International Astronautical Federation
International Project / Programme Management Committee

IAF-IPMC Young Professionals Workshop 2022

Workshop Results Report

Workshop Organizing Committee
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The 2022 IPMC Young Professionals Workshop Delegates
on 17 September 2022 during the hybrid (online + in-person) Final Event

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1. Executive Summary

The International Project / Programme Management Committee Young Professionals Workshop (IPMC YP WS) sought to gather ideas and recommendations from early career employees in the international space community and provide the IPMC and IAF member organizations with knowledge, insights and perspectives to help 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 previous workshops and served as the Workshop Organizing Committee (WOC) to manage the overall process and finalize the preparation of an overall report.

The workshop began in the second quarter of 2022 with the nomination and selection of participants, who were assigned to one of five working groups, each focusing on a different discussion topic. During the ensuing period these groups discussed and investigated the topics and reached conclusions. The groups compiled their results, findings and recommendations into reports and video presentations. Major findings were then presented and discussed live with the IPMC members, workshop delegates and guests during the final event held in conjunction with the 73rd International Astronautical Congress.

Following the workshop, the WOC prepared this final report with a summary of the results and recommendations.

Topic 1: Commercial space: challenges and opportunities for Project Management

The team started by identifying the **peculiarities of "New Space" and commercial space across ten different processes of project management**, namely project governance, value chain, human resources, procurement management, stakeholder management, communications and outreach management, scope management, time management, project financing, and risk management. They did so by combining literature research and interviews with experts.

Their findings indicate that project management trends are being influenced by the drivers of space commercialization:

- **Accessibility** of commercially favorable legal and regulatory frameworks, increased use of private financing and the diversity of financing instruments across jurisdictions, cross-continental accessibility of licenses and data from upstream infrastructure owners and the ease of engagement between downstream businesses and upstream providers are influencing project scope management, time management, cost and financing management.
- **Collaborations** across space agency clusters e.g. the European Space Agency (ESA) and the African Union (AU) space programs, collaborations between private players to form "industry clusters," and collaborations of both public and private entities with research and development centers like universities. These collaborations are influencing governance, value chain, stakeholder management, communications and outreach, and risk management approaches.

- **Growth of small and medium enterprises (SMEs)** stimulated by incentivizing governmental policies, space agencies strategic positioning procurement policies and rewards to level the participation field while encouraging collaboration with big private entities.

The team crafted recommendations for each of the 10 project management processes mentioned, for either institutional or commercial players.
They also postulated that **the role of the Project Manager (PM) should shift from emphasizing technical expertise to business expertise**, with the ability to embrace complexity and to fill the gaps between the space and non-space sectors.
Finally, they highlighted that **space commercialization is influencing how young professionals perceive the market and their own professional lives**, thanks to a diversification of skills and jobs required in the space domain and to the increase in the number of potential employers.

Topic 2: Delivering digital transformation and building Digital Governance in an ESG-focused world

The team studied digital transformation and digital governance in the space sector and, after interviewing relevant personnel from government agencies and "New Space" companies from various countries around the world, developed practical recommendations.
They identified areas that are significantly impacted by digital transformation:

- Organizational development strategy
- Project management & project controlling
- Knowledge management
- Human resource management
- Funding acquisition / procurement management
- Customer acquisition management & business models
- Engineering operations & MAIT (Manufacturing Assembly Integration and Testing) management
- Cyber security

The implementation of digital transformation can lead to significant disruptions in the legacy systems of an organization. **Project managers have to shoulder several additional responsibilities towards various stakeholders**. In addition, the organization has to overcome various technical and non-technical challenges directly related to the implementation of digital transformation. Although **digital transformation initially appears to be an expensive and tedious process full of risks and uncertainties**, the benefits outweigh the costs when it is implemented correctly with proper digital governance. **Automation** improves employee productivity and leads to increased job satisfaction. In addition, **streamlining and standardization of Human Resource Management (HRM) practices** helps solve talent shortages and saves the time of HRM personnel. The **use of a secure Single Source of Truth (SSOT) architecture with backup** for the centralized database in the organization ensures that only authorized stakeholders have access to an enduring source of updated, authoritative, and consistent information during the lifecycle of a project. The **combination of big data analytics**

and cloud computing allows satellite data and ground operations data to be processed much faster, leading to faster and more accurate data-driven development of products and services. **Reliable and secured information networks** based on shared web Application Programming Interfaces (APIs) allow stakeholders scattered across locations worldwide to connect and collaborate, share knowledge, and make more accurate data-driven decisions (resources allocation, scheduling, etc.).

Topic 3: Project management in a VUCA world: effects on the workforce well-being

The team carried out a literature review and interviewed experts. They sought to properly define VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) and Well-being, before moving on to mapping how VUCA impacts workforce well-being. They also investigated how managers and leaders can assist their teams in a VUCA world and which opportunities arise for YPs in this environment.

Their results show three main axes for improvement in project management and leadership:

- a **hybrid agile project management method** will always be the preferable choice in a VUCA context;
- **emotional intelligence** and a **coaching leadership style** are particularly relevant when working with YPs;
- project managers can improve team cohesion, workload management, and well-being by using **7 key traits**: **Vision**, **Understanding**, **Clarity**, **Agility**, **Networking**, **Openness**, and **Participation**.

The team acknowledged that **YPs have several opportunities in a VUCA world**: they can showcase their flexibility, ability to adapt and love for change, they can propose innovative high-risk ideas, and they can leverage their status as digital natives to complement the experience of senior colleagues.

The team gives four major actionable recommendations to managers:

- **Adopt an Agile PM style** that can counteract complexity by breaking down large projects into smaller tasks and can adapt to change via continuous iterations
- **Pave the road for bottom-up initiatives** that can unleash YPs ingenuity and offer them a motivational and formative experience if they are allowed to manage their own small projects
- **Allow seniors to speak and to be heard** so that there are no barriers to knowledge/experience transfer between senior and young professionals and both feel incentivized and comfortable communicating with each other
- **Make well-being a priority**, disseminating a shared understanding of what well-being actually is and how to pursue it in the workplace
- **Nurture team building** to make sure teams are up-to-date and engaged, but also collectively aware of the effort required to build and maintain a team.

Topic 4: Space projects without frontiers: how to leverage cooperation and organizational diversity

The team focused on three types of diversity:

1. **Geographical diversity**: current global dynamics and how they impact the space industry
2. **Industrial diversity**: collaboration of space and non-space organizations
3. **Gender diversity**: an axis introduced after reflecting on the composition of the team and on the fact that it is a topic discussed intensively around the world.

They based their research on qualitative methods including a literature review, interviews of relevant space actors and a subset of tools described in the methodology section.

The group reviewed five case studies to investigate and substantiate their assumptions:

- Case Study 1: **Artemis Accords**, to explore aspects related to interoperability, and how new space nations will seek to contribute to a shared goal whilst developing their own space industry.
- Case Study 2: **Analogue Astronaut Missions**, to detail how gender diversity is playing an important role for this kind of mission.
- Case Study 3: **Space Medicine**, to show how industrial diversity is mandatory where collaboration between experts of totally different fields is needed.
- Case Study 4: **Industry Collaboration**, to cover how industrial diversity can bring technological and cost benefits to space programs and how government agencies can help accelerate commercialization of space missions to develop a self-sustaining private space economy.
- Case Study 5: **Sprint Advanced Concept Training**, to substantiate how collaboration and geographical diversity are crucial to the success of space situational awareness (SSA) and space traffic management (STM).

The team provided relevant recommendations, classified into 5 different themes:

1. Organizational culture
2. Public outreach
3. Communications and logistics
4. Innovation and technology uplift
5. Project Design

Finally, the team explained how Young Professionals can play a role in enhancing diversity via advocacy, discussion, and trust.

Topic 5: Sustainability of space projects

Among the several possible definitions of sustainability, the group focused on the growing space debris problem, and specifically on the **effects of space debris on space projects in Low Earth Orbit** (LEO).

The team decided to structure their research by expanding on the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities (LTS Guidelines) of the United Nations

Committee on the Peaceful Uses of Outer Space (COPUOS). This is a landmark international soft law instrument adopted by 95 States members of COPUOS in 2019.

- With respect to paragraph one of LTS Guideline B.8, the group highlighted the role of **trackability** and **transparency** in tackling the space debris problem.
- With respect to paragraph two of the LTS Guideline B.8, the team advocates for implementation of **end-of-life solutions** enforcing the **25-year rule**.
- Finally, regarding paragraph three of LTS Guideline B.8, the YPs conducted interviews to probe observations and recommendations regarding **smallsats, particular designs and orbital and mission profiles** to limit space debris.

The group suggests the following recommendations for project managers:

1. Train teams to learn space sustainability guidelines
2. When dealing with small-size space objects, plan for cost-neutral optimized payload and mission objectives
3. Enhance communication and stakeholder engagement during operations through data sharing
4. Schedule and execute dedicated end-of-life plans.

