challenge through the establishment of online communities. Using social networking internally, individuals can find internal subject matter experts, and share improvement experiences.

Based on an informal survey prepared by discussion group members and conveyed to project managers, methods organisations utilise for collaboration purposes include the following:

- Bilateral S&T agreements
- Memorandums of Understanding
- Protocols, Executive Programmes
- Joint working group and committee meetings
- SVN Tortoise (utilised at the project and department levels)
- Team websites or Wikis

The above collaboration methods include both technical approaches to collaboration and the use of administrative tools.

Using these collaboration tools can involve risks that, according to the same informal survey, can include the following:

- Lack of funding
- Lack of functioning communication mechanisms
- Extensive bureaucratic 'overhead'
- Technical problems associated with software and hardware

Examples of existing collaboration initiatives designed to boost performance:

The discussion group participants identified and have listed below a few representative

programs and initiatives that involve collaboration to boost performance which are utilized by IAF member organisations. These programs include workshops, special events, and learning opportunities that allow YPs to take on roles that they wouldn't otherwise have in normal working life due to their experience or technical knowledge level.

Airbus Defence and Space:

- Cubesat project: Each intake of graduates is introduced to satellite systems engineering by involvement in a Cubesat design. The graduates are split into teams and each team is responsible for a subsystem. The group can decide what payload they will include. This gives hands-on and complete system experience to young engineers who are otherwise working on support roles or part of a subsystem. The cost of this project includes buying a Cubesat kit and the time of the experience engineers who act –as teachers/mentors.

- STEM ambassadors: All graduates are encouraged to become an ambassador for science, technology, engineering, and mathematics outreach programs. The ambassadors gain presenting skills, as well as experience in planning and delivering events. Management support is needed to allow time away from the office, and at Airbus Defence and Space, a budget allows outreach work to be done in office hours.

NASA:

- Centre of Excellence for Collaborative Innovation (CoECI), according to its NASA website: helps NASA generate ideas and solve important problems. By using challenges, the participants in the CoECI program can readily increase their creative capacity and reach by tapping into diverse talent internally and from around the world. Using open innovation methods and tools, the NASA CoECI provides organisations with a cost-effective and complementary means of extending their innovation boundaries.

International Astronautical Federation (IAF):

The IAF has a series of programs aimed at young professionals that encourage or give YPs the opportunity to participate in their events. Attendance at most of these events needs the support of a line manager for time off work, or budgetary support for travel and registration.

- Young Professionals Programme: YPs can register for the annual International Astronautical Congress at significantly lower fees and participate in the IAF's Young Professional Program at the IAC. The lower registration fees make it easier to persuade \ management that YPs should be supported to attend, or for a YP to self-fund their attendance. The IAC networking events allow YPs from around the world to meet and share experiences and ideas. The enthusiasm created at these events should not be underestimated in terms of boosting performance on returning to the office, as well as giving YPs the opportunity to learn new methods and skills from each other.

- Virtual Forums: For those who cannot attend the IAC, the virtual forums provide a chance to present a paper from anywhere in the world. This is a good opportunity to present for the first time, and experience publishing.

- IPMC YP Workshops: These are dedicated workshops, such as the one that produced this report, that give YPs from different organisations and nations the opportunity to work together. They often included experienced leaders and engineers as hosts or mentors that ordinarily YPs would not get the opportunity to meet.

Space Generation Advisory Council (SGAC):

- Space Generation Congress: The SGAC organises this meeting of international students and young professionals with lectures and workshops led by experienced leaders and engineers. This provides a networking opportunity, as well as an educational experience. Management support is needed for time out of the office and possibly for a travel/registration budget.

- Project Groups: The SGAC also provides a forum for students and YPs to discuss current topics and cooperate on analysis, papers and reports: Commercial Space Project Group, Near Earth Objects (NEO) Project Group, Space Safety and Sustainability Project Group, Small Satellites Project Group, Space Law Project Group, Space Technologies for Disaster Management Project Group and Youth Promoting Cooperation and Education in GNSS (YGNSS).

Competition for Performance Enhancement

The discussion group noted that, as a driver of performance, competition can be highly beneficial or very detrimental in the high consequence environment of the aerospace industry with overall performance being affected by management practices. Competition in aerospace centres on funding and strengthening a company's reputation through various competitive measures such as: government contracts (the NASA commercial cargo program, COTS), grant money, and innovative competitions (Google X Prize).

