B.7. Systems Thinking & Complex Systems

Systems Thinking & Complex Systems. This stream will cover elements of systems thinking within complex, dynamic systems. Submissions are welcome that explore the application of qualitative and quantitative systems thinking tools and techniques to deliver better insights and drive better decision-making in complex socio-technical systems.

Lead: Contact the Technical Committee if you can assist in Chairing this session
Domains: All domains welcome

Submissions Summary:

1. **Identifying Effective Tools for Risk Management of Complex Systems**
   Full Paper
   Ben Luther 1, Indra Gunawan 2, Nam Nguyen 2, Nova Systems, Adelaide, SA, Australia, University of Adelaide, Adelaide, SA, Australia
2. **Setting up for Successful System Integration in Large Scale Projects**
   Full Paper
   Jon Lancaster 1, Dave Healing 1, Mott MacDonald, Melbourne, VIC, Australia
3. **Beyond Solving the problem right Solving the right problem**
   Full Paper
   Varun Prakash 1, Nam Huynh 1, Jacobs CMS, Melbourne
4. **Assessing the practical implications of new developments within systems engineering practise on novel aircraft.**
   Paperless Presentations
   Edward Burnham 1, Alauda Aeronautics, Beverley, SA, Australia
5. **A Systemic Emergent Perspectiveof the UN SDG's**
   Paperless Presentations
   Jawahar Bhalla 1, Shoal Group / University of Adelaide, Harrington Park, NSW, Australia
6. **Soft Systems Methodology - Another Layer to the 'V'?**
   Paperless Presentations
   Simon Hutton 1, JOHN HOLLAND GROUP, MELBOURNE, VIC, Australia

20628 Identifying Effective Tools for Risk Management of Complex Systems

Authors
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Provided Keywords
complex, system, risk management
Natural Language Keywords
complex, effective, flight, management, risk, statistical, systems, test, theory, tools
Presentation format decision
Full Paper - Presentation Preference
Stream submitted
B.7. Systems Thinking & Complex Systems
Stream proposed
B.7. Systems Thinking & Complex Systems

Abstract

Experimental flight test routinelymanages risk within complex socio-technical systems. The flight test system already encompasses the crew, sothe potential catastrophic consequencespreclude typical mitigations of robustness and resilience. This leaves flight test professionals to manage risk using a framework of tools that is guided by cultural lore.

Observation of the professional flight test community identified that their approach to managing risk in complex systems was unique. Yet with a few notable, tragic exceptions, their approach was clearly effective in circumstances that would otherwise be fatal.

Ethnographic research into this flight test risk management framework identified a combination of statistical and non-statistical tools in use, in parallel. They always had both at hand, though the flight test crews did not have knowledge of why different tools were effective. Their blanket approach assured effectiveness at the expense of efficiency.

Research identified that there is no grand theory of risk and that risk management is grounded in economic theory. Examination of economic theory finds that Friedman's Utility Theory and Probability Theory are being read across, though the context is not being maintained. For complexity, alternative theory from Knight and Keynes is being used by the flight test community in their adoption of non-statistical approaches that accept uncertainty rather than assign a subjective probability.

Complicated systems respond to statistical approaches, though complexity denies these same tools. Complex systems require risk management approaches that accommodate emergence, dynamic configurations and non-deterministic system performance. An understanding of why the flight test risk management framework is effective provides a case study for the wider industry dealing with complex systems to emulate.

21252 Setting up for Successful System Integration in Large Scale Projects

Authors
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Provided Keywords
Complex Systems, Systems Integration, Role of the Integrator, Operational Integration
Natural Language Keywords
approach, guidance, holistic, integration, integrator, large, paper, people, projects, role
Presentation format decision
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B.7. Systems Thinking & Complex Systems
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Abstract

Overview

The integrator, responsible for orchestrating the coming together of the entire system and its incorporation into the operational environment, must understand the holistic process from concept to disposal or upgrade.This paper provides some guidance to integrators for managing integration, and for delivery authorities in shaping the integration functions and teams on large complex engineering projects.

Context

Systems Integration plays a pivotal role in getting a project into service, ensuring seamless coordination among technical and operational elements of the system.Lessons learned from past projects frequently cite the lack of up-front integration work as a key cause of the project's troubles.

Purpose

This paper explores the significance of holistic integration and owning the whole, emphasising that problems often arise during the integration phase due to issues originating in earlier stages of developmentand most importantly how to avoid them.

Approach

Holistic Approach: Define integration across the lifecycle from concept to disposal, and frame it within the context of a wider capability uplift.

Identify Common integration challenges: Highlight common challenges faced during integration,both technical, and human/organisational.

Role of the Integrator: Define the role and qualities of a good integrator.

Insights

This paper underscores the need for proactive integration planning, emphasising the interconnectedness of people, processes, and infrastructure within engineering projects,and provides guidance on the qualities of the people on these essential roles.

20762 Beyond Solving the problem right Solving the right problem

Authors
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Provided Keywords
Systems thinking, Requirements Engineering, Problem Definition, Technical Debt
Natural Language Keywords
debt, engineering, identification, problem, project, right, root, solution, solving, technical
Presentation format decision
Full Paper - Presentation Preference
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B.7. Systems Thinking & Complex Systems

Abstract

In complex systems engineering projects, solving the right problem is imperative to ensure that the solution addresses the root cause rather than treat the symptoms, which often result in the creation of technical debt. By focussing on the right problem, we can develop solutions that are effective, efficient and resilient in the long run, resulting in a sustainable solution, thereby creating opportunity for innovation. Project technical problems are not independent of each other and are often masked by inter-related technical issues making the identification of the right problem highly challenging. In this paper, we explore how we can identify the right problem for a specific project phase and scenario by asking the right questions leading to root cause identification. We also emphasise the importance of event-driven approach in the validation of engineering progress by gathering and analysing relevant data as well as continuous implementation of lessons learnt to minimise the risk of technical debt.