To conclude, the team argues that the recommended sustainability measures produce better success criteria, because they will grant the individual project and the broader space community long-term utilization of space.

2. Introduction

On 17 September 2022, a group of 30 international young professionals working in space agencies, companies and professional organizations met to participate in an annual event sponsored by the International Project / Programme Management Committee (IPMC) of the International Astronautical Federation (IAF) as the culmination of a 4-month-long workshop. The workshop was planned and organized by a team of alumni working in collaboration with the IPMC. The final event was held in affiliation to the 73rd International Astronautical Congress (IAC), and carried out in hybrid fashion, with simultaneous online and in-person attendance.

The IPMC—which brings together representatives from more than twenty IAF member space agencies, companies, and professional organizations—meets semi-annually to exchange experiences, best practices and to collaborate on projects that nurture the global space workforce. The IPMC Young Professionals (YP) Workshop is an annual initiative, and its final event is held just prior to the IAC. The IPMC selects a small group of young professionals who previously participated in a YP Workshop to serve as the Workshop Organizing Committee and help the IPMC organize and manage the event. The 2022 Workshop Organizing Committee (WOC) members were:

Linn Boldt-Christmas	Communications Manager
Mark Fittock	Operations Manager
Birgit Hartman	Strategy and Implementation Manager
Ekaterina Seltikova	Correspondence Manager
Takeshi Shoji	Delegates Manager
Eleonora Zeminiani	Project Manager

The Workshop Organizing Committee members were also asked to closely follow the development of the discussion topics, guide the discussion group deliberations, and prepare this final report. The 2022 IPMC Young Professionals Workshop attracted 30 early career employees from government, industry, research, and professional organizations throughout the world. Each of the participants was nominated by an IAF member organization to attend the workshop in response to a call for nominations.

The workshop participants selected one out of five discussion topics to be researched in smaller discussion groups that met virtually during the period from May to September, in preparation of the final event. For further information, please see Chapter 3: Workshop Activities and Virtual Sessions Collaboration.

The results of these investigations and deliberations, with 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 organizations.

3. Workshop Activities and Virtual Sessions Collaboration

In Spring 2022, the Workshop Organizing Committee (WOC) published the Statement of Work (SOW) and Call for Delegates and then collected candidatures and applications.
After the selection of the delegates, the organizing committee administered a questionnaire to obtain information including profiles of each delegate, along with their preferred social networking tools, professional capabilities, and personal interests. This information helped establish a basis for assigning the delegates into the various topic groups. Each participating young professional 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 Young Professionals Workshop is a monthslong initiative gathering a globally distributed and diverse group of delegates. In order to establish relationships among the delegates and promote teamwork on the assigned topics, the WOC encouraged use of online virtual, social and collaborative tools, such as Slack, Google Docs, and the scheduling tool Doodle. Delegates were also free to propose and use other tools of choice, such as WhatsApp, Teams, and Miro.
The goal was twofold: on one hand to facilitate "breaking the ice," and on the other hand to initiate and maintain group conversations around the chosen discussion topics.

The WOC then organized a first meeting via MS Teams to introduce the Statement of Work and explain in detail the expectations, goals, timelines, and deliverables. This was also a good time for the delegates to ask any question, and to share their initial thoughts and ideas.
Each group was assigned 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 and ensure consistency of the deliverables with respect to the SOW requirements.

The virtual sessions process began in late May 2022. Until the final event in September, the delegates were asked to work on their single-team topics. Discussion group meetings were facilitated via videoconference and digital collaboration tools, which allowed young professionals to self-organize teamwork in line with their availability. Documents, such as mid-term reports and project execution plans, were submitted as deliverables and shared under folders in Google Docs. This proved to be a good approach to have material always accessible by delegates, mentors, and WOC representatives around the world. The teams 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 platform for collaboration among the participants from diverse locations globally, the virtual sessions worked well and were a means to bring the delegates together and facilitate the research prior to the live final event.

Mentors—senior professionals with specialized insight into the topics being investigated—have been key contributors to the success of the initiative.
Mentors were selected by the WOC in Spring 2022, by collecting volunteer applications and by scouting suitable profiles and connections. An orientation session (once more, an online virtual meeting) was held between the WOC and mentors to introduce the purpose and inner workings of

the workshop and to better explain to the mentors what was expected from them. One or two mentors were assigned to each topic group, with the objective to offer advice and steering, evaluate ongoing research, and critically assess results and recommendations. Mentors were the "critical voice" that helped the delegates measure their work against the typical key drivers of project management (cost, schedule, quality) and build the case for their proposals by discovering weaknesses and clearly identifying the possible "return on investment."
Mentors were in contact with their assigned topic group (through the topic leader) and each team agreed on a preferred pattern of attendance. Some teams worked more closely and more often with their mentors, involving them in every teleconference and every discussion. Others established recurring checkpoints spaced out by periods of autonomous research.
In any case, young professionals and mentors formed fruitful alliances to improve the value of workshop outcomes and to collectively grow the space community. They also greatly contributed to the quality of the final event where they had a chance to discuss live the results of their own and other teams' research.

Mentors for the 2022 IPMC YP Workshop were:

Sabrina Alam	Senior Specialist, ESG and Sustainability at SES
Anthony Murfett	Head of Technology and National Security for the Australian Government
Gabriel Pont	Project Manager for FSS and DragonFly at CNES
Thomas Sinn	Founder and CEO of DcubeD
Rüdiger Süß	Senior Strategist, Foresight and Trends at DLR
Hirohiko Uematsu	Chief Engineer at JAXA

4. IPMC YP Workshop reaching Young Professionals worldwide

In the eleven editions of the workshop since 2012, a total of 338 people have participated, drawn from an average of 16 different countries each workshop.

Based on the location of the IAC, the WOC can observe the following:

- The nationality of the participants shows a direct link to the location, i.e. more Asian Nationalities at IAC Beijing, a majority of Europeans at IAC Bremen, etc.
- The cost of accommodations and travel is an important decision factor for young professionals to attend.
- Visa requirements can prevent young professionals from attending.
- Virtual collaboration sessions and virtual final events allow attendance of a larger pool of delegates by cutting out travel expenses and associated limitations in a Company's sponsorship budget.
- Travel limitations linked to work-from-home and pandemic prevention practices in place at Company or Country level still heavily affect the possibility for young professionals to attend the final event in-person.

Once more, the workshop proved how younger generations and their smart work approach are intrinsically resilient and more efficient in face of challenging boundary conditions such as delocalized teams and travel limitations.
The delegates to the 2022 IPMC YP WS have tackled the topic proposed in the SOW with effort and dedication, reflecting on the peculiarities of project, people and knowledge management in current times.

2022 marked the 12th anniversary for the IPMC and the eleventh occurrence of the YP WS. Young professionals accepted the challenge and demonstrated that successful teamwork and brilliant results can be achieved in spite of challenging, volatile, and uncertain circumstances.

5. Group Topic Results

The 2022 IPMC Young Professionals Workshop dealt with five different topics pertaining to project/program management, people management, and knowledge management. During the final event, the five discussion groups met in a plenary live session for the first time and presented their findings to the other groups, IPMC representatives, and a general audience. The topic reports prepared by the five groups, together with each group's concluding observations and recommendations, are presented below. This report is a concise compilation of the results. Links to the full research materials can be found in the concluding chapters.

5.1 Commercial space: challenges and opportunities for Project Management

Space commercialization has defined and driven the global trends of outer space programs and projects of the twenty-first century. The team conducted their research to identify and compare the distinctive trends and considerations for the management of commercial space projects undertaken by public institutions (space agencies and governments entities) and private entities.

The framework and findings of this research have been aligned to the definitions and terminologies presented by the Project Management Body of Knowledge of the Project Management Institute (PMI). The findings pertain to different areas, namely project governance, value chain, human resources, procurement management, stakeholder management, communications and outreach management, scope management, time management, project financing and risk management.

The findings indicate that project management trends are being influenced by the drivers of the space commercialization:

- **Accessibility** of commercially favorable legal and regulatory frameworks, increase of private financing players and the diversity of financing instruments across jurisdictions, cross-continental accessibility of licenses and data from upstream infrastructure owners and the ease of engagement between downstream businesses and upstream service providers are influencing project scope management, time management, and cost and financing management.
- **Collaborations** across space agency clusters e.g., the European Space Agency (ESA) and the African Union (AU) space programs, collaborations between private players to form "industry clusters," and collaborations of both public and private entities with research and development centers, such as universities. These collaborations are influencing governance, value chain, stakeholder management, communications and outreach, and risk management approaches.
- **Growth of small and medium enterprises (SMEs)** stimulated by government incentives, space agency strategic positioning, procurement policies, and rewards that level the playing field while encouraging collaboration with big private entities.

