Call for Papers

This document serves as a call for papers for a special issue of the journal *Safety and Reliability* on space debris. The primary aim of this special issue is to establish a two-way transfer of knowledge between the space industry and other non-space, safety- and reliability-related sectors.

To elicit this discussion, six topics have been identified and are detailed below. Each topic is hyperlinked to a brief description of what the paper on that topic should aim to cover.

Paper Topics

- Engineering removal - solutions and reliability of systems - Net Zero
- Accidents in space: What the past can help us predict
- Technical aspects of risk assessments, limitations and learning from other sectors
- Digital in space: vulnerabilities and strengths
- Creating change, responding to societal needs world wide: Space supporting development
- What works in space education, what's being done ?

Potential Authors

One of the key goals in producing this journal is to not only constitute a cross-sectoral transfer of knowledge, but also to initiate a link between students/early careers individuals and established professionals in their respective fields. To do this, our aim is that each paper will have between three and five authors, the composition of which will include at least one student/early careers individual and one established professional in the space or other relevant non-space industry.

Acceptable Submissions

Original research, review articles, opinion pieces, and other styles of paper will be accepted; however, they should not be previously submitted pieces of work, nor should they be intended as submissions for other publications. Submissions will be peer-reviewed.

Submission Deadline

If you would like to contribute to any of the above topics, please ensure your entry is submitted by 31 January 2022.

How to Submit

Safety and Reliability is published by Taylor & Francis Group. To manage submissions, Taylor & Francis Group utilises a submission portal, which is located here. For information on how to submit an article, as well as additional guidance, please see the instructions for authors, located here.

Editors

Dr Emma Taylor, Cranfield University, emma.a.taylor@googlemail.com
Christine Vincent, University of Portsmouth, vincent.christine.m@gmail.com

Paper Topic Descriptions

Engineering removal - solutions and reliability of systems - Net Zero

Space debris poses a threat not only to other objects in LEO, but also to the atmosphere and to life on earth, particularly through uncontrolled re-entry and the potential for atmospheric pollution (Boley & Byers, 2021). As awareness of these risks rises, it is becoming increasingly important to reduce space debris through innovative approaches to engineering removal which address the need for the space industry to embrace the Net Zero concept as well as considering design ideas for de-orbiting and in-orbit resilience.

To discuss these topics, this paper should aim to answer the following questions:

- What does Net Zero look like for the space industry? How does it compare to the Net Zero concept on Earth?
- Is Net Zero for space a realistic goal?
- Why is implementing a Net Zero goal in the space industry important?
- What would be the benefits of achieving, or even working towards achieving, Net Zero in space?
- What are some of the potential barriers/limitations that could prevent Net Zero from being achieved? How can these barriers/limitations be mitigated to reduce the likelihood that they will negatively impact achieving the goal?
- What are current ideas around designing for de-orbit and, importantly, what are the safety and reliability implications of these designs?
- How is the topic of in-orbit resilience being addressed currently? How can or should it be addressed in the future?

Accidents in space: What the past can help us predict

In order to stay relevant, operational, and successful, it is imperative that organisations learn from failures to avoid repeating them. To do this, organisations must not only learn from major failures that occur within their own organisation, but from smaller failures and those that occur at other organisations. However, in order for small failures to be learned from, they must first be identified as failures, which notoriously does not tend to happen. How, then, can organisations within the space industry prepare themselves to (1) identify failures as such, even if they do not result in catastrophic loss, (2) identify and mitigate potential barriers to organisational learning from an identified failure, and (3) ensure that any changes made to the organisation as a result of the learning process are embraced and maintained by employees? This paper should focus on identifying key barriers to organisational learning and make suggestions for how the likelihood of organisational learning to occur can be increased, with particular regard being paid to the acquisition and embedding of organisational knowledge following small scale failures and those that occur at other organisations. It should highlight current accident investigation processes in the space industry (whilst also comparing these to processes in other safety-critical industries), in order to evaluate how these processes do or do not allow for organisational learning to occur.

Technical aspects of risk assessments, limitations and learning from other sectors

Space has a unique risk profile, based on a highly complex interconnected in-orbit and ground based global system. One country's activities can directly impact another. One analogy, both in scope and uncertainty as to the future state, is that of the development of understanding climate change. Broad trends and outcomes are broadly understood, but the detail, as it impacts the risk profile of a particular satellite or national liabilities, cannot easily be quantified to a high level of accuracy.