Internal challenges and best practices:

Competition for funding and recognition inside companies can drive high levels of performance but runs the risk of decreasing innovation. This is especially true within the research and development (R&D) sections. Managers in aerospace science and engineering companies have two options for R&D work. One involves providing high-powered incentives based on output to motivate individual teams towards greater levels of performance. An alternate approach involves providing soft incentives and letting the researchers name be attached with the work allowing their professional reputation to act as incentive for promoting increased performance. (Lacetera and Zirulia, 2012) 20

The first benefits the company by increasing worker output, but due to this, the increase tends to drive innovation down. The second has the reverse effect; workers take much longer and focus more intently on the project, but the potential for innovation and new development increases.

Competition between organisations and teams:

The discussion group took note of several innovative programs that involve competition between organisations and teams:

- **NASA's Commercial Orbital Transportation Services (COTS) competition** that NASA used to select firms to provide commercial cargo services to the International Space Station.

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[20] Lacetera, N., & Zirulia, L. (2012). Individual preferences, organization , and competition in a model of R&D incentive provision. Journal of Economic Behavior & Organization , 84(2), 550-570.

- **X Prize Competitions** funded through the privately endowed X Prize Foundation including the Ansari X PRIZE for development of a reliable, reusable, privately financed, manned spaceship and the Google Lunar X Prize for landing a privately funded robot on the surface of the moon.

- **Caltech Space Challenge** organised by the California Institute of Technology and focused on design of space missions. Students are divided into two teams; they attend lectures and get necessary development tools. It is a unique opportunity to talk, work and share experience and ideas with real space experts.

Management factors in these types of competitive environments can have a significant impact on the success of the initiative. Successful management can be complex and can require a high level of:

- Organisation,
- Communication,
- Presentation skills, and
- Support (resources, time, etc.)

Recommendation and Conclusion:

The discussion group concluded that a wide variety of methods are currently utilised in space organisations to boost performance through collaboration and competition inside an organisation and between organisations. Based on its investigation, the group notes that:

- While both collaboration and competition can be successfully employed to boost productivity, collaboration appears to produce the most positive outcomes both at the individual level. Collaboration, however, often takes time to be effective, but as an African proverb says: "If you want to go fast, go alone. If you want to go far, go together."

- Competition as a driver of performance can be either beneficial or detrimental in the highly competitive environment of the aerospace industry with overall performance being affected by management practices. Managers should identify carefully the environment in which they are working in before determining amount of internal competition needed to have a beneficial impact on their workforce.

- One attractive approach involves generating internal competition through prizes with groups collaborating to win the prize. In this way, both cooperation and competition can be enabled at the same time. To achieve this, organisations need to create an environment that is receptive to idea sharing, innovation, collaboration and teaming to propose new ideas to management. One possible implementation could be to create a platform for proposing ideas for challenges/innovation inside the organisation that are selected based on corporate priorities. The senior managers would then be the "champion" for this process, taking the burden of ensuring everyone involved is on board and behind the ultimate success of the project.

- To promote successful collaboration among young professionals, management and human resources support is fundamental. Early career employees performance should be measured not only on personal achievement but also on the ability to collaborate successfully. In addition employees should be allowed time on a regular basis to team with colleagues to discuss and elaborate new concepts that can be proposed to management.

The discussion group members also explored the potential of international collaboration that could be enabled through creation and development of a common online portal for sharing local research systems, procedures of the partnering organisations and national regulations. This might result in creating an inter-organisational knowledge management tool for space initiatives pursued collaboratively.

Topic 4.5: "What are the best methods for YPs to engage and interact with more senior professionals in their working environment?"

Background

The discussion group analysed various ways to enable interaction between senior professionals and young professionals within space organisations. The group sought to identify the main benefits of these activities in terms of engagement, knowledge transfer, and competency development. The group noted that some programs on mentoring or coaching are behind website firewalls and difficult to access. Others are informal programs that are managed "bottom up" by young professionals with little organisational recognition.