The research was guided by three main questions:

1) How do commercial space projects differ from institutional projects?
2) Which new challenges and opportunities meet the Project Manager in this context?
3) What is most striking or impactful for Young Professionals who are just joining the workforce?

The research used both literature and empirical sources. The team followed a four-step approach with the final objective of developing a set of recommendations addressed to project managers in both the institutional and private commercial space sectors.

- First, a literature review was conducted in order to conceptualize the research subjects of "space commercialization" and "project management." This led to the selection of 10 distinct project management processes to guide the analytical framework of the research.
- Second, empirical evidence was gathered by conducting in-depth interviews of 23 experts in the institutional and private commercial space sectors. In order to compile as many different points of view as possible, interviewees with relevant backgrounds were selected from different seniority levels, positions, regions and domains.
- Third, the findings from both the literature review and the expert interviews were combined in a comprehensive research analysis.
- Finally, a set of recommendations was formulated per project management process, addressed to the two main target audiences: namely project managers of public institutions/space agencies and project managers of new and entry-level companies.

The key findings and relative recommendations are presented below.

Governance

Space program governance in the "New Space" has seen private entities acquiring, developing, installing, and operating space infrastructure to claim a segment of the upstream commercial market. The private entities have dominated the downstream commercial market, offering their data and services to public and private end customers all over the world. Despite operating in a government/contractor partnership with private enterprises, space agencies are currently forging new contractual arrangements (e.g., Public Private Partnerships), functioning as space program partners and technical advisors to commercial entities.

Data show this phenomenon has important implications, including that it leads to time-effective development of the space infrastructure, encourages innovation, and promotes commercialization.

Recommendations to public institutions and space agencies include embracing complexity and opening to private markets and end-user sectors by hiring non-space managers who worked in end-user sectors. Promoting incubation, accelerators and call for ideas to foster the adoption of space technologies in new domains. Public institutions may foster space commercialization by providing their expertise.

The team recommends that new and entry-level companies look for public-funded initiatives, know the context, understand the new market, and leverage innovation intermediaries—organizations who act as knowledge brokers between the parties of the space ecosystem, filling the gap between the space and the end-user sector.

Project value

New industrial dynamics are disrupting the space sector and the value proposition of space projects and programs. Space projects must be valuable for a wider set of end-users, asking not only for economic returns but also social and environmental benefits. Interviewees suggested several key themes that space agencies, public institutions, and private organizations must take into consideration to define, develop, and deliver value on their projects or programs.

Project value considerations include looking beyond the return on investment, broadening value propositions, creating inclusive value propositions, and playing a new role in the ecosystem.

Recommendations to public institutions and space agencies include reducing time to market for technology transfers, engaging with end-users to understand their needs, and delivering a valuable project outcome by promoting open innovation initiatives and targeting innovative space and non-space startups. Adopting service-oriented practices and methods to develop end-user-oriented projects. Space projects must be valuable for many stakeholders who have to be willing to pay for them.

Recommendations to new and entry-level companies include understanding the space market and promoting co-creation and collaborative innovation with space agencies and companies to developing project outcomes that answer the end-user needs. This may foster inclusive value creation and higher return of investments.

Human Resources Management and Organisation

Traditionally, governments and space agencies were setting the pace of projects and defining the roles and responsibilities using conventional cost-plus contracting. Long time horizons of projects and budget allocations in the public sector make it necessary to have dedicated employees to deal with administrative, procurement, engineering, and processes facets throughout the duration of the project.

The "New Space" trend sets a clear change. Emerging commercial entities now rely more on funding from private investors who need to demonstrate faster time to market and achieve breakeven for investors. Investors also rely on the diversity and experience of the teams as their number one criterion when choosing to invest or not in a company. This means that employees, and especially in small entities, need to have complementary skills assigned to each employee, in management, engineering, administration, and communication.
The consequences of this trend are that companies, both legacy space companies and emerging ones, need to adapt to a faster paced environment, with a need for more efficient management. New approaches to management, such as lean management can help reduce inefficiencies in companies.

Although human resource management is always crucial to the success of a project, for the reasons mentioned above, diverse teams with several skill sets are critical to the success of a company in "New Space." This is even more important for start-ups as there is no such thing as a solo entrepreneur. The lack of a strong team with the necessary project management and engineering skill sets can be detrimental to the success of a company.

Procurement Management

Today, a short development cycle and time to market are vital to support the ambitions of "New Space" endeavors, in particular for closing the business case. Public entities worldwide need to align and ensure more adapted approaches to the planning, conducting, and controlling of procurement.

Traditional acquisition processes in the public sector usually mean more people involved on both the public sector and private sector side and require longer time to contract, which can be detrimental to small entities requiring rapid cash flow. Yet procurement from public institutions can be one of the most important levers to ensure industrial readiness of a region. Governments are also crucial in leading cultural change, guiding industry into harmonization of components, and facilitating collaborations between established companies and small entities.

Nonetheless, while sometimes there is a need for strict rules, requirements, and reporting, this burden should be reduced to the minimum. This can be solved by being less prescriptive and adopting a more solution based contracting model.

Stakeholder Management

When it comes to the process of Stakeholder Management, one of the key findings of the research was the importance of regional/national networks and clusters for new and entry-level companies who use these networks as a way of finding partners, discovering synergies, gaining visibility, and tapping into sector-wide knowledge.

Another key finding was that it is considered crucial for commercial success to adopt an end-user perspective across the development of a product/service. End-users may not always have a structured or formal association to represent them, thus special attention on ways of inclusion is needed.

As a recommendation, is it advised for the public institution/space agencies to take the regional/national lead in creating and facilitating such a regional/national network, and for new and entry-level companies to take part in existing regional/national networks, or to join forces and create one, should one not be available. Such networking can boost their visibility for new and entry-level companies, helping them find partners, create synergies, capitalize on opportunities, and exchange knowledge with established players. This can work as a catalyst for their eventual commercial success.

Communication and Outreach Management

In the area of Communication and Outreach Management, a striking observation was that commercial private space players naturally operate more outside of the space-bubble and thus recognize a need for awareness-raising to customers and investors of the potential and relevance of commercial space products or services. This seemed especially crucial for companies that rely on funding from private actors. An increase in awareness, knowledge, and interest in the commercialization of space is needed so that it becomes attractive for all types of potential investors. With such awareness-raising comes the need for communication and outreach of commercial space programs/projects to be inclusive and impact-focused.

This means that entry-level companies should gear their communication towards explaining their added value and thus the return on investment for potential customers and investors. Whereas

public institutions/space agencies can contribute to public awareness by equally including end-user and impact-focused perspectives in their communication and outreach. For new and entry-level companies, this will potentially increase investor and customer willingness to pay, whereas for public institutions/space agencies it will raise their public profile and their impact on society.

Scope Management

Scope management is considered from two perspectives 1) which is the subject of the deliverables: product or service, downstream or upstream and 2) how to best manage said scope of work until successful delivery.

For the first perspective, findings from interviews show that scope depends on the geographical environment of companies and projects, with downstream services more suitable for emerging countries. For the second perspective, it is suggested to include "business development" functions at the top of the organization and to nurture an "entrepreneurship culture" in all employees. Also, precise planning while dividing the project into smaller achievable steps is suggested.

Time management

Time management is observed to be very different between institutions and private companies. While survival of private parties is dependent on reducing the time to delivery, in institutions it is common for projects, especially mega projects, to go over schedule and budget. Also because of hierarchical and multi-layer nature and structure of institutions and governmental organizations it is observed that dealing with private parties is prone to delay as well.

Therefore, it is recommended for institutional project managers to always have a properly sized time contingency and strict schedule monitoring and management. Also schedule and delay management should be included in risk management and associated financial and time contingencies should be allocated.

Regarding newly established companies, it is observed that too much time is spent on design and theory rather than physical implementation. Therefore, schedule margins become very tight close to the end of the project. It is recommended that a balanced time (not necessarily equal time) be dedicated to design and hardware development, making good use of Minimum Viable Products to test the theoretical design assumptions and at the same time create customer engagement and collect feedback.

Financing and Cost Management

Traditionally, space projects have been solely funded by government. The commercialization age has seen hybrid funding models. Some space agencies are able to leverage private funding to complement government funding. The increase in available funding means that a space agency can fully contract upstream and downstream companies. To stimulate the participation of start-ups and SMEs, grant givers/funders can impose a percentage of the grant to be allocated to SMEs and used to grow the industrial base and value chain.

Governments will have to increase cooperation on international law to enable international financing systems e.g. the asset-based financing model where financiers can register their security rights in assets in an international registry, and help both big private companies and SMEs to get asset-based financing and secure transactions for high-value space infrastructure across jurisdictions. Countries should create enabling legislation for more private companies to get

involved. One way to stimulate the space industry is to create a preferential tax environment that attracts private companies. Space agencies can also have advance payments on contracts awarded to SMEs, as most space programs are capital intensive and this is an entry or participation barrier to SMEs.

