

SpaceOps-2023, ID # 215

The user-driven innovation from ideation to inception

Artur M. Palowski*, Michelle Baker

European Space Operations Centre, European Space Agency, Robert-Bosch-Strasse 5, 64293 Darmstadt, Germany

* corresponding author, Artur.Palowski@ESA.int

Abstract

Space operations centres, due to their significant role in the context of safety, are by nature conservative and zero-failure environments. In such a cultural setup room for experimentation and creativity is limited, whereas both phenomena are key enablers for innovation. It is essential to drive efficiency through innovation, but also to continue to provide world-leading software and services to industry in a rapidly changing market conditions. Therefore, ESA's European Space Operations Centre has decided to improve its innovation enablement and adoption capabilities. Among other initiatives, the room for experimentation and supervised fail-forward has been created under the framework of intrapreneurship contests. The aforementioned contests' frameworks will be presented, their key assumptions, the implemented process and its evolution as well as the lessons learnt for the future.

Keywords: innovation management, innovation tournaments, intrapreneurship, culture, mission operations

1. Introduction

The process of innovation is challenging [1] as it requires a right combination of creativity, resources, and execution. It is a complex endeavour that involves identifying a problem or opportunity which requires a significant investment of time and resources (financial, technological, and human resources), to research and analyse the market, customers, and competitors, generating new ideas, developing a solution, and bringing it to market. Therefore, some of the decision makers may perceive innovation as an extra cost sponsored by core business. Additionally, innovation requires a willingness to take risks and experiment with new ideas [2], which can be difficult for organizations that are risk-averse or have a culture that does not support experimentation and failure is not accepted [3]. All the mentioned aspects are relevant to space operations. [4, 5]

Despite these challenges, innovation is important because it drives economic growth and competitiveness. It allows organizations to differentiate themselves in the market and create new products and services that meet the changing needs of customers. Additionally, innovation can lead to new business models and revenue streams, which can help organizations to grow and prosper. In the context of European Space Operations Centre (hereinafter: ESOC), it means meeting needs of European institutional missions, ensuring sovereignty, spin-out/spin-in for European industry.

One of the concepts to mitigate the challenges of the innovation management are innovation tournaments are a method used to generate new ideas, products, and solutions through a competitive process.

The main advantage of innovation tournaments is their ability to generate a large number of diverse and creative ideas. By bringing together a diverse group of participants, the tournament can tap into a wide range of perspectives, skills, and experiences, leading to more novel and effective solutions. Additionally, the competitive nature of the tournament can increase motivation and engagement among participants, leading to more effort being put into the development of solutions. Another advantage of innovation tournaments is their scalability. They can be used to solve problems of various sizes, both big and small ones, an example of the latter in ESOC context could be the existing OPSSAT cube-sat operations related experiment (e.g., on-board AI training).

There are a number of examples of innovation tournaments that have been implemented in various industries and contexts. One notable example is the XPRIZE Foundation [6], which runs a series of large-scale innovation tournaments with the goal of solving global challenges such as space exploration, ocean health, and carbon reduction. In the technology industry, the Defense Advanced Research Projects Agency (DARPA) has run a number of innovation tournaments to encourage the development of new technologies for USA national security. One notable example is the Grand Challenge [7], which invites teams to develop autonomous vehicles that can navigate a difficult course without human intervention.

“Copyright 2023 by European Space Agency. Published by the Mohammed Bin Rashid Space Centre (MBRSC) on behalf of SpaceOps, with permission and released to the MBRSC to publish in all forms.”

Intrapreneurship is the practice of creating and driving new business opportunities within an existing organization, often referred to as "corporate entrepreneurship." [8] One of the main benefits of intrapreneurship is that it allows organizations to foster innovation and stay competitive in a rapidly changing market. By encouraging employees to think creatively and take initiative, companies can tap into new ideas and perspectives that might not have surfaced otherwise.