During the previous IPMC YP workshop (2013), the closely related subject of mentorship and shadowing programs in various space sector organisations was discussed. During this workshop the participants:

- Identified various forms of **formal and informal interactions** between the early career and more experienced professionals,
- Discussed results of **informal interviews with senior professionals**, and
- Prepared a **partial listing of young professional programs and opportunities** in the global space sector. This listing is shown in the appendix below

After discussing the results of these activities, the discussion group developed several observations and recommendations.

Formal and Information Interactions between young and senior professionals

The discussion group identified the following forms of formal and informal interactions between early career and more experienced employees:

Formal:

a) Mentoring Programs
b) Industry Associations
c) Graduate Program
d) Networking events
e) Knowledge transfer systems
f) Career counseling
g) Orientation training

Informal:

a) Friday drinks

b) Company retreats
c) "Lunch and Learns"
d) Sporting events
    i) YPs become less bulk to organisational changes
    ii) Increased creative or innovative potential

Informal Interviews with Senior Professionals

The workshop discussion group members interviewed several members of their workforce who were considered senior professionals. These interviews included questions regarding the benefits of and experiences associated with interactions with young professionals. This information provided useful insight that helped inform the workshop discussion group deliberations.

Question 1: What are some success factors that enable young/senior professional relationships?

Question 2: What are some of the benefits of young/senior professional interactions?

Question 3: How was the young/senior culture when you first started your career?

Question 4: How have you dealt with international interactions and globalisation in your career?

Question 5: From your perspective, what have been the benefits from interactions between senior professionals like yourself and Young professionals?

Question 6: What is your general point of view regarding senior – young professional interactions?

Question 7: Are there restrictions on depth of discussion while interacting with personnel from other space agencies or institutions?

Question 8: If there are, in what areas are you required to be conservative or keep silent?

The results from individual interviews with senior professionals in their workplace are listed below:

Interview 1:

Age Range: 40-50
Highest level of education: (PhD)
Years working in the space sector (16):
Continent of Origin: Europe
Continent current working in: Europe
Type of workplace: (Space agency)

Question 1: Mutual acceptance, openness for new/established ideas/views, listening and no prejudices, willingness to learn.

Question 2: Fresh blood/ideas brought by young ones, fresh outside view and at the same time chance to learn from an experienced senior very often young ones are open to new technologies, while senior ones have the experience and can realistically assess and start up new activities, using new ideas.

Question 3: some very open, some thinking here comes the stupid young blonde

Interview 2:

Age Range: 40-50
Years working in the space sector: 18
Continent of Origin: Europe
Continent current working in: Europe
Type of workplace: (Space agency)

Question 1: respect and the understanding that it will benefit both sides.

Question 2: For younger professionals, to gain trust and respect from senior professionals. To learn from their experience and also to benefit from the knowledge related to previous programs/missions.

For senior professionals to have a link to the new and fast changing knowledge available nowadays. Younger people know better how to research quickly on topics and can give substantial support to senior staff.

Question 3: Very rigid system with not much understanding and patience for newcomers or younger people.

Interview 3:

Interviewed: SM Chief Engineer for the Partnering for Success organisation .
Results of interview:

Question 1: Priority and Time. We need to find innovative ways to make mentorship a priority for senior professionals. A great way Boeing does this is the 6 Step Program (mentioned in section 5 of our document). Mentoring comes in different colours, and a one-on-one relationship is effective, but not the only way to mentor. Young professionals need to take part in the all team meetings and knowledge sharing at cross talks. It is the duty of the young professional to go and seek out the opportunities; they are responsible for their own careers.

Question 2: Learning, fun, camaraderie, insightful (for both parties) awareness of surroundings and brings the human relationship aspect to the forefront.

Question 3: When I first started I had lots of interaction with other young employees. Was on a baseball team and I was excited about what I was doing. I didn't really make mentorship a priority, so I didn't think about it. Mentors at the time were leads or first line managers.

Question 4: Yes. The fundamentals of relationships and cultures have not changed however the speed at which we are expected to do things has changed. This shift makes culture and relationships take a lower priority. (He gave a good example about his time at leadership school at Duke. Two Koreans were in his class and he had lunch with them every day for the first week.

The lunch conversations were incredibly short, think yes/no one-word answers, until one day he showed them a picture of his daughter. Once he made it more personal and shared something with them outside of school they began to have much more animated and exciting conversations.)

Interview 4:

Interviewed: Senior professional, male, mid 50s, working for Air Force and NASA for 34 years.