Risk Management

Private entities and institutional entities can consider embracing the "failure tolerance" approach to risk management at the overall system level (instead of the incremental approaches to reducing risk at the subsystem level) and applying risk reduction through constellation redundancy. Public institutions must embrace and leverage the "fail fast, learn fast, and move forward quickly" approach for which commercial actors have demonstrated the rate of returns in bringing forward new technology. Space agencies can act as the first adopters of new technologies for commercialization from start-ups and SMEs. Furthermore, in handling technical risks, it is important for program managers to look at contracting SMEs for their distinct, highly specialized knowledge in specific technical areas.

In the case of in-house developed technology, start-ups and SMEs should be bold in handling calculated risk. In developing and launching new technologies, the entrepreneur will not have all the information needed to make decisions. Collaborating with good partners will help increase the chances of success. Expert advice is important in identifying risks and drafting mitigation measures. Start-ups can also consider buying and/or collaborating on technology that has been tested and incubated in R&D centers. It is important to agree on a risk management approach at the beginning of the contract/agreement and by accepting that continuous development and improvement in products/services approaches are useful risk mitigation strategies for "New Space" projects.

Conclusion

The Team investigated the distinctive characteristics of commercial space projects, identified the associated changes in project management approaches, and the considerations that make a successful commercial project.

The analysis showed that commercial space projects have greater probability of failure, and the magnitude of risks are higher for start-ups and "New Space" companies. Commercial space projects present radical changes in the financing mechanisms, with private stakeholders acting as sponsors of the projects and venture capitalists playing a key role. The new context forces companies to attract and build new capabilities oriented toward non-space sectors with a strong managerial and commercial background. In this regard, the role of PM should shift from technical expert to business expert, able to embrace complexity and to fill the gaps between the space and non-space sectors. The PM and the PM office should, more than before, integrate diverse teams with several skill sets that are critical to the success of a company. This is even more important for start-ups, as there is no such thing as a solo entrepreneur. The lack of a strong team with the necessary project management and engineering skill sets can be detrimental to the success of the company.

A commercial project manager in the commercial domain can be successful when they leverage the higher flexibility the private entity offers rather than the institutional one, with the possibility to easily shift priorities. Commercial projects are end-user oriented—the project value is developed

and delivered to solve end-users' needs. Commercial projects are the result of a convergence of different domains and sectors. The project manager should engage the end-users and the entire ecosystem to create value.

Space commercialization is influencing how young professionals perceive the market and their own professional lives. While institutional or established players were for a long time the most attractive employer in the market to (young) professionals because of reputation, technical excellence, stability of working conditions, etc., the commercialization of space has brought new employers to the market who are becoming more attractive. The emergence of "New Space" companies has meant that new skills and jobs are brought to the space domains: young business analysts, young consultants, and marketeers find their way easier to space, whereas space engineers have more potential employers interested in their specific skills and technical competencies.

5.2 Delivering digital transformation and building Digital Governance in an ESG-focused world

Space Sector and Digital Transformation

Space has increasingly been gaining attention in recent years. There is an assumption that space can be leveraged commercially, as well as to help humans on Earth to solve socioeconomic and environmental problems. Many private space companies have emerged and are currently trying to validate this assumption. In addition, space is becoming the scene for ambitious new science and exploration programs, driven by both established space players and newcomers from around the globe. Last, but not least, the domain of space still serves as a means for the demonstration of national prestige and the demonstration of military power. In brief, recently observed developments in space are often compared to a sort of renaissance of the golden space age dating back to the 1950s and 1960s. Now, new private players constantly challenge the well-established paradigm of what can be done in space and how activities are accomplished. How can this positive trend be maintained? To begin with, it needs to be acknowledged that activities in space still require solving complex and complicated problems. Yet, something that has changed over time is how things are being done. The umbrella term which encapsulates this change is called digital transformation (DX).

What does digital transformation specifically mean for the space sector and for the people in the industry? How can it be linked with the goal to minimize the consumption of time and vast financial resources for technology developments? How does it serve as an enabler for the proposed new businesses? Today, digital transformation is defined as a combination of automation technologies such as cloud computing, blockchain, Internet of Things and robotic process automation. It also consists of data science technologies that include big data analytics, machine learning, and artificial intelligence. On the other hand, there are risks and challenges that are involved in implementing digital transformation. Digital governance needs to be implemented carefully to avoid transforming the organization in the wrong direction. Thus, it is important to investigate the current situation of digital transformation, and digital governance in the space sector.

The team created a roadmap for project managers in the space industry to implement digital transformation successfully within their organizations, as well as to manage the associated digital governance successfully. This revolves around answering three key questions:

- What are the effects and consequences of digital transformation on space projects?
- What changes do they imply for the space project manager's role and their responsibilities?
- What's the best way to implement digital transformation while maintaining a proper digital governance?

Methodology

The working group relied on interviews with professionals from across the space sector. Given the time frame and to set an achievable goal for this research project, only interview partners from the "New Space" sector as well as space agencies were selected. Strictly speaking, questions were prepared in a way that they were tailored to the role and responsibilities of the interviewee within their organizations. Answers obtained from the interviews were consistently sorted and classified. Finally, the information was rearranged in clusters for each identified area of relevance with respect to digital transformation.

The team reached out to around 50 space agencies and "New Space" companies from 21 different countries around the world. Fifty percent of these organizations did not respond, and 4 percent mentioned that they don't have any digital transformation and they are still doing work manually. However, they have plans to digitize their work. One organization mentioned that they are still doing the paperwork due to dealing with manual governmental processes. The data shows that 56.5 percent of the interviewees are working in "New Space" companies, while 43.5 percent are from space agencies. In total, 23 diverse interviews were conducted as part of this study.

Literature Review

To prepare for the interviews, the team performed an extensive literature review. The scope of interview questions was based on an extensive literature review.
Besides learning about potential benefits, such as increased productivity, the literature review allowed the team to identify challenges associated with digital transformation.

As a first challenge, digital transformation is frequently seen as a source of costs, and evidence to create a return on investment (ROI) is not always clearly predictable. Furthermore, challenges are being observed with respect to legislation and regulations. Human-related aspects, namely the reluctance to change, and cultural issues of entrenched perspectives pose the risk of being showstoppers. Last, but not least, another significant challenge posed by digital transformation is the requirement to maintain a high level of cyber security in data processing and information management.

As a generalized statement, undertaking a transformation at the organizational level is regarded to be a protracted, complex process with many unknown variables. Despite the potential of huge benefits from digital transformation, the implementation requires a well-balanced and reasonable strategy.

Results

The interviews conducted with professionals working in the space sector revealed very interesting insights. The information shared by the interviewees matched the literature in terms of the benefits and challenges of digital transformation. Currently, the Environmental, Social, and corporate Governance (ESG) criteria do not seem to have much influence over digital governance in the space industry as obtained by the team's analysis.

A number of relevant areas that are significantly impacted by digital transformation have been identified throughout the evaluation of the answers obtained from the interviewees. These encompass:

- Organizational development strategy
- Project management & project controlling
- Knowledge management
- Human resource management
- Funding acquisition / procurement management
- Customer acquisition management & business models
- Engineering operations & MAIT (Manufacturing Assembly Integration and Testing) management
- Cyber security

For all of the above areas, various examples with either general or space-sector-specific validity could be analyzed and placed in context.

In general, with respect to the organizational development strategy, it is widely shared that implementing digital transformation, at least in certain operational areas of an entity, is a crucial step to be well-prepared for the future.

The increase in transparency and the amount of data available changes the way a project is managed, and the required skills of the project manager. This might bring benefits, such as faster decision-making, but also yields challenges, such as extensive training in data management or the risk of being over-stressed by floods of unstructured information.

In addition, significant potential is generally seen in the way knowledge management can be handled. For instance, following the "single source of truth" approach is expected to entail a lot of time savings, more efficient communication as well as process robustness.

In the area of human resource management, the digital transformation can both help to reduce the number of employees on one hand, while serving a global delivery of education, and thus supports the inspiration of future generations to work in the space sector. An associated challenge is to train and motivate employees to adapt and to actively contribute to the digital transformation.

Furthermore, digital transformation is regarded as being helpful in certain aspects of partnership management such as contact data exchange and communication (e.g. investors or customers). However, crucial social constructs, such as personal trust and intangible analyses, are hard to build up in a digital world.

Another result that needs to be highlighted is that various "New Space" companies believe digital transformation will be a key enabler for new business models with customers from non-space industries. With respect to engineering operations and MAIT management, interconnected tools, automation of test data analysis and robust integration procedures gain more attention in the space

sector. However, a currently underdeveloped tool landscape, and highly customized products are barriers to realizing the vision of a fully data-driven and automated engineering world.

Finally, cyber security is a major challenge. It includes the establishment of standards and policies as well as the creation of awareness among employees. Typical features of the space sector, namely the involvement of third parties (private or public) and the high sensitivity of information emphasize how crucial cyber security is.

