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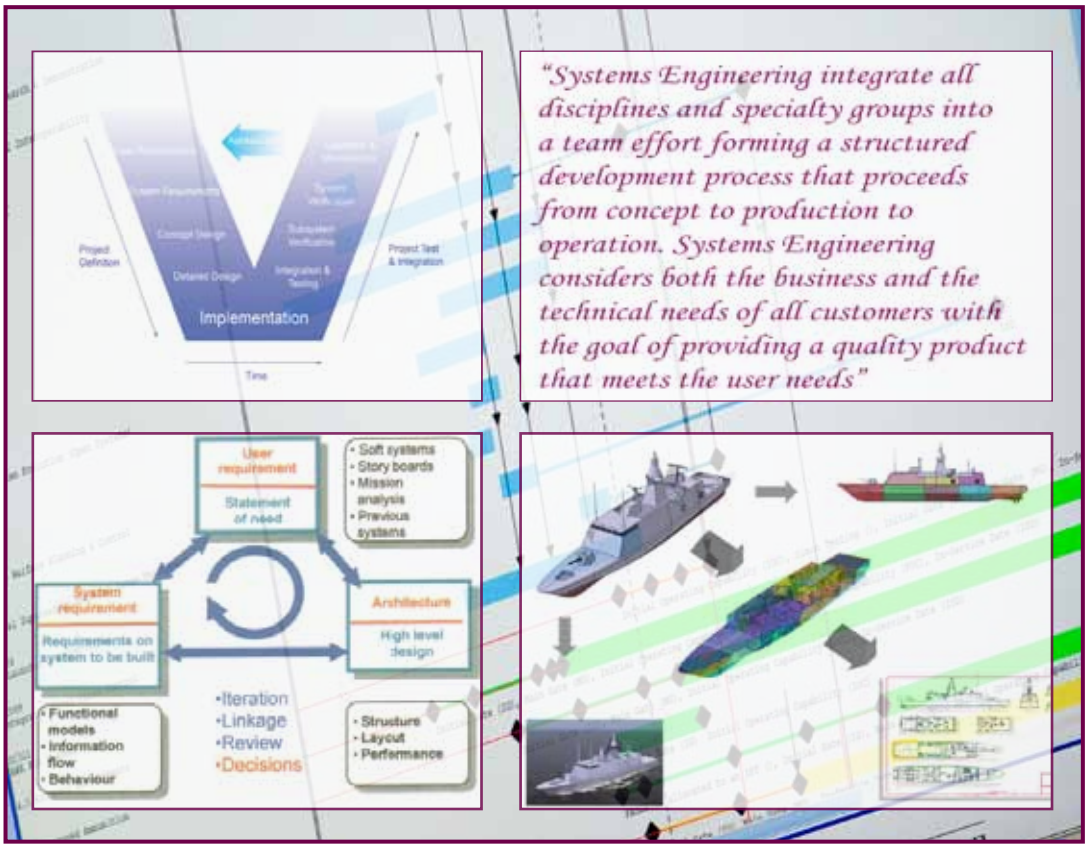

Systems Engineering Conference papers include:

TWO SYSTEMS ENGINEERING MODELS AND THEIR RELEVANCE TO COMPLEX MARINE SYSTEMS DESIGN
David Andrews, Design Research Centre, Department of Mechanical Engineering, University College London, UK

The author's paper to the first RINA Conference on the principles and application of systems engineering to marine systems addressed the very specific, and highly contentious, issue of Requirements Engineering versus Requirements Elucidation. In doing so, that paper first considered the origin of the former practice in the broader context of systems engineering being applied to naval ship and submarine design and acquisition. This paper will take a similar broad view in considering two very different models of applying systems engineering to the design of complex systems. The first of these approaches to systems engineering addresses the generality of defence systems, where it could be seen that a certain maturity has now been obtained given over half a century of application, particularly with regard to the procurement of most major defence systems. A distinctly more specific approach to applying the systems method was produced over thirty years ago at the height of the "hard systems" fashion in the field of architecture and urban planning. Despite the fact that such an approach to engineering complex systems was subsequently rejected by architectural designers, this approach is worth contrasting with the current defence systems model. This is because, in comparison to other major defence systems, naval vessels can be seen as anomalous to architectural and urban design precisely because they are not only complex but also physically large entities. In particular, the reason why the architectural system model "failed" could be informative in assessing why, in the design of such marine systems, the application of systems engineering remains problematic, beyond its use in the direct project management of such systems. By drawing on recent examples of UCL DRC's design studies of naval vessels, the applicability of these two models of systems engineering to such major marine systems is contrasted. Conclusions are drawn on the relevance of each approach to future marine systems design and acquisition.