In addition to driving innovation and growth, intrapreneurship can also lead to increased employee engagement and motivation. Employees who are given the opportunity (freedom) to take on leadership roles and drive new initiatives are more likely to feel invested in the success of the company, which can lead to higher productivity and job satisfaction. [9]

Overall, while there are certainly risks and challenges associated with intrapreneurship, the potential benefits make it a worthwhile endeavour for many organizations, by encouraging employees to think creatively and take initiative. Therefore, it was decided to introduce an innovation tournament concept at ESOC in order to allow experimentation, fail-forward and bottom-up approach in the context of mission operations and space safety.

2. Approach

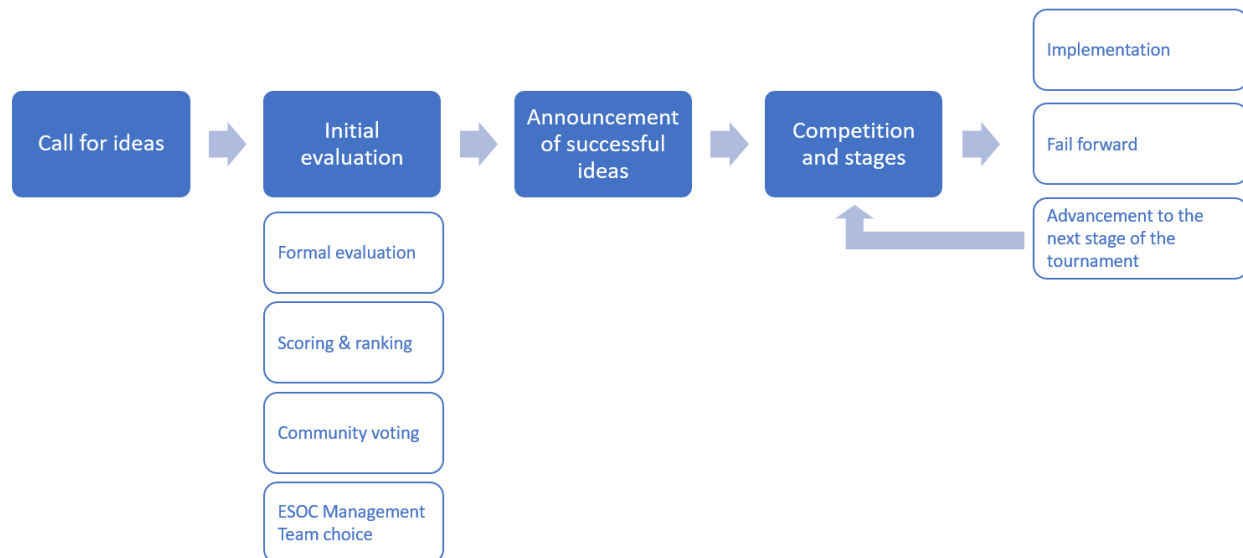


Figure 1. ESOC’s innovation tournaments general process flow.

In 2020, ESOC’s senior management approved the introduction of innovation tournaments as a mechanism for the allocation of resources for innovation related activities, their goal was to support the ideas development and experimentation process within ESOC community.

The following process has been implemented:

- Phase#1 – Call for ideas:
 - On a regular basis, ideas= to be called via the existing ESA web platform [10]. The information provided through the call should entail:
 - Submissions’ minimum requirements,
 - Timeline: date of call opening, deadline for submissions, deadline for community commenting and voting,
 - Description of evaluation criteria,
 - General information on next phases.

After the opening announcement, the entire community of ESOC to be allowed to submit ideas via the aforementioned platform. The submission process intends to be an easy and non-bureaucratic exercise. It must be stressed that the platform utilises the concept of crowdsourcing where an organisation pulls ideas, or content by soliciting contributions from a large group of

“Copyright 2023 by European Space Agency. Published by the Mohammed Bin Rashid Space Centre (MBRSC) on behalf of SpaceOps, with permission and released to the MBRSC to publish in all forms.”

people. It allows organizations to tap into the collective intelligence and creativity of a large group of people, potentially resulting in better and more innovative solutions. It can also be a cost-effective way to gather information and ideas, as the organization does not have to invest in hiring new employees or paying for expensive research. Crowdsourcing can also increase engagement and participation among stakeholders and customers, as they feel that their contributions are valued and heard. [11]