Recommendations

Results from the interviews were taken to compile recommendations for project managers (PMs). The implementation of DX will bring numerous benefits to both space agencies and "New Space" companies in terms of employees' well-being, processes, finances, operations, and efficiency.

- **How to best implement digital transformation?**
  Digitization and automation are recommended to be implemented early in the business or project to save time and effort and reduce future costs. To promote DX and encourage member participation, it is necessary to set up a meeting with members of the project or organization to ensure that all members are on the same page. To avoid stress and unhappiness caused by DX, it is important to choose the right tools and ensure that employees receive proper training. However, the team recommends that DX implementation should proceed with the recognition that some values will not change with DX. It is important to build trust with stakeholders and understand that their needs are human and personal.

- **How can Project Managers enable successful digital transformation?**
  As DX becomes more common, the team suggests that PMs should take the initiative and learn how to use digital tools to support employees and executives. They also need to learn about cyber security and data management.
  In addition, the team recommends that PMs should ensure that employees receive appropriate training (e.g., workshops, etc.) and that everyone participates in digital platforms. As the work style changes due to digital platforms, PMs also need to be able to build trust and motivate people to use digital tools.

- **How to handle the risks associated with digital transformation?**
  DX creates new risks as well as benefits. Cybersecurity is the main concern in DX implementation. It is necessary to coordinate with government agencies early on to assist with risk assessments and to continually improve and update countermeasures. Since centralized databases are at risk for data loss, availability, and integrity, it is important to create backup policies in advance. Policies for granting access rights are also an effective measure to enhance safety. In addition, when selecting a DX platform, there is a risk of selecting an inappropriate one. Sufficient advance research is required to identify the necessary items. At this time, it is advisable to select one that can accommodate future expansion of the business. Furthermore, if the business operates internationally, attention should be paid to the laws governing data regulation.

Conclusions

The team studied the current situation of digital transformation and digital governance in the space sector, interviewing relevant personnel from both government agencies and "New Space" companies from various countries around the world, then developed practical recommendations based on the research. The implementation of digital transformation can lead to significant disruptions in the legacy systems of an organization. Project managers must shoulder several additional responsibilities towards various stakeholders. In addition, the organization must overcome various technical and non-technical challenges directly related to the implementation of digital transformation. Although digital transformation initially appears to be an expensive and tedious process full of risks and uncertainties, the benefits outweigh the costs when it is implemented correctly with proper digital governance. Automation improves employee productivity and leads to increased job satisfaction. In addition, streamlining and standardizing Human Resource Management (HRM) practices helps solve talent shortages and saves the time of HRM personnel. The use of a secure Single Source of Truth (SSOT) architecture with backup for the centralized database in the organization ensures that only authorized stakeholders have access to an enduring source of updated, authoritative, and consistent information during the lifecycle of a project. The combination of big data analytics and cloud computing allows satellite data and ground operations data to be processed much faster, leading to faster and more accurate data-driven development of products and services. Reliable and secured information networks based on shared web Application Programming Interfaces (APIs) allow stakeholders scattered across locations worldwide to connect and collaborate, share knowledge, and make more accurate data-driven decisions (resources allocation, scheduling, etc.).

5.3 Project management in a VUCA world: effects on the workforce well-being

In choosing this topic, team members had a common rationale—to dig into something that would transcend the space sector and that would be applicable in the day-to-day activities of any workplace. Team members particularly cared about the potential development and growth of soft skills, which are applicable regardless of sector. These skills enable individuals to be better team players, project managers, and ultimately leaders, equipping them with the confidence to successfully navigate challenging workplace environments.

Every professional increasingly must deal with Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) at work. This can be encountered at a project management scale or a broader organizational scale while navigating the structure and hierarchy of the workplace. The team was particularly interested in investigating how VUCA concepts are tied to the well-being of the workforce and understanding and analyzing the implications of VUCA on the workforce with a focus on the space sector. They wished to identify actions project managers could undertake to improve cohesion, workload management, and well-being in their teams, and provide recommendations on how to foster effective and efficient teamwork sustainably while understanding the practical role that YPs and senior leaders could play to mitigate these effects.

Although the acronym VUCA was known to the team, its full implications and relationship to the workforce and well-being were less widely appreciated. In today's workplace, there is indeed a

more widespread concern for well-being, work-life balance, and mental health, but this does not usually go beyond common understanding and common sense. The team has therefore worked to produce research containing useful and actionable ideas for YPs and senior leadership on this matter.

Methodology

The method adopted to research the topic included findings from a literature review of books, online articles, webinars, and theses. Furthermore, qualitative interviews with managers, supervisors, human resources, and learning & development departments of ArianeGroup, DLR, ESA, Leaf Space, and MDA UK were performed. Additionally, the team contributed by brainstorming on personal professional experiences concerning well-being and workload management as well as trends in the space sector impacting employees' work-life balance.

Research, analysis, and discussion

Before explaining why project managers and senior professionals should (i) make themselves and their team more aware of what well-being is, (ii) move to a more Agile project management style, and (iii) propose more bottom-up initiatives—to only name three of the many recommendations and suggestions—it is important to define VUCA and well-being.

VUCA is an acronym standing for Volatility, Uncertainty, Complexity, Ambiguity. It may be defined as a framework, an approach, or simply a list of challenges that make a situation or condition difficult to analyze, respond to or plan for. The initial origin of the acronym is unknown as this specific term is not widespread across the business and management communities where other terms, such as "change management" are more commonly used. Nevertheless, VUCA is a tool that can help leaders to navigate strategic planning, and is comparable to SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, in that it focuses on the environment one operates in rather than on internal organizational elements. A better understanding and contextualization of VUCA comes from the Harvard Business Review (HBR) framework by Bennet and Lemoine (2014). This framework arranges the VUCA elements in a matrix, as a function of information availability and outcomes predictability. Through this matrix, VUCA is explained as the context in which day-to-day business operations unfold.

Regarding well-being, after analyzing the available definitions in the literature, the team concluded that there is no unique and standard definition of the term, which is constantly evolving given its steadily expanding context. Hence the team defined an employee's well-being as a combination of three major categories:

1. The meaning of the job: including mental fulfillment, overall interest in tasks, etc.
2. The environment: including work-life balance, physical health, tools and resources, relationship with peers and management
3. Recognition: including financial recognition, status recognition, and self-esteem.

The relationship between well-being and productivity, and well-being and motivation were also studied, with the conclusion that it is necessary to take into account the well-being of the team to be productive—enhancing the team's wellness induces a performance increase. At the same time, as performance is not just the product of skills, but a product of motivation, employees are motivated when their needs are met. It is the task of leadership to find ways to motivate a team

and increase the team members' job engagement, taking into account both inherent and extrinsic factors.

The team then studied **how VUCA impacts the workforce** by cross-analyzing the VUCA-related elements of the HBR framework and the well-being definition, with a particular focus on *job meaning*, *environment*, and *recognition.* The result is that VUCA, a lack of preparedness towards it, and/or the poor management of its effects can make the workforce feel overwhelmed, under-prepared, under-staffed, helpless, demotivated, and stressed, with strained work relationships, and less financial stability. At the same time, the interviews conducted by the team show that preparedness for VUCA, with training to properly manage uncertainty and enhance resilience can turn VUCA into a positive force for some types of personalities. For instance:

- Uncertainty can give individuals the opportunity to creatively contribute to new challenges
- Rapid changes can be seen as an opportunity for growth, due to the need to adapt quickly to new things
- Challenges due to increased volatility and ambiguity can make tasks more interesting for a proactive person, removing the routine aspect of one's job
- Solving complexity-related issues can boost self-esteem. Facing and positively addressing VUCA problems can increase status recognition (more trust, more responsibilities, more respect from peers, promotions) as well as financial recognition (e.g., company bonuses, promotions).

The ability to predict VUCA allows organizations to tackle and implement changes in a timely manner, while providing the support needed to the individuals. Conscious of this, the team used several models to analyze how workforces tend to react to change, and provide leaders with the actions and methodology to address these reactions.

One of the models the team analyzed was the Kubler-Ross change curve. This presents four main reactions to change, which could be balanced with targeted actions, presented in the table below:

Table 1: Kubler-Ross change curve reactions and actions to balance them

Stage	Reaction to change	Action to help cope with it
1	Shock, Denial	Communicate clearly
2	Anger, Fear	Listen and observe
3	Acceptance	Offer training and opportunities
4	Commitment	Celebrate and share in success

Finally, the team's VUCA research focused on the challenges in the space sector, particularly due to the COVID-19 pandemic and the Ukraine-Russia conflict, but also more generally due to the difficulties in finding suitably skilled personnel for projects.