SYSTEMS ORIENTED DESIGN IN MARITIME DESIGN
Dr Birger Sevaldson, Oslo School of Architecture and Design, Norway

Systems Oriented Design (S.O.D.) is the designerly way of systems thinking. It is tuned towards working with the dynamics of human activity systems and its interactions with technology rather than constructing technological systems. The complexity in modern high end ship building has increased on several fronts. This is especially true for the design of vessels for very complex offshore operations demanding visualisations of rich information to the officers on the bridge or other operators and human actors, to facilitate fast and reliable control. A holistic approach to the interplay between human activity systems and between human and technical systems becomes crucial when regarding e.g. safety. Such holistic approaches in maritime design are hindered because the production processes are extremely complex. Customized solutions, dependencies between subcontractors, class rules and safety regulations make innovation difficult. The result is often a compromise that does not render the optimal solutions. Through focussing also on the innovation process as a human activity system, involving e.g. the client, class organizations, authorities etc, S.O.D. holds the promise to help to bridge these problems. Through the visualization of super complexity and visions for the near future one can communicate and create enthusiasm and willingness to stretch innovation processes across the organisations, from the board room to the authorities. The paper will present and discuss some early findings and innovative cases from oil spill recovery and ship bridge design and discuss how the approach of S.O.D. can contribute to radical innovation in maritime design.

EMBEDDING HUMAN SYSTEMS INTEGRATION WITHIN MARINE SYSTEMS ENGINEERING
Trevor Dobbins, STResearch Ltd, UK, Chris McKesson, University of New Orleans, USA, Julie Stark, Combatant Craft Division, US Navy, USA

The inclusion of Human Systems Integration (HSI) within platform requirements definition, design and acquisition is mandated within the US DOD (DOD 5000) and recognised within many other systems by the use of Human Factors (HF) standards, e.g. MIL STD 1472 and DEF STAN 00-250 and the promotion of the Human Element by the IMO. Even with this mandation, and the inclusion of HF requirements within acquisition/tender documents, it can be observed that HSI is typically poorly represented during the design and development process, even though the potential for enhancing performance, safety, and reducing through-life costs, by investing in HSI is generally accepted. This lack of HSI within the systems engineering process may be addressed through a greater understanding of the HF disciplines and the requirement to embed HF Subject Matter Experts within the platform design team. One of the keys is the quantifying of HF metrics within the systems requirement documentation and the education of marine systems surveyors who can assess the HF aspects and approve the design. This paper will illustrate how HSI may be better incorporated into the marine systems engineering process and how its effectiveness may be facilitated.

INTEGRATING EVERYTHING? - THE APPLICATION OF PRAGMATIC SYSTEMS ENGINEERING TO NAVAL DESIGN AND CONSTRUCTION
Robert Skarda, Steller Systems Ltd, UK

Systems Engineering can be a powerful tool in driving out risk in a project, but only if used in a pragmatic and value adding manner. This paper will describe a proposed top level process for managing the integration of the vessel and the wider enterprise, pulling together many strands. Requirements elucidation requires the User to determine what they need, engineers to feedback the art of the possible, financiers to determine affordability and all of these to be agreed, based on robust information in as short a time as practicable. The key to successful projects is establishing exactly what is inside the delivery boundary, then managing the interfacing projects and systems in a robust but pragmatic fashion. Only through managing the dependencies across the Lines of Development, from early requirements elucidation and trading to the delivery of capability will the most cost effective solution be put into service. Tests and trials are expensive, but in many areas essential to establishing achievement of capability. Through a risk based approach it should be possible to prove the right hand side of the 'V' diagram without adding unnecessary cost or time to the project. Based on experience across Government and Industry, through Maritime and Land projects the paper will seek to establish an effective line between the perceived 'dark arts' of Systems Engineering and a 'seat of the pants' engineering driven process to show how value can be added through integrated Systems Engineering based processes, in a pragmatic fashion.

WARSHIP TRADE SPACE EXPLORATION: CHALLENGES AND APPROACHES
Courts, M. D. & Brittain R., BAE Surface Ships, UK

The paper discusses the challenges associated with exploring a wide range of options for a prospective warship design. The main objective is to manage the interface between the engineering problem of quickly generating and assessing a very wide selection of potential balanced ship designs with assessment of customer perceptions of the value of those solutions. Ship balancing concept tools can be used for the former while the latter requires assessment of a range of measures of performance and effectiveness. Operational analysis approaches are traditionally used for measure of effectiveness assessment but when a wide range of missions and factors have to be considered over an extremely large number of potential solutions, decision analysis methods become more useful. There is a fundamental difference between the engineering synthesis of viable solutions and the assessment of customer value when both are defined as functions of a range of input options. The former displays very strong interdependencies between options while the latter is indifferent to such complications! As a result of this and the problems that can ensue, value assessment of ship designs has traditionally been restricted to a limited number of viable solutions. However, when there is a requirement to explore a very wide range of potential options covering a large trade space, alternative approaches based on building block approaches become necessary. The tools and processes that have been evolved to support warship trade space explorations and the issues that emerge are discussed with reference to experiences during development of the Type 26 frigate concept.

