A.6. Mission Engineering

Mission Engineering and Capabilities. Mission Engineering elevates thinking from system level to the concepts of Systems of Systems, Operational Concepts and the integration of Mission Capabilities. Presentations to further the theory as well as the practical implementation of Mission Engineering are invited.

Lead: Michael Edwards, Theo Venter
Domains: Defence

Submissions Summary:

1. Integrated by Design: The use of Mission Engineering to achieve a focused Australian Defence Force (Full Paper)
2. Designing Mission-Aware Systems through ME and MBSE Integration (Full Paper)
3. Mission Engineering Modelling & Reporting: Lessons from Model Based Capability Design (Full Paper)
4. Blurring the Line: Adopting Mission Engineering Methods in Product Development Programs (Paperless Presentations)
5. A Short History of Mission Engineering (Paperless Presentations)
6. Minimum Viable Capability - Mission Engineering on a Budget (Full Paper)

21239 Integrated by Design: The use of Mission Engineering to achieve a focused Australian Defence Force

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Keywords: Mission Engineering,ADF

Type: Full Paper
Stream submitted: A.6. Mission Engineering

Title submitted by M.Edwards as stream lead for Mission Engineering. Mark Gilchrist is only intended author/presenter and has committed to provide abstract by 14 June. Suggest we can use this title at least for initial agenda formulation and confirm later.

21076 Designing Mission-Aware Systems through ME and MBSE Integration

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Keywords: Mission-aware systems,MBSE,Mission Engineering,Causal models,Unified profile

Type: Full Paper
Stream submitted: A.6. Mission Engineering

The Defence Strategic Review (DSR) highlights the need for effective Mission Engineering (ME) to develop capabilities that meet specific mission objectives efficiently and cost-effectively. For ME to be effective, adaptable systems need to be developed that can address a wide range of evolving problems and meet specific mission requirements. Such systems must be versatile and broad, remaining relevant across various scenarios and precise needs. This demands significant foresight and ingenuity in the design stages, where architects must anticipate future challenges and opportunities, embedding both flexibility and specificity into the system. Mission-aware systems offer a solution to this challenge by integrating mission goals directly into their architecture and development lifecycle, ensuring technical soundness and alignment with future mission requirements. This alignment is crucial in contexts where strategic planning and execution are essential, synchronizing technological and human capabilities for mission success. By aligning systems engineering efforts, which focus on technical development, with mission engineering, which emphasizes overall mission success, organizations can ensure that their technological solutions support strategic objectives. This paper proposes an approach for designing mission-aware systems by integrating ME with Model Based Systems Engineering (MBSE). The integration occurs in two stages: first, by introducing missions as an intermediary that influences system capabilities alongside operational capabilities through a structural causal model; and second, by mapping ME frameworks, such as the DoD ME guide, with systems architecting frameworks, such as the DoDAF or MoDAF, to create a unified profile. This unified profile is used to describe and document ME artefacts within the MBSE model, ensuring that mission requirements are integrated into the system design from the outset. This approach, also, provides a common language between ME and MBSE, producing mission-compatible products that facilitate mission guided system design and evaluation.

21104 Mission Engineering Modelling & Reporting: Lessons from Model Based Capability Design

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Keywords:

Type: Full Paper
Stream submitted: A.6. Mission Engineering

Key to the effective employment of Model-Based Systems Engineering (MBSE) is the ability to effectively communicate the rich information contained in the model to stakeholders. This paper provides insights and examples for effective reporting of digital Mission Engineering models, drawing on lessons learned from similar approaches. Mission Engineering is the application of formal approaches to plan, analyse, organise, and integrate current and emerging system/ operational capabilities to achieve desired effects. It is used to examine missions for several purposes, including identification of capability gaps, needs and solutions. Mission Engineering practitioners will define missions, timeframes and capability states to examine, then model functional and physical architectures to provide structural and behavioural representations to facilitate mission analyses. The Unified Architectural Framework (UAF) provides a standardised enterprise architecture framework, is being adopted by the United States Department of Defense, and has been demonstrated as an effective, consistent, and standardised means for the digital engineering implementation of Mission Engineering. The Whole of Systems Analytical Framework (WSAF) provides a digital engineering approach to Capability Design within the Australian Defence context. There is significant cross-over between the application of WSAF and the Mission Engineering process, and the lessons learnt from its application can be applied to the adoption of Mission Engineering. A key component of WSAF is a suite of report generating tools, that supplements the MBSE environment, enabling the modelled information to be consistently reported and presented in a form readily understood by decision makers (i.e. Capability Definition Document). This paper examines the reporting principles employed on WSAF, how these can be applied in the Mission Engineering context, and demonstrate the adaption of these principles in reporting UAF-based Mission Engineering architectures and analyses. The authors provide insights and practical examples based on their experience in developing and applying MBSE-based reporting.