- Phase#2 – initial evaluation
 - Formal evaluation
 - After reaching the deadline, the Innovation Management Committee (hereinafter: IMC) – an independent body of ESOC experts, is to review the submitted ideas and possibly engage (some of) the Authors for dedicated brainstorming sessions. During the revision and brainstorming, the IMC is to try to develop a better understanding of the details of the ideas and the required resources for potential projects.
 - Afterwards, the IMC (excluding its members who may have enrolled for participation in the tournament) is to run a formal assessment of whether the process to assess if the submitted ideas are aligned with the tournaments’ targeted assumptions. In particular, the IMC is to assess if the submissions are considered ‘real’ ideas or more simple remarks or observations, if the submitted ideas can be run using a project approach (with clearly defined timeline, stages and assumed deliverables), and if the resource requirements are compatible with the available budget.
 - As soon as the formal assessment is closed the Authors will be informed on assessment outcomes.
 - Scoring & Ranking
 - The ideas in-line with formal constraints for submission are to be scored individually by the IMC members (excluding its members who enrolled for participation in the tournament) against the following unequally weighted criteria:
 - Impact:
 - The idea is of a high potential, it can be easily scalable inside or outside ESOC. It can be utilised by many ESOC units/missions.
 - The idea has limited impact, is very specific and cannot be (with reasonable adjustments) easily scaled.
 - Novelty:
 - The idea is a creative new approach, and exceeds the business-as-usual way of thinking.
 - The idea stays within the business-as-usual paradigm. It focuses on minor, if still valid, improvements.
 - Relevance:
 - The idea fits into the ESOC strategy. One can easily identify which strategy area is supported by the idea.
 - The idea lies outside the landscape of ESOC 2025 strategy.
 - Teamwork and user engagement:
 - The idea promotes teamwork and cross unit collaboration.
 - The idea has the nature of a study performed only by its Author.
- Community Voting - simultaneously to the internal assessment process run by the IMC, a community voting is to be allowed via crowdsourcing platform to ESOC community. ESOC community members to be allowed to vote in 3 equally weighted categories (Impact, Novelty & Teamwork). Upon voting all the ideas to be averaged and ranked. The IMC to select the top ideas (no more than 2) for the tournament participation, unless already selected during the IMC scoring & ranking phase or they do not meet the tournament formal criteria.

“Copyright 2023 by European Space Agency. Published by the Mohammed Bin Rashid Space Centre (MBRSC) on behalf of SpaceOps, with permission and released to the MBRSC to publish in all forms.”

- OPS Management Team (OPS executive) choice - out of the ideas meeting the formal evaluation criteria, the Management Team may select 1 additional idea for the tournament participation.
- Phase#3 – Announcement of successful ideas
 - After collection of all the evaluation inputs the IMC to announce the final number of participating ideas, the shape of the tournament tree (size of groups, number of rounds) and the innovation mentors in the IMC responsible for trouble- shooting and general assistance throughout the tournament. Additional activities around the announcement may take place, e.g., Q&A sessions, meetups etc., depending on the nature of the tournament themes.
- 2.4. Phase#4 - Competition and stages
 - Authors of ideas invited for the competition to form project teams who agree on deadlines proposed by the IMC and oblige themselves to provide particular deliverables (discussed during brainstorming sessions of formal evaluation) within agreed timeframes. The IMC provides the project with the required resources and evaluates the deliverables at the deadlines. Innovation mentors from the IMC support particular projects during the course of the tournament.
 - Upon reaching the deadlines the deliverables to be assessed against following dimensions:
 - Progress:
 - The project is progressing according to the agreed timeline.
 - The project is delayed w.r.t. to the agreed timeline.
 - The project did not progress at this stage.
 - Expectations
 - The deliverables and their impact exceed expectations.
 - The deliverables and their impact are in line with expectations.
 - The deliverables and their impact did not meet expectations.
 - Spin out / Adoption
 - The deliverables are promising but require additional time and resources.
 - The deliverables are already implemented.
 - The deliverables are source for further innovation related activities.
 - The following outcomes of the assessment are foreseen:
 - Advancement to the next stage of the tournament (unless the project is completed),
 - Deliverable(s) implementation:
 - At ESOC
 - Outside of ESOC (as an innovation activity or different type of improvement)
 - Fail forward and recording of lessons to be learned.