21090 Assessing the practical implications of new developments within systems engineering practise on novel aircraft.

Authors
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Provided Keywords
Aerospace, Hydrogen, Electric, Complex Systems
Natural Language Keywords
aerospace, aircraft, engineering, evidence, guidelines, implications, industry, new, novel, systems
Presentation format decision
Paperless - Presentation or Poster
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B.7. Systems Thinking & Complex Systems
Stream proposed
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Abstract

Overview

Novel aircraft and their systems have largely been developed with systems engineering practices that have had to be adapted to account for their novel nature. However, the last 12 months has seen the publication of updated guideline for aerospace systems engineering that may go some way to amend this issue. Namely; ARP4754B, ARP4761A and the INCOSE Systems Engineering Handbook. This presentation shares an industry-focussed analysis on the implications on these updates for complex and novel system-of-systems.

Context

The aerospace industry is well known to rely heavily on prescriptive certification standards to ensure airworthiness, and whilst systems engineering guidelines are not required, they are referenced significantly as an acceptable means of compliance, especially as evidence for design assurance. The advent of novel technologies such as hydrogen, batteries, UAVs and eVTOLs has led to a significant shift in the way airworthiness is being approached.

Purpose

The purpose is to analyse ongoing industry projects, a hydrogen fuel-cell powered aircraft and specialist-use manned eVTOL system and how the adoption of these guidelines may have impacted them from a systems engineering perspective. One area that is of interest in particular is the promotion of MBSE within ARP4754A and how this affects novel aircraft development.

Approach

The implications will be analysed in the context of 3 novel applications and the first-hand experience gained in their development. This evidence will be presented against a theoretical application of these standards against these completed projects and how this may impact future novel applications in aerospace contexts.

Insights

The new guidance material leaves less ambiguity for systems engineering in novel aerospace contexts

The new guidance goes someway to aiding allowing MBSE as formal certification evidence in novel contexts

The new guidelines may provide less ambiguity for certifying authorities of novel aerospace vehicles.

21270 A Systemic Emergent Perspectiveof the UN SDG's

Authors
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Provided Keywords
Systemic Approaches, Systems Thinking, Emergence, Human-Centric
Natural Language Keywords
challenges, development, global, goals, life, sdg, sdgs, sustainable, systemic, work
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B.7. Systems Thinking & Complex Systems
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Abstract

The United Nations Sustainable Development Goals (UN-SDGs) are a set of 17 interconnected goals that were adopted by all UN Member States in September 2015 as part of the 2030 Agenda for Sustainable Development.The SDG's cover a broad spectrum of issues, spanning poverty, hunger, health, education, gender equality, clean water, sanitation, affordable and clean energy, decent work, industry and innovation, reduced inequalities, sustainable cities, responsible consumption and production, climate action, life below water, life on land, peace, justice, and strong institutions, and partnerships for the goals. The SDGs were designed to guide international efforts towards a more sustainable and equitable future, with the intent of providing a universal framework for countries, organisations and individuals to work together towards addressing these global challenges.Given the complexity and interconnectedness of these global challenges, it is clear that they require a coordinated, comprehensive, and perhaps most importantly, a systemic approach. Symptomatic quick-fixes may well achieve specific goals in the short term, but only further exasperate the situation in the longer term.This presentation will consider the UN-SDG's from a systemic perspective, highlighting the complex and interconnected nature of the challenges, and suggesting a naturally emergent human-centred approach may well lead most efficiently and effectively towards their attainment.

20878 Soft Systems Methodology - Another Layer to the 'V'?

Authors
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Provided Keywords
Soft Systems Methodology, Systems Thinking, Systems Lifecycle, Requirements Definition
Natural Language Keywords
improvements, methodology, problem, problems, socio, soft, ssm, structured, systems, technical
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B.7. Systems Thinking & Complex Systems
Stream proposed
B.7. Systems Thinking & Complex Systems

Abstract

Our minds solve problems by applying frameworks of ideas, concepts and methods to areas of interest. Clearly defined situations allow the re-use of themes and structured methods to progressively decompose, analyse, define and integrate systems as solutions. Systems engineering as a methodology is a structured framework typified by the familiar V lifecycle. However, socio-technical situations are complicated by unpredictable human responses, conflicting objectives, interdependencies and perceptions. These soft or wicked problems can be difficult to resolve without an understanding of the problem situation and viable improvements that may not be limited to a technical solution.

Soft systems thinking methodologies evolved to encourage a holistic approach to exploring unstructured, complex problems and improve the integration of technology in society. Examples include ETHICS (Mumford), Multiview (Avison and Wood-Harper) and Soft Systems Methodology (Checkland). An early version of the latter is a seven-stage model, and SSM has evolved into a framework for exploration based on interacting logical and cultural streams of analysis. Irrespective of Checklands observation that only neophytes apply SSM as a seven-stage process it does provide a mosaic of activities suited to exploring the interplay between society and systems.

This presentation describes the application of Soft Systems Methodology to understand complex socio-technical problem situations and identify improvements. In the spirit of Checklands action research approach the presentation uses research into a Marine Safety System to illustrate SSM in a real-world environment. Excursions into other methodologies including Information Systems Methodology (Wilson) and Socio-Technical Stages of Growth (Galliers) are introduced to illustrate the derivation of socio-technical requirements from the problem situation analysis. The findings are used to summarise the benefits of a soft systems thinking approach to understanding the problem situation and viable improvements alongside a structured system-based methodology, proposing another layer to the V lifecycle.