Question 1: Diversity, respect, enthusiasm and motivation on both parties.

Question 2: Enthusiasm and excitement for their work and their willingness to interact with seniors and learn from each other.

Question 3: During the start of his career, there were a lot of people well over his age and the military etiquette did not allow for much young-senior professional interaction. He worked with a lot of World War II veterans and only remembers one or two women that work in the scientific field. It was not a diverse place and he appreciates the diversity of age, gender, and race in the current workforce.

Interview 5:

Position held: Deputy Director
Company: Centre for Satellite Technology Development (CSTD)

Question 4: One of the benefits of SP – YP interaction is the exchange and expansion of knowledge on both sides. Even though the SP's may be more experienced on-the-job than the YPs, a good number of SPs are not that competent or conversant with electronic devises, software and even computer programs and troubleshooting. So this is a typical case where SP-YP interactions become symbiotic.
SP - YP interaction has also been known to create potential moral pathways for YPs

Question 5: Provided the boundaries, sometimes unwritten are clearly defined and maintained, SP - YP interactions will always productive in terms of mutual benefits, positive collaborations and strength augmentation.

Question 6: As expected there are issues/topics that one may not be required to discuss, but by and large, it is imperative to portray ones institution in good light all the time

Question 7: When it has to do with business, technology transfer that of course comes with some legal obligation. In such instance absolute caution needs to be taken.

Interview 6:

Position held: Chief Engineer
Company: Centre for Satellite Technology Development (CSTD)

Question 4: SP - YP interaction has also been known to create potential moral pathways for YPs. SPs orient YPs on the realities of structural and administrative inefficiency and how to stay focused and productive in the face of these challenges.

Question 5: There is so much that is expected by YPs from their SPs but sadly these expectation are cut short because the SPs are also inadequately supported. Subsequently, some YPs loose interest and consider career changes.

Question 6: There are restrictions especially as they relate to technology transfer. For instance there are nondisclosure agreements on some shared technology.

Question 7: When the discussions are oral and informal, it is more difficult to breach these sort of agreements.

Young Professional Programs and Opportunities in the Global Space Sector

The group participants developed the following partial listing of programs and opportunities in the global space sector, listed below by region. This listing – which includes information gathered informally by the participants and may not be current and complete – is shown below:

AFRICA

a) **National Space Research and Development Agency (NASRDA)**
   i) This is not a professional relationship outright but rather a professional development. The Centre of Satellite Technology Development is a centre under a mother body, NASRDA - being a nascent Space institution, a lot of effort is made to consolidate and build upon its current human capacity, thus forcing the centre to cooperate with several local educational institutions to develop career pathways for young professionals.
b) **Surrey Satellite Technology Ltd (SSTL)**
   i) In a Know-How-Technology-Transfer program between NASRDA and SSTL Nigerian Engineers worked alongside with SSTL engineers to build NigeriaSat-2 and Sat-x satellites as a result of this international cooperation, several professional relationships were established.

ASIA/PACIFIC

Government/Agency

(1) CSIRO

(a) CSIRO has a very well developed Young Professional Program called CMP. CMP provides information and practical assistance using on-line tools, personal development plans and discussion planners to assist in developing a career plan. It is supported by learning and development opportunities offered across CSIRO.

(b) In CSIRO staff are given the opportunity to enhance their skills through on-the-job training, course participation and conference attendance, both domestic and international. This includes the Leadership and Learning Program, Mentoring and a National Orientation Program. Staff from across the organisation meet regularly to hear from interesting speakers, visit other CSIRO sites and have informal discussions between senior professionals and young professionals.

(2) JAXA

(a) International Top Young Fellowship (ITYF)

(i) Established for PhD graduates as a prestigious new fellowship program in 2009. The ITYF is designed to attract outstanding, highly motivated, early-career researchers in any of the space science fields covered by the Institute of Space and Astronautical Sciences (ISAS) to work in Japan for 3 (extendable to 5) years.

(b) Education activities and Graduates

(i) Countless young professionals are necessary to ensure successful future space development. In order to enhance development of these young professionals, Japan Aerospace Exploration Agency (JAXA) is strengthening educational collaborations on graduate -level in Japan. Currently, over total 200 students are learning at JAXA/ISAS from universities in Japan.