As indicated in (Figure 1) the number of stages could be flexible and tailored to needs and constraints of particular competition. In ESOC context the first competition lasted over 3 stages with more than 50 submissions and only 6 winning ideas presented in the Grand Finale of the tournament. Whereas competition related to a cube-sat on-board experimentation was limited to a single round where all experiments were conducted end to end. From a bureaucracy point of view, the described process was designed to be slim. Moreover, meets the key elements of the theory presented in the Introduction.

3. Results

Under Results we would like to present details about the very first innovation tournament conducted at ESOC. In addition to the formal process a variety of communication actions were taken: mailing, Q&A sessions, and intranet for a discussion. The first call for ideas of ESOC innovation tournaments collected over 50 submissions. The submissions were divided into four categories:

- Technology,
- Culture/Diversity/Sustainability
- Outreach
- Other

The most frequently used key words of submissions were: software, operations, AI, telemetry, monitoring, ESTRACK, Python, spacecraft, analysis, space, innovation, learning, ground, CCSDS, experiment, infrastructure, interactive, planning, tool. Therefore, it may be easily concluded that majority of the submission related to ESOC's

“Copyright 2023 by European Space Agency. Published by the Mohammed Bin Rashid Space Centre (MBRSC) on behalf of SpaceOps, with permission and released to the MBRSC to publish in all forms.”

core business and category “Technology”. Such a result was foreseen and intended however, submissions to remaining categories were also provided and analysed. Their utilisation allowed inclusiveness and encouraged the engagement of all ESOC community members.

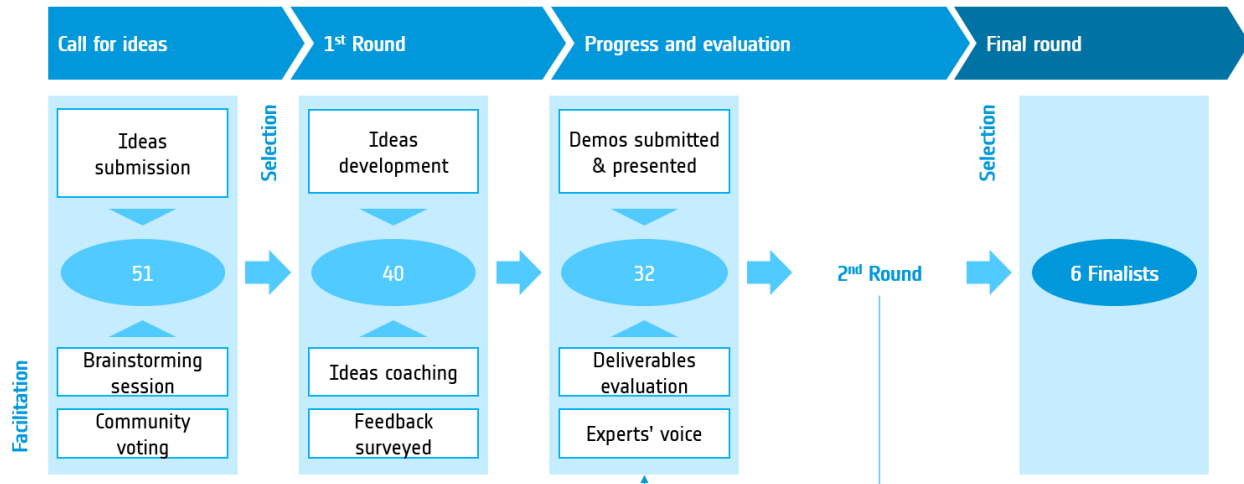


Figure 2. 1st Innovation Tournaments at ESOC - overview

After thorough examination, almost 80% of the ideas were qualified for the first round of the competition. It is worth stressing that the number strongly exceeded the foreseen limit of 20, which was a reflection of extremely high quality of ideas and documented in an anonymous scoring procedure. Nearly 60% of them were provided direct resources, whereas 20% due to the nature of the ideas were of negligible level of effort. The resources provided to the participants were comparable to earlier mentioned Google & 3M benchmarks.