The team conducted research into the specific **roles in a VUCA world**: particularly project managers, young professionals, and senior professionals. Starting with **project managers**, different PM styles were analyzed to understand which one could help managers to coordinate their teams and their projects effectively, especially in a VUCA type of context. Seven main project management styles were studied, with their pros, cons, and examples in the space. Based on the authors' experience and analysis, **an Agile style resulted as the best suited to a world that needs to be flexible to react quickly to VUCA**. Agile PM methods are in fact able to counteract and cope better with uncertainty, leaving space to continue testing new ideas and "learning while doing," instead of rigid processes. However, as every project is unique, **a hybrid method will always be the preferable choice** and a PM will only remain truly flexible in adopting a hybrid style, not fully fixed to one method.

Alongside PM styles, emotional leadership styles identified by Goleman, Boyatzis, and Mckee were studied. A project manager needs to have, or at least cultivate, leadership qualities to guide their project and team to completion successfully. Merging research with the interview responses, the team found that **a coaching leadership style is particularly relevant when working with YPs**. Nowadays, the role of a manager has changed: managers are now coaches, accompanying teams on the PM journey instead of supervising. If a management style is too authoritative, members of younger generations will not hesitate to find another organization to work for. Moreover, **the leadership of a project manager can be improved thanks to the use of Emotional Intelligence**. Emotional Intelligence is the ability to recognize, interpret and process emotions in yourself and others. With this, the leader fully understands their team's needs and emotions and can anticipate and counteract VUCA.

Specific actions for project managers to improve team cohesion, workload management, and well-being, are summarized below:

- **Vision**: project leaders should focus on a long-team vision rather than short-term decisions. This will help to tackle *Volatility* by conferring meaning to teamwork and sparking motivation, hence productivity. Achievement is one of the highest causes of satisfaction, which induces better self-esteem in the team members and so motivation in return.
- **Understanding**: project managers can tackle *Uncertainty* by listening to others, being empathic, and using emotional intelligence.
- **Clarity**: *Complexity* can be mitigated by practicing clarity and so building and having trust in each other.
- **Agility**: as already said, the preferred and most used PM style should be an Agile one, which can combat *Ambiguity* by moving quickly to apply solutions and communicating across the organization
- **Networking**: as everything is in constant change, someone cannot be continuously up-to-date with everything. The more people you know, the more knowledge you have together.
- **Openness**: leaders should be the first ones to talk about their failures, ideas, and plans openly with their team members. This creates an organizational climate where subordinates are likely to share their own mistakes and are more willing to accept feedback about their blind spots, as well as to propose new ideas and give feedback to superiors and colleagues.

- **Participation**: alongside the fact that project managers should nowadays be coaches, rather than supervisors, they should systematically involve employees in important decisions, and empower them. This will motivate them and make them feel valued.

It is important to showcase the major challenges and opportunities **young professionals** face in the VUCA world. Key competencies for YPs were obtained by comparing the results of the *Future Skills 2021 Survey* with responses from interviews performed by the team. These were:

- **Classic competencies**: problem-solving, entrepreneurship & initiative, resilience, and creativity.
- **Transformative competencies**: the ability to solve, the ability to engage in dialogue and conflict, judgment, innovation skills, and the ability to change were also rated as important.
- **Key digital competencies**
- **Technological competencies**

Of course, even with dedicated training, finding all these skills in one person is rare. Assembling a team with mixed competencies who can network with others helps to ensure all key skills are covered. Additionally, the team recommends project managers undertake further training of existing personnel to mitigate skills shortages risk as technology develops within the sector.

The team also considered **cross-generational interactions a key component to tackle VUCA** in the sector. The presence of four diverse generations in the current workforce can present challenges regarding respect, communication, and the effectiveness of work styles. Indeed, according to the interviewees and literature review, young professionals are generally open and not afraid of speaking with older generations, but the latter may find it difficult to interact with the YPs, who have different core values, which dictate their approaches to work and hierarchy. To address this intergenerational communication issue, project managers can implement several key mechanisms for **intergenerational knowledge transfer** and relay to cultivate **intergenerational solidarity** in the workplace and among their project teams. According to interviewees, a number of these mechanisms are already widely implemented in space sector organizations with varying degrees of success, such as mentoring & reverse mentoring, intergenerational knowledge capture, cross-training, job rotation, and others.

Regarding the **opportunities YPs have in a VUCA world—**the results from interviews, team experiences, as well as literature, all converged on the fact that young professionals are actually:

- Very flexible, adaptable, and keen to change. Volatility can provide an opportunity for YPs to **showcase these skills**.
- Able to think outside the box, more than the older generations. Whilst the accumulated knowledge and experience of the older generations are extremely valuable, YPs can counteract Uncertainty with **innovative ideas (which may involve higher risk)**. If YPs are allowed to lead their innovative projects, they can gain experience and advance in their roles and careers.
- Older generations have gained most of their knowledge from years of experience: however, new issues can arise that require modern, innovative solutions. YPs are however able to navigate the Complexity of the VUCA world thanks to their **technological skills**. They are **digital natives** who know how and where to find complex information that their more senior colleagues do not.

- Finally, Ambiguity can be tackled by the YPs by taking the lead in "contained" initiatives.

Last but not least, the most important strength of the **senior professionals** in a VUCA world is the ability to create a collaborative culture in the company, thus helping young professionals to grow and understand the complex context in which they are.

Recommendations
Project managers, young professionals, and senior professionals, through this actionable list of recommendations, will have the opportunity to improve their work environments and counteract VUCA.

- **Adopt an Agile PM style**
  Adopting an Agile project management style is a recommendation for project managers, and leadership in general, in a VUCA world. Its iterative systems and continuous adaptive behavior make it the perfect antidote to VUCA by naturally constantly readapting to uncertain situations. Agile styles are characterized by the fact that they reduce large, complex projects into smaller tasks, and this is exactly what is needed to counteract Complexity.

- **Pave the road for bottom-up initiatives**
  YPs gain experience by taking on additional responsibilities. Organizations should ensure they have created one or more paths and formal processes for YPs to propose bottom-up initiatives inside the organization, allowing YPs the opportunity to be the project manager in charge. This is a professional development and retention policy that can lead to greater satisfaction, motivation, and well-being for YP employees.

- **Allow seniors to speak and to be heard**
  Organizations should institutionalize ways and initiatives in which senior leaders can interact with YPs to mitigate generational barriers and facilitate knowledge/experience transfer. YPs might have fresh graduate knowledge, but they may not have the ability to see patterns and make "gut" decisions due to their lack of experience. Through these initiatives, it is important to ensure senior leaders are incentivized and comfortable freely communicating with YPs and at the same time, make sure YPs are accommodating towards expertise coming from (older) colleagues.

- **Make well-being a priority**
  Organizations should ensure all employees (young professionals, managers, and senior professionals) are aware of what the current definition of well-being includes by organizing proper training (e.g., workshops) on the topic.

- **Team building 101**
  Every team leader should make sure their employees are aware of the effort required to build and maintain a team. By remaining open and properly communicating with their team, leaders can ensure team members are kept up to date with the activities and progress of the team toward the completion of a project.

5.4 Space projects without frontiers: how to leverage cooperation and organizational diversity

The first striking finding for the team was that people struggle to define diversity. Answers differ depending both on the professional and personal experiences of each person.
It is noted that diversity does not exist exclusively within itself and separate from social contexts. Different layers of diversity intersect and affect one another. Due to this complexity, each person uniquely perceives diversity through their own experiences and feels the impacts differently.

The team focused on three types of diversity:

1. Geographical diversity: current global dynamics and how they impact the space industry
2. Industrial diversity: collaboration of space and non-space organizations
3. Gender diversity: an axis introduced after reflecting on the composition of the team and on the fact that it is a topic discussed intensively around the world.

To detail these different types of diversity and understand their impacts, the team based their research on qualitative methods including a literature review, interviews of relevant space actors, and a subset of tools described in the methodology section. The literature review drew from outside of the space sector to understand more broadly how diversity is key. It highlighted **four key themes** among the examined literature: **types and levels of diversity**, **intersection and balance of diversity**, **societal impacts on diversity**, and the **cyclical relationship between diversity and work**.

The group also highlighted the importance of diversity as an inherent characteristic of the space sector and sought to understand what changes occurred in the last decades to arrive at this result.

Throughout different case studies the team deep dived into some specific topics to better understand the effects, either positive or negative, of diversity, understand which are the drivers of diversity in space projects, highlight the different patterns being seen in their analysis and list the drivers of collaborations that have been observed.

It is crucial to note that today the reasons for collaborations are numerous: financial, political, technological, scientific. The team highlighted the reasons that lead to those collaborations and the advantages/drawbacks it could lead to.

Case Study 1: Artemis Accords
The Artemis Program seeks to become perhaps the most ambitious international project ever attempted, with as many as 21 nations having signed the Artemis Accords. With a large and diverse team, including multiple corporations and “New Space” nations such as Australia, it is important that the project has a solid direction and set of principles to guide each of the contributors. The team used this case study to explore aspects related to a project of such diversity, including interoperability, and how “New Space” nations will seek to contribute to Artemis whilst developing their own space industry.