Industry Associations

(c) **Engineers Australia**

(i) Continuing Professional Development (CPD) Chartered Engineering Course for Young Engineers' Professional Development (offered by the Industry Association to all companies nationwide).

(ii) Young Engineers Australia group supported in every State: who run events, awards, industry development, site visits and socials.

(iii) This CPD and Graduate development for Young Professionals is used by all engineering companies in Australia, including aerospace.

EUROPE

Agencies

(1) ESA

(a) Very well structured support systems for young professionals such as internships and the YGT program. Knowledge transfer happens naturally from senior to young professionals and it's a supportive career environment at all stages. Many unofficial events are organised at each centre and official mentoring programs are being tried to add to the existing professional development programs and young graduate trainee programs.

(2) DLR Graduate Program

(a) DLR offers junior scientists further education and training. The DLR Graduate Program opens up numerous opportunities for PhD candidates. With this modular programme, they provide key technical, scientific and methodological qualifications, but also put an emphasis to develop social skills. They currently have 300 participants.

(3) BELSPO

(a) Belgian National Trainee Programme at ESA. The aim of the program is to offer young engineers and researchers the opportunity to work on space projects and obtain the work experience during a 12 month internship, which could be extended to 24 months. In this way, both BELSPO and ESA want to encourage young engineers and researchers to go for a career in the space sector and the program is financially

supported by the Belgian Federal Government. While it is indisputable that there is indeed a growing demand for highly skilled professionals from the Belgian aerospace industry, it remains difficult for a young professional to find a steady job within this industry. Companies prefer people who already have work experience, for the obvious reason that the time it takes for a person to bring a return on investment (ROI) to the company is shorter.

(4) FCT (Fundação para a Ciência e a Tecnologia)

(a) As the state organisation for science, the space office is also under this, but it's quite small. FCT coordinates the training program at ESA, ESO and CERN. They also provide the funds for this. There is no YP program within Portugal however. The Space Office deals with Space Policy and the interface between ESA, Portuguese Industry and Government. There is also no space program within the Space Office and only occasional student memberships.

Industry

(1) Airbus Defence and Space

(a) Graduate Program

(i) Very well structured program combines placements and focussed training plus senior professional interaction for the new young professional.

(b) VIE

(i) Young professionals have the chance to volunteer for international experience to develop their technical or business skills abroad.

(c) PROGRESS

(i) A Professional Graduate Entry Support Scheme – currently under redesign and will be released soon.

(2) OHB

(a) Efficient corporate structure with flat hierarchies and short decision-making routes, giving young professionals the scope for enhancing their personal and professional development. By working in international multi-discipline project teams, new employees are placed on real world projects from day one and enjoy a high degree of scope for creativity, independence and self-initiative.

(3) Space Applications Services

(a) Offers Company events each year several times and facilitates knowledge transfer by initial mentoring and giving new employees the opportunity to make direct impact from the start on real world projects. Senior professionals are approachable and can be asked for guidance at any time. Excellent senior to young professional relationships are a natural company culture.

MIDDLE EAST

Several countries in the Middle East are involved in space and have government and industrial organisations that participate as members of the IAF. Among these countries, activities for students and young professionals pursuing space careers exist in Algeria, Morocco, Israel and the United Arab Emirates.

NORTH AND SOUTH AMERICA

Agencies

(1) NASA

(a) Offers many programs to their employees including Presidential Management Fellows Program, Intern Programs and special programs for recent graduates.

(b) Most new employees in STEM degrees go through a rotational program or introductory orientation that allows mentoring and interface with upper management.

(c) Young Professional groups exist at NASA centres, which do reverse-mentoring programs or have informal guest speakers with upper management.

(d) NASA KSC has employee resource groups (ERG) that are chaired by a member who hold a Senior Executive role.

(e) STEM - science, technology, engineering, and mathematics program set up to increase the amount of students graduating with STEM degrees

(f) Goal is to get grade school students more engaged in seeing how fun science, math and engineering at a young age.

Industry

(1) Rockwell Collins:

(a) Young Professionals

- Offers tuition reimbursement
- Leadership development programs
- Community of Practice
    - Networking groups that allow employees to share knowledge and experiences on a specific topic
- Enterprise mentoring program
    - Open to all salaried employees directed match program for developing their leadership bench strength to an open self-selection program targeting development of talent across the enterprise.