The first round of the competition was concluded after four months. Despite COVID circumstances, 87% of the projects submitted on time deliverables for further evaluation and additional financial support. Two demo days were organised in order to connect innovators with additional customers and evaluate most importantly present and evaluate the prototypes. The demo days concluded with selection of over 50% projects for further development and two moved directly to implementation phase e.g., “Computer in a room challenge” project. [12]

The first round of the competition was concluded after six months. However, only 60% of the remaining contestants were able to provide minimum viable products. A “show and tell” session opened by ESOC Director was facilitated. Its result was selection of the most advanced and promising MVPs for operational deployment at ESOC. The total amount of the targeted deployments equalled approximately 10% of the total submitted ideas. The most promising developments were named “winners” of the tournament and awarded trophies; the fields of developments were:

- Speech-to-Text for Automatic Transcription and Indexing of Voice Loops,
- Mobile Spacecraft Operations,
- Digitalisation of Ground Segment System and Operations Engineering [13].

After two years as of start of the innovation tournaments all of them are functional and appreciated auxiliary tools – three of them are communication tools, one is utilised by a mission, one within quality assurance domain and one in the knowledge management. Some of the developments from ESOC innovation tournaments were successfully made available ESA-wide, with one of the finalists winning ESA Knowledge Champion Award in the Category Innovator.

In addition, the innovation tournaments format was already utilised three times under different financial (resources injected in other innovation opportunities loosely connected with innovation tournaments though [14]) and technological constraints in order to maximise return on investment of the concept but also other assets (e.g., labs). The second of the tournaments was limited to experiments run on the ESOC’s cube-sat [15] whereas the third focused on artificial intelligence applications and refreshing and polishing prototypes developed earlier.

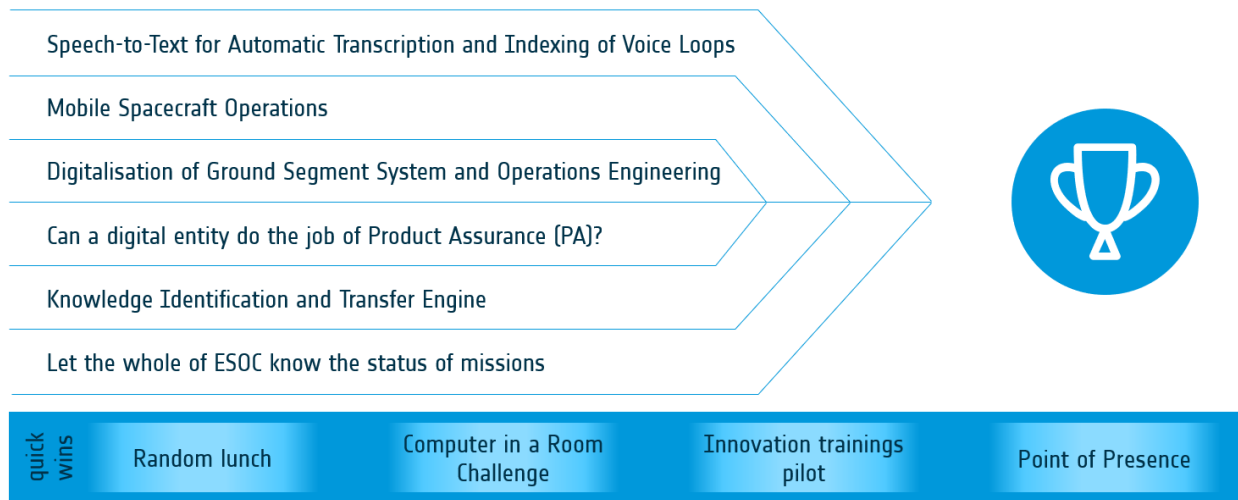


Figure 3. 1st Innovation Tournaments at ESOC - results

4. Discussion

In conclusion, innovation tournaments can be a powerful tool for generating new ideas, products, and solutions. They can tap into the diversity and creativity of a wide range of participants and can be used to solve problems of various sizes and in various industries. However, they also have the potential for bias and a lack of collaboration, which can limit the effectiveness of the solutions generated. Therefore, it is important to design and implement innovation tournaments in a way that addresses these potential drawbacks. And as mentioned in the title place a user in the driving seat of the endeavour. In ESOC context it's been observed the most successful outcomes of the tournaments were the projects that were involving early wide audience of potential users. Moreover, it provided a fail-forward opportunities in the failure-intolerant environment. It also facilitated meaningful communication and exchange between various units and actors of the organisation. Lastly provided high motivation to the community members who appreciated participation in the side-events of the tournaments (brainstorming sessions, workshops, pitching sessions, demo days, etc.)