Case Study 2: Analogue Astronaut Missions
Space analogues on Earth are important in a range of space fields and they are particularly useful for testing a range of experiments, human factors, and more with analogue astronauts. Often taking place in extreme environments, analogue astronauts and mission control support mimic the conditions and operations involved in human spaceflight missions to further the likelihood of success in space. The team used this case study to detail how gender diversity is playing an important role for this kind of mission.

Case Study 3: Space Medicine
Space Medicine has been extremely important in the space sector since the 1960s when space missions involving humans were first conducted. It involves industrial collaboration as a guiding principle, since medical and space experts need to collaborate with each other to ensure the safety and well-being of astronauts. The team used this case study to show how industrial diversity is mandatory in some specific cases—without it there would be no collaboration between experts of different fields to develop methodologies used to maintain the physical and mental condition of astronauts.

Case Study 4: Industry Collaboration
The "New Space" economy is entering an era of access and opportunity with the commercialization of space missions historically performed by government agencies. From near Earth missions to lunar exploration, private companies are increasingly supporting government programs as well as developing purely commercial business cases for space. The team used this case study to cover how industrial diversity can bring technological and cost benefits to space programs and how government agencies can help accelerate commercialization of space missions to develop a self-sustaining private space economy.

Case Study 5: Sprint Advanced Concept Training
Sprint Advanced Concept Training (SACT) is a global training exercise to advance joint space operations. It engages data from ground-based and space-based sensors around the globe to be analyzed by space operators to form a holistic picture of what's happening in space, to gain space situational awareness. SACT comprises three operation cells: Meridian, Pacific and Americas, each active at a different time to maintain operational capacity in a follow-the-sun modality. The team used this case study to substantiate how collaboration and geographical diversity are crucial to the success of space situational awareness (SSA) and space traffic management (STM).

Recommendations
The team provided relevant recommendations, classified into 5 different themes:

1. **Organizational culture**
    - Create a shared set of values (ethical, legal, etc.) to improve project unity.
    - Maintain a political and diplomatic framework to commit to large international space projects and ensure that funds are committed on an ongoing basis.
    - Incorporate diversity and collaboration into organizational systems and practices that are regularly engaged.

2. **Public outreach**
    - Increase communication across a broad range of stakeholders including government appropriators, commercial investors, companies (start-ups & non-traditional), and general public.
    - Leverage all types of effective outreach, including innovation hubs, community workshops, childhood education, public engagement, and marketing.

3. **Communications and logistics**
    - Use virtual tools and software to enable collaboration and work across time zones.
    - Understand the benefits of specific locations.
        - Be aware of the tools and options available at different geographical sites of your company (for example, some sites provide better geographical vantage points for observing space).
        - Opportunities for specialists located in specific places to engage.
    - Develop communications plans and engagement strategies in initial planning phase to ensure collaboration is a core element of project development and delivery.

4. **Innovation and technology uplift**
    - Modernize acquisition policies to encourage commercial investment and enable innovation.
        - Use of Firm Fixed Price contracts vs. Cost Plus contracts with milestone payments to encourage innovation. To be tailored depending on the missions.
        - Procure services instead of dictating hardware specifications.
    - Favor intellectual property transition of dormant technologies (e.g., technology licensing, commercial IP rights) across industries and countries.
    - Build partnerships by creating trust, funding to support challenges for start-ups, develop relationships between "New Space" participants including public-private partnerships.

5. **Project Design**
    - Set mutually beneficial mission objectives that encourage industrial and international collaboration.
        - International and industrial partners are driven by differing priorities (e.g., scientific return, profit, politics).
        - Program design should differ between types of missions: science more naturally aligned to international collaboration, while industry drawn to dual-use technologies with an opportunity for return on investment.
    - Encourage commercial innovation by guiding mission objectives versus specifying detailed technical requirements (i.e., "guide" instead of "rule" programs).
    - Government should focus on testing unproven technology and developing future exploration infrastructure to encourage commercial space economy development.
    - Set consistent technical standards that allow for interoperability between partners and encourage contributions from international countries and industrial partners.
    - Publicly release scientific data to ensure transparency and encourage collaboration.

Concluding Remarks

To conclude, the team, as young professionals, wanted to discuss how students and early career professionals can personally make an impact within their team, across their organization, and more broadly in the industry. After researching diversity in space programs, interviewing experts in the sector, and distilling the key points of the research paper, the three key traits young professionals should strive to exhibit and project into their teams are **Advocacy, Discussion, and Trust**.

Advocating for diversity across international borders, companies, and genders means fighting for others to have a voice. The recommendations encourage public outreach because many people or organizations within the industry that may have the interest and capability to contribute to space programs may not be aware of the opportunities. Young professionals have the platform, through social media and other internet tools, to ensure that diverse groups have the awareness and opportunity to contribute their voices and solutions. Through use of modern collaboration tools, design of non-restrictive project requirements, and by promoting inclusive organization practices, professionals can ensure that diverse members of the team have the opportunity and feel comfortable speaking their opinion about their solutions or challenges. Young professionals should advocate for diversity through broad organizations such as the IAF, the IPMC, this Workshop, but also within their own teams and institutions.

Discussion means that not only are diverse voices allowed to speak within space projects, but they are also heard. Often within space programs, dissenting voices are dismissed to seek program priorities either for technical, political, or cost reasons. Proactive, clear discussion within teams or across teams helps ensure that a problem is not allowed to persist, and new solutions are given the opportunity to be implemented. Young professionals can work to promote discussion through one-on-one meetings with mentors, team workshops, or industry organizations such as IAF.

Finally, after advocating for discussion, the most important trait for project success is mutual trust. Often with teams—whether homogeneous or diverse and across nationalities, industries, and genders—priorities are not always 100 percent aligned. By building true partnerships with other countries, companies, and most importantly with teammates, space projects will not resort to instincts of control and exclusion. Young professionals can exhibit trust by believing that colleagues have the capability and desire to deliver mutually beneficial results. If young professionals do not have confidence in their teammates' capabilities or motivations, then advocating for open discussion and team development can help build the trust that will ensure space program success.

5.5 Sustainability of space projects

Among the several possible definitions of Sustainability, the group focused on the growing space debris problem because it is an imminent threat to the space community and is a significant challenge. Without sufficient collective action to address the proliferation of space objects and debris, future generations may not benefit from access to space.

Within the topic of space debris in outer space, the group focused on the effects of space debris on space projects in low Earth orbit (LEO). LEO was chosen because of the growing complexity of space actors that are involved, the concentration of existing space debris, and the increasing number of mega-constellations further cluttering this orbital region. Lastly, the group wanted to address concerns about consequences of increased access and use of LEO by a growing number of small satellite operators who may be less familiar with, or experienced in, implementing space sustainability measures.

The group emphasized that a multistakeholder approach, including the private and non-governmental sector, is inevitable to solve the space debris issue. Following the "New Space" characteristics, it has become cheaper, faster, and easier than ever for non-governmental entities to go to space. Consequently, the fundamental nature of space and LEO is predominated by commercial actors. Recommendations, directly addressed to non-governmental Project Managers (PMs) in the space sector, are therefore of particular importance.

Although a non-binding document, the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities (LTS Guidelines) of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), is a landmark international soft law instrument adopted by 95 States members of COPUOS in 2019. The LTS Guidelines give an overall perspective of applicable measures to prevent and mitigate space debris and prompt all space actors—irrespective of their nature—to make their operations sustainable. In recognition of the pivotal role of the LTS Guidelines, and in agreement with its stipulations, the group calls on all Project Managers (PMs) to become familiar with and then implement the LTS Guidelines throughout all phases of their space project.

The team also highlights other important aspects such as the mitigation of space debris using technologies and approaches, and the design, planning, and operation phases of space projects. The group interpreted the three paragraphs of LTS Guideline B.8, "Design and operation of space objects regardless of their physical and operational characteristics," and found tangible and viable technologies, along with operational approaches, to develop key recommendations to Project Managers. The group identified recommendations that fall within the following 11 project management categories:

- Scope statement
- Schedule and timeline
- Risk management
- Resources planning (human, equipment, material, skills, and knowledge)
- Critical success factors
- Deliverables
- Work breakdown
- Budget and cost
- Quality
- Communications
- Stakeholder management.

Space sustainability—and specifically space debris—is closely linked to the *risk* aspect of project management, both for short and longer term activities of a company and other entities. The group also recognized that not only risk, but scientific uncertainty, should be considered as an extra, early step for PMs when dealing with risk posed by space debris and planning for sustainable measures.

In the short term, the risk relates to collision aspects and the need to plan the mission around this risk, with potential consequences on *cost* and *schedule* of a mission design phase. In operation, *communication* and *stakeholder management* are critical for project managers to avoid collisions. The group aims to identify recommendations that are practical and tangible with the most efficient sustainable impact and limited cost.