Risk assessment approaches from other sectors may be able to provide additional clarity, particularly those applied with low probability/high consequence events (e.g. nuclear sector) and those undergoing significant technical changes, with novel and irreversible characteristics (e.g. digitalisation of rail and aviation). This paper sets out a synthesis of current developments in risk assessment methodologies across all critical national infrastructure and highlights where they may be of potential use to risk assessment for space design and operations. The paper does not directly address the current risk assessment methodologies used by nation states as part of the current space law and treaty practices, e.g. as part of launch and frequency licensing, but takes a longer term perspective. System modelling practices, including system boundary definition (individual satellites or constellations; operating altitude or divergent orbits at end of life), and developments in risk matrices incorporating technical, reputational, commercial, social contexts, will be included. Addressing this technical risk assessment challenge is of increasing importance, autonomous satellite operations, and decision-making and data analysis algorithms will only add further to the complexity of risk assessment. It is important to note that legal obligations for risk assessment - established in scope, mandatory in other sectors - are still maturing as implementation of space law, space regulation and space licensing continues to develop. They provide one context for technical risk assessment, societal expectations and meeting the UN SDP provide another.

Digital in space: vulnerabilities and strengths

In-orbit satellites, communication networks, and ground-based control and data processing systems have always relied on some form of digital systems. From the earliest days of electrical and electronic programmable systems, which were stand-alone, satellites have been both built from physical parts and digital parts. More complex on-board command and control autonomy and data processing and compression is now routine practice; the move to large numbers of small satellites has been enabled by reduced costs and mass combined with. An iPhone in space functionality is now not unusual, the inherent conservativism of the sector on technical innovation is counterbalanced by the demonstrated capabilities of pioneering missions showing it can be done.

Driven by cost pressures and client expectations on availability of satellite products, ground stations are now increasingly becoming virtual, and cloud-based operations represent the new industry trend. However this leads to increasing risks of data modifications with the consequent impact on safe operations and the potential for incorrect decision making based on ‘faulty’ data (incomplete, too late, missing etc.). The increasing size of the system boundary, large number of assets (satellite operations and company IT systems), and ever-changing cybersecurity threats mean that a system-wide look at the risks is timely. This paper will capture the current and anticipated industry trends towards digitalisation of space, comparing them with other sectors, particularly air traffic management. Given the ever-closer overlaps between air traffic and satellite operations, bridged by high altitude flights, satellite re-entry paths, developments in both sectors and their overlaps will help inform the overall picture. Noting their roles in ensuring reliable launch through, digital vulnerabilities and threats to in-orbit software/firmware safe operation will be profiled. Satellites provide a clear benefit to society, it is of increasing importance in maintaining societal confidence in the satellite data products as well as ensuring ongoing access to space through management of in-orbit risks due to increasing space debris.

Creating change, responding to societal needs world wide: Space supporting development

In an attempt to address the substantial challenges faced by humans on Earth, the UN has defined 17 Sustainable Development Goals (SDGs). These range from addressing poverty to hunger, health, economic growth, gender inequality, and climate change, amongst others. One of the key ways these SDGs can be addressed is by harnessing the power of space technologies. It has been suggested that two European programmes (European Geostationary Navigation Overlay Service (EGNOS) and Copernicus) could be used for this benefit, to attempt to address the UN SDGs not only in Europe, but worldwide. This paper should highlight how other current and future projects can be used to directly and/or indirectly address the UN SDGs. It should aim to discuss projects wider than Earth Observation (EO) and geolocation, bringing in up-and-coming solutions and technologies. Additionally, it should evaluate if there are other methods of development outside of the SDGs that space technologies could be used to address. It is important to highlight, particularly, the non-space benefits of utilising space technology. Finally, this paper should touch on the important role of space debris intervention when using space technologies for on-Earth development. It is important to highlight that space debris poses a serious threat to these missions. However, rather than simply discussing the risk space debris poses, it would be beneficial if the discussion in this paper also highlighted the potential impact of using the conversation around space debris as a platform for promoting ideas surrounding the use of space technologies for on-Earth development.

What works in space education, what's being done ?

Rapid growth of a space sector, as outlined in governmental plans (e.g. UK) and encouraged through frameworks such as the UN SDG, requires an equivalent rapid growth in skills and competencies, growing a community of professionals at all levels who develop and operate space systems. More broadly, the potential users of space resources and data products also need access to skills development platforms. A company may develop a useful product, but if people don't know how to use it, its impact may be limited. This paper outlines a range of strategies and implementation plans, taking guidance from other sectors such as oil and gas which, following a series of incidents and near misses, instituted a one week programme of safety education and assessment which all offshore workers, from cooks to drillers, had to take. As all are responsible for safety, all need to be aware. In parallel, a range of specialist skills (known as SQEP or suitably qualified and experienced professionals) in safety and reliability embedded in discipline specialists will need to be developed, and certifications established, through apprenticeships, professional registration e.g. CEng/IEng. This paper will outline a skills development and deployment framework, covering manufacturing through to programming, and different approaches required for larger organisations through to start ups, both directly involved in the space industry and wider users of the product. Both technical and non-technical disciplines will be considered, effective implementation of safety and reliability is as much legislation and company culture as engineering design and operations. The importance of a lifelong learning approach in future space safety, incorporating embedded workplace learning e.g. apprenticeships will be highlighted. Competency development will likely form part of future space regulations, it is an integral part of safety management systems licensing for other industries.