Moreover, there are also some potential downsides to intrapreneurship. One of the main challenges is that it can be difficult to balance the needs of the intrapreneurs with those of the rest of the organization. Intrapreneurs may be focused on developing a new product or service, while others in the organization may be more focused on maintaining the status quo. This can lead to tension and conflict, which can be difficult to manage. In addition, it must be remembered that participation in the innovation tournament is not a core activity of the participants. Therefore, delays in deliveries and drop-outs are to be expected.

Another potential downside is that intrapreneurship can be risk for organizations. New products and services can take a long time to develop, and may not be quickly adapted by the market. Therefore, in a short term a lack of return on investments may be observed, even though properly developed ideas of the high probability of adoption.

5. Conclusions

In this paper, we presented the concept of innovation tournaments as implemented at ESOC. We believe that this approach can be applicable for a variety of use cases for mission operations, the main element worth stressing is the creation of a sandbox for experimentation and failure. The second one is a number of smallish activities driven by users from the bottom-up. Both components in a long term should contribute to a cultural evolution within conservative mission operations environment. In our opinion that potential evolution does not undermine the “no room for error” principle but provides an opportunity to the siloed and hierarchical organisations (very common structures in the public domain). We hope that our work will inspire other mission operators who would be keen to exploit with us innovation potential in the context of mission operations and space safety.

References

- [1] Christensen C. (1997) *The Innovator's Dilemma*, Harvard Business Review Press
- [2] Dyer J., Gregersen H., Christensen C.M., (2011) *Innovator's DNA*, Harvard Business Review Press
- [3] Christensen C.M., Raynor M.E., (2003) *Why Hard-Nosed Executives Should Care About Management Theory*, Harvard Business Review
- [4] Mark J., Lewis M.J. *Challenges and Opportunities in Space Mission Operations*. *Journal of Spacecraft and Rockets*, Vol. 53, No. 1, pp. 1-9 (2016)
- [5] Dooling D.F., Shaw M.W. *Innovations in Spacecraft Design and Operations*. *Annual Review of Astronomy and Astrophysics*, Vol. 55, pp. 1-34 (2017)
- [6] <https://www.xprize.org/> (January 26th, 2023)
- [7] Iagnemma K., Buehler M. Editorial for *Journal of Field Robotics - Special Issue on the DARPA Grand Challenge*. *Journal of Field Robotics* 23(8), pp. 461-462 (2006)
- [8] Hesselbein F., Goldsmith M. (2010). *The Leader of the Future 2: Visions, Strategies, and Practices for the New Era*. John Wiley & Sons
- [9] Timmons J., Spinelli S. (2007). *New Venture Creation: Entrepreneurship for the 21st Century*. McGraw-Hill.
- [10] <https://ideas.esa.int/> (January 30th, 2023)
- [11] Howe J. (2008). *Crowdsourcing: How the Power of the Crowd is Driving the Future of Business*. Random House Business
- [12] <https://esoc.esa.int/content/take-part-esa-computer-room-challenge> (January 25th, 2023)
- [13] <https://indico.esa.int/event/386/contributions/6241/attachments/4279/6489/1355%20-%20Implementation%20of%20MBSE%20solution%20for%20Advanced%20Digital%20Ground%20Segment%20Engineering.pdf> (January 30th, 2023)
- [14] De Canio G., Eggleston J., Fauste J., Palowski A.M., Spada M., *Development of an actionable AI roadmap for automating mission operations*, SpaceOps ID #303, 17th International Conference on Space Operations, Dubai, United Arab Emirates, 6-10 March 2023.
- [15] https://www.esa.int/Enabling_Support/Operations/OPS-SAT (January 30th, 2023)