In the long term, the focus shifts to the end of life of the project. In order to ensure sustainability, not only for the current project but for a portfolio of current and future projects, *planning* for deorbiting non-active objects is key.

With respect to paragraph one of LTS Guideline B.8, the group elaborated on the role of **trackability and transparency** in tackling the space debris problem. Improving spacecraft trackability will support a better prediction of the object's trajectory and an improved assessment of collision risks. Transparency relates to critical information sharing to support decision-making processes. This includes contact information, satellite metric information (e.g., ephemeris, covariance) and spacecraft characteristics (e.g., operational status and maneuver capability). This information is valuable to refine collision risks and support further decision-making processes, if a need to maneuver is identified. From a project management perspective, tracking and trackability aim to reduce project risks through project *scope* (e.g., adding a trackability device) or communication and *stakeholder management* (transparency on critical information). Analysis shows that transparency is a cost-neutral solution with limited impact for the project manager, but highly effective from a sustainability point of view.

Paragraph two of the LTS Guideline B.8 relates to guidelines, standards supporting sustainability in space, and more specifically end-of-life solutions. For end-of-life solutions, **additional components for deorbiting,** such as drag sails or tethers, as well as additional services for in-orbit refuelling can be considered. For PMs, these solutions affect the project management aspects *budget and costs* as well as *risk management* quite significantly. Nevertheless, the *quality, scope statement* and the overall *critical success factor* of the project are positively influenced if end-of-life strategies are incorporated. The IADC guidelines and the ISO Standard 24113 both integrate the **25-year rule**, stating that a spacecraft or orbital stages that are terminating their operational phases in orbits that pass through the LEO region should be deorbited within 25 years of completion of the mission. If the project follows these guidelines and regulations, end-of-life needs to be acknowledged.

Finally, regarding paragraph three of LTS Guideline B.8, observations and recommendations regarding **smallsats** such as CubeSats and how to optimize on standardized cubesats, deployers, and certain commercial-of-the-shelf (COTS) items; additional publication of **particular designs; and orbital and mission profiles** were put under scrutiny. Interviews were conducted to seek

interpretation and implementation practices of LTS B.8, as well as recommendations, inspirations, cost analysis, etc. from the relevant stakeholders to support the development of PM recommendations.

The group suggests the following recommendations for project managers, incorporating sustainable measures, to prevent and mitigate the risk of space debris:

1. **Train team to learn space sustainability guidelines:** Even though non-binding instruments, international guidelines and standards represent the *quality standards* recognized by experts and the international space community. Teams will benefit from learning about these guidelines. The need for information sharing and international cooperation cannot be stressed enough, specifically the role of participation in space consortiums, and in initiatives to voluntarily reduce the risk of space debris, on-orbit collisions, and unsustainable space operations (e.g., Space Sustainability Rating). This relates to project management aspects such as understanding the balance between *risk* and *costs*, or how proper training can be implemented to focus on sustainability during planning of space missions.
2. **Resource planning for a cost-neutral optimized payload and mission objectives of small-size space objects:** Optimizing the satellite design considering maximized sensors, technologies, and applications can drastically limit the growth of the number of objects in orbit. Moreover, designing with sustainability in mind at an early stage of the mission can have limited *cost* impact compared to last-minute adjustments to future sustainability requirements.
3. **Communication and stakeholder engagement during operation:** There is a need for information sharing in terms of both transparency about the intended satellite operations and trackability of a satellite. The project management elements *communications* and *stakeholder management* are affected by this recommendation since open communication through data sharing needs to be considered.
4. **Schedule and execute your end-of-life plan:** PMs will need to adequately *scope* the design of their satellite and mission profile at the early planning stage in order to achieve an end-of-life *plan*. Long after the design and launch phase, the PM will need to then *communicate, train, and execute* the plan with their team whenever necessary.

The risk associated with space debris affects the space community as a whole. Therefore, preventing and mitigating such risks should be a priority to all PMs carrying out their projects relevant to LEO. The group also recognized that addressing *short- and long-term risks* associated with space debris can cause great constraints to PMs—especially to the growing number of small satellite operators in LEO—and return of investment in this regard is not always visible to stakeholders. As such, the group aimed at highlighting necessary and viable recommendations to PMs equally weighing *cost, interests, and risk factors*. In project management terms, the group argues that the recommended sustainability measures produce *better success criteria*, because the more thought-out planning will produce higher *quality standards* that are better *executed*, and enable the individual project and broader space community the utilization of space in the future.

6. General Concluding Observations

Every year the IPMC YP workshop topics are carefully chosen in close collaboration with the committee members. The topics represent the interests of the aerospace industry and challenges that the organisations face on a daily basis.

The 11th edition of the IPMC YP WS chose to introduce Topics that were completely new and different from those investigated in previous years. Young professionals had to familiarize themselves with the context and chose their preferred axis for investigation. They were encouraged to use their first-hand experiences, their informed opinions, and their fresh ideas to provide an insightful analysis of the research themes.

The young professionals have a clear view of how the space sector is changing and how to navigate in this change. They have a distinctive approach to the evolution of the market and their future careers: they have more opportunities and more motivation to choose a new employer if the current one does not meet their expectations for self-realization and well-being.
They believe diversity is key to success: they advocate for inclusive diverse teams, with varied skillsets, including non-traditional and transformative skills. Also, they believe in inter-generational solidarity and exchange. And they make it clear that communication and mentoring goes both ways.
Young Professionals are asking for modernization of acquisition policies and diversification of funding opportunities, to leverage commercial investments and increase inclusion of SMEs and startups in the space sector. In fact, they postulate that a multistakeholder approach, including private and non-governmental players, is inevitable to solve many of our current issues. They truly believe in the power of "New Space."
But most of all, the delegates encourage us to think beyond our individuality, to plan and act for the future and common well-being of our workplaces, of the entire space sector and of humankind at large.

We invite the IAF's IPMC committee members and the young professionals to further discuss the findings on these topics and find a way to implement the recommendations in their respective organizations. The recommendations are evident, well thought out, and based on examples, experiences, and input from a truly global perspective.

7. List of Workshop Delegates

First Name	Last Name	Organisation
Aysha	Alharam	NSSA (Bahrain's National Space Science Agency)
Elyse	Allender	Australian Space Agency
Nick	Barracca	Firefly + Space Generation Advisory Council
Lauriane	Bertrand	ArianeGroup
Gisela	Brand	Deutsches Zentrum für Luft- und Raumfahrt
Matteo	Cappella	Leaf Space + Space Generation Advisory Council
Eleni	Charitonos	Space Generation Advisory Council
Shotaro	Futamura	Japan Aerospace Exploration Agency
Desislava	Gancheva	Australian Space Agency
Estelle	Godard	European Space Agency
Alejandro	Gonzalez	European Space Agency
Joram	Gruber	DcubeD (Deployables Cubed GmbH)
Chris	Gurjao	University of Bologna
Maren	Hülsmann	Space Generation Advisory Council
Annie	Kazarjan	World Space Week
Marie	Le Pellec	Australian Space Agency
Valentina	Luchetti	Space Generation Advisory Council
Phylis	Makurunje	Space Generation Advisory Council
Mickey	Mathew	Sierra Space
Jean-Hugues	Migeon	European Space Agency
Chiara	Palla	MDA UK
Alessandro	Paravano	Politecnico di Milano
Flavie	Rometsch	European Space Agency + Deutsches Zentrum für Luft- und Raumfahrt
Alex	Rosenbaum	European Space Agency
Julian	Strauss	European Space Agency
Tori	Tasker	Australian Space Agency
Gaia	Verhulst	European Space Agency
Raleigh	Wooldridge	American Institute of Aeronautics and Astronautics
Koji	Yamada	Japan Aerospace Exploration Agency
Shabnam	Yazdani	KERAsat

8. Previous Workshop Reports

All previous IAF's IPMC Young Professional Workshop reports are available on the IAF website, please follow this link.

9. Acknowledgements

The workshop organizing committee greatly appreciates the support of the IAF, the IPMC, and all their affiliated organizations who nominated delegates for the 2022 edition. The WOC would like to warmly thank the mentors for their inspiring and selfless support to the young professionals. The WOC also thanks the IAF Secretariat for their continued interest and assistance in including the workshop among the IAC satellite events.

The workshop organizing committee also extends a special thank you to the 2022 cohort of delegates, who put great effort into providing quality results and recommendations and navigated with tenacity and flexibility the uncertainties of the post-pandemic aerospace world.

The WOC is looking forward to the future with preparation for the next workshops and the continuation of the implementation of previously presented recommendations. The WOC, in close collaboration with the IPMC, strives to advance on the development and empowerment of the next generation space workforce.

10. Full topic reports

The full reports, one for each topic, are available via the following link.