21199 Blurring the Line: Adopting Mission Engineering Methods in Product Development Programs

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Keywords: mbse,methodology

Type: Paperless Presentations
Stream submitted: A.6. Mission Engineering

Overview: With emerging customer trends toward rapid product development programs, and strategic capability accelerators, the traditional 'above-the-line' (ATL) to 'below-the-line' (BTL) systems engineering divide is eroding. Blurring of these lines has heightened the need for primes to understand mission engineering principles, and achieve better horizontal and vertical information integration such that confidence in the mission-product fit can be developed, assessed and evolved with pace. Context: Mission Engineering has traditionally been the purview of above-the-line (ATL) systems engineering efforts, undertaken by a customer in eliciting their internal mission and operational needs. The mapping of specific missions and capability needs to new platforms, requires bridging of the operational and system lenses, which is beyond the scope of any one method or architecture framework. Purpose: Developing a proactive understanding of the customers intended missions and concept of operations, via mission engineering, and achieving traceability from mission needs through to design is deemed a critical enabler for effective product development activities. Model-based systems engineering was proposed to help bridge this divide and provide a pattern for multi-project/program research and development. Approach: Modelling and architectural themes across mission engineering, operational/service modelling and object-oriented systems modelling were analysed and mapped to derive a holistic metamodel, methodology and viewpoint set. The resultant method was applied to an internal product development program as a case study and means of validation. Insights: The investment in proactive mission engineering and alignment is feasible and effective, albeit expensive and assumption driven. Clear articulation of missions, capability needs and customer investment priorities would provide a more robust basis for proactive mission engineering and allow industry to deliver a more competitive set of products and capabilities. Mission modelling holds greatest value when used as the basis of program/portfolio approach of research and development, thus allowing for re-use of the mission modelling investment.

21242 A Short History of Mission Engineering

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Keywords: Mission Engineering,Systems of Systems

Type: Paperless Presentations
Stream submitted: A.6. Mission Engineering

Note: this is a placeholder for a significant keynote or presentation slot for Dr Jim Moreland, placed by M. Edwards as presumptive stream lead for Mission Engineering. To be confirmed and expanded upon, but to start with: * Jim will explain the early development of Mission Engineering that he led through US Government, initially at Naval Systems Warfare Center, Dhalgren and then the Office of the Secretary of Defense. * Jim will explain the state of professional education and academic research of Mission Engineering in the US, relying on his teaching experience including at MIT, Virginia Tech, and Old Dominion universities. * Jim will explain the role and interest of US industry in Mission Engineering. * Jim will provide his thoughts on the future practice and development of Mission Engineering, in particular what are the needed lines of research to develop the discipline.

21283 Minimum Viable Capability - Mission Engineering on a Budget

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Keywords: Systems Integration,Mission Engineering,Capability

Type: Full Paper
Stream submitted: B.2. Future of Systems Engineering

Overview This paper examines how Mission Engineering can be used to inform decision-makers attempting to deliver the most capability with the minimum amount of infrastructure. Where projects are delivered across migration stages, this paper explores how Mission Engineering and Systems Integration allow operators to map the staged capability uplift across multiple migration stages and manage the transient risk profiles across a suite of temporary configuration states. Context Decision-makers face the challenge of maintaining or growing capability amid decreasing budgets, rapidly changing operational environments, and phased delivery of complex systems. In situations where decisions can mean significant operational limitations, identifying the impact on mission and capability empowers decision-makers tofocus on best-for-project outcomes . Purpose This paper describes using Mission Engineering and Systems Integration methodologies to enable operators to make informed investment decisions to deliver the Minimum Viable Capability in the face of time, cost, and availability constraints. By understanding the relationship from capabilities to the people, process, technology, and associated risks, a delivery authority can manage project change and assess the consequences of changes in terms of capability rather than just in terms of time and cost. Approach Building on existing Systems Engineering frameworks used on complex projects in highly regulated industries, the view is expanded to include the lens of capability.A framework is provided that links existing artefacts (hazards, operational scenarios, test cases, GSN goals) to the mission. By viewing technical integration and operational readiness through the lens of missions and capabilities it enables delivery authorities to place complex systems into service effectively. Insights Projects / technology suppliers speak in terms of system functions,whilst operators speak in terms of operational capability. Establishing a framework that enables both parties to speak a common language aids collaboration and provides a common basis for making decisions.