(2) Lockheed Martin

(a) Leadership Forums are established by executive management to address enterprise-wide matters affecting the Lockheed Martin Workforce. Forum members are made up of senior leaders in the corporation.

(3) Boeing

(a) Offers mentoring courses on the Boeing Education Network

(b) Other programs and events offered by Boeing:

(i) Training is offered on a wide range of topics, including awareness of cultural, gender and international sensitivities, avoiding stereotypes and micro-inequities, understanding generational differences, and how to positively impact culture change.

(ii) Heritage Month commemorations are held company wide to recognise and promote awareness of different cultures and experiences, to encourage employee involvement, and to develop a diverse and inclusive work environment.

(iii) Mentoring programs are conducted company-wide at two levels: Enterprise Executive Mentoring (for executives and middle managers)

and Enterprise Mentoring (for managers, team leaders and others). The programs provide multicultural discussion tools. Boeing also provides a variety of mentoring programs at the program, job/profession or site level, as well as those sponsored by affinity groups. Reference.

Observations and recommendations:

Based on its preliminary investigation of this topic, the discussion group members agreed on the following observations and recommendations that may merit consideration by space faring organisations:

- Organisations that do not already have early career programs should consider establishing groups and mechanisms for newer employees to network, collaborate and grow in their careers. Such efforts should ensure that early career employees have a clear perception of potential career pathways.

- Young professionals can be 'tapped' to help create and help conduct early career networking activities.

- Mid-level managers may not always be receptive to facilitating opportunities for younger professionals. Senior management should ensure that mid-level managers understand and promote the importance of early career activities.

- The following factors are associated with successful relationships between early career and more senior relationships:

    - Trust building and veracity in thoughts and actions
    - Establishment of mutual respect
    - Creation and maintenance of collegial atmosphere
    - Openness to diversity
    - Increased commitment
    - Clear perception career pathway
    - Higher chances of career success
    - More job satisfaction

5: Conclusion

It is challenging to grow in any professional field and especially in the aerospace sector. This workshop report discusses the perspectives, interests and recommendations of thirty young professionals from all around the world, working in the aerospace sector in the hope that interested management officials in IAF member organisations will take note of the ideas presented and begin a dialogue that leads to better understanding and promotes both individual and organisational needs. The perspectives presented by the 2014 Workshop participants are also intended to promote greater discussion within the community of early career space program employees.

The 2014 IPMC Young Professionals Workshop benefited from two IPMC/IAF member organisations – The Boeing Company and the Japan Aerospace Exploration Agency – that provided funding for coffee breaks and a working luncheon during the one-day workshop. The workshop participants and the IPMC members appreciate this support.

6. Workshop Delegates

TEAM – Competences and Skills for the Space Sector		
Kretzenbacher	Micheal	Aerospace Concepts
Hong Yam	Chit	JAXA
Kobrick	Ryan	Space Florida
Ferreira	Luis	SGAC
Delgado Lopez	Laura	SWF
Burg	Alexander	George Washington University
Campan	Jérôme	DLR
TEAM – Relevant Tools and Methods for Innovation		
Adriaensen	Maarten	European Space Agency
Hernandez	Stephan	European Space Agency
David	Emmanuelle	DLR
Salaverria	Luis	ESL
Singh	Balbir	Manipal University
Dick	Brandon	Boeing
TEAM – Management Practices to Boost Innovation		
Seward	Elisabeth	Astrium Toulouse
Kunes	Michal	Czech Space
Castorina	Michele	European Space Agency
Ida	Kyotaro	JAXA
Yunus	Arslantas	ESL
TEAM – Evolution of Professional Relationships		
Boyd	Andrea	European Space Agency
Hoffman	Nadine	European Space Agency
Farid	Ahmed	DLR
Caraccio	Anne	NASA Kennedy Space Center
Umunna	Reuben	NASRDA
Gorman	Erin	Boeing
Latif	Muhammad	Suparco
TEAM – Starting a Career in Aerospace		
Burgett	Taylor	AFRL's University Nanosat

Kara	Ozan	KOC University
Yamashiro	Ryoma	JAXA
Kingsley O.	Ukaegbu	Federal University of Technology Owerri
Park	Ji Hyun	Seoul National University
Weber-Steinhaus	Luise	Airbus Defence and Space