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MULTILEVEL LIFECYCLE ASSESSMENT FOR SHIP PRODUCT MANAGEMENT
Nabile Hifi, University of Strathclyde, UK

The work reported here has developed a framework to relate (link) design parameters with cost and earning models, in a generic Life cycle Cost Model for ship vessel in a comprehensive and consistent manner. The model establishes the relationships between design parameters and key performance indicators addressing the most important impacts and operational parameters with estimates of lifecycle cost and earnings. The aim is to make the model sensitive and responsive to changes at any level of detail. As such, it can be used during early design stages to obtain quantitative cost/earning information on various baseline designs and subsequent design alternatives. The model includes two modes of calculation for cost-earnings figures. The discrete mode used for discrete unit figures (cost and earning data) and the probabilistic mode that has many advantages including the essential ability to consider variation of input parameters for the sensitivity analysis. The calculation process utilises the advanced simulation technique of Monte Carlo simulation to combine a number of parametric and non-parametric probability distributions to establish the distribution of the whole life cycle.

A SURVIVAL GUIDE FOR SYSTEMS ENGINEERS IN DIVERSE PROJECTS
Mr Ralph Hudson, BMT Defence Services Ltd, UK

The many conflicting demands on defence projects suggest that the value of systems engineering should be ever clearer. Although experience has grown fast, however, and the tools and techniques are becoming more embedded in routine project business, there remain practical challenges that prevent systems engineering reaching its full potential. This paper discusses some of the realities the systems engineer has to face when it is often a change of culture that is needed, not an ever increasing range of analytical options. It also addresses the challenges of effective quality management in situations where deliverables come from architectural models that are too large or complex for those outside the immediate modelling team to deal with. The paper will discuss useful principles behind typical systems engineering strategies and pass on lessons from experience that offer practical ways to engage the full project team. The relationship between requirements engineering and concept analysis will be discussed, for example, and how to build modelling and project documentation into the same overall structure. Careful balances are needed to ensure that quality management is cost-effective for the scale of the project concerned. The model outputs can be linked to the project's deliverables whilst ensuring that the key elements can be subjected to suitable checking by people with the right skills. The discussion reflects the diversity of domain and modelling knowledge to be found in a typical project and shares experiences on how management overheads can be reduced by minimising the interpretation needed between analysis and deliverable.

A SYSTEMS APPROACH TO DESIGN FOR ENHANCED SITUATION AWARENESS ON THE VESSEL BRIDGE
Ms Sigrun Lurås, The Oslo School of Architecture and Design, Norway

Lack of Situation Awareness is a common cause of human error. Operations on the bridge of offshore service vessels are becoming increasingly complex due to more complicated operations and introduction of modern technology. Systems Oriented Design (S.O.D.) is an approach which may be useful for designing bridge interfaces that support the officers' Situation Awareness. S.O.D. originates from industrial design and merges designers' way of working with problems, often referred to as Design Thinking, with the approaches of relevant systems theories. S.O.D. has many similarities with Systems Engineering (SE). Both approaches embrace a holistic view and strive to grasp the complexity of systems in order to develop good quality products with a high degree of user satisfaction. However, while SE traditionally focuses on development of complex physical systems, S.O.D. focuses on using a systems perspective in design for human-activity systems. Further SE is concerned with system boundaries and simplification in order to control the system, while S.O.D. encourages richness in an almost boundless system in order to understand the complexity of the system designed for. The author presents how S.O.D. will be used to design for Situation Awareness in her PhD project, and discusses how an S.O.D. approach differs from a traditional SE approach. The author argues that a systems perspective is important in design practices as well as in engineering practices and that it may be fruitful to investigate how S.O.D. and SE can be combined.

A ROLE OF DESIGN AUTOMATION IN SHIP DESIGN AND BUILDING PROCESS
Mr. Surendra Mohite, Neilsoft Ltd., India

A ship building process is comparatively complex process than other manufacturing processes. In that process designing, modeling Ship structures and components is time consuming and crucial one. To get an optimized design solutions and ensuring stability of ship, Engineers uses Ship Design and Building softwares in Shipyards and Design Houses. Engineers follow certain steps that could be repetitive or need to do changes in design & ship model due to change requests or changes in dependent components or systems. This affects overall productivity and quality. The productivity and efficiency of Engineers in Shipyards and Design Houses can be improved by customizing Ship Design/Building softwares as per requirement of Shipyards. Such automation of design processes will reduce design life cycle and will give better quality.

USING ONLINE IMAGE SHARING OF SHIP BRIDGES IN MARITIME RESEARCH AND DEVELOPMENT
Kjetil Nordby, Christoffer Lange, Oslo School of Architecture and Design
Sashidharan Komandur, Aalesund University College, Norway

In a previous study it was observed that a large collection of images helped facilitate rich discussions during the concept design stage for new ship bridges. However, the collection of images was limited to just one bridge. On the other hand to collect images from many ships for a single research group may be challenging due to lack of resources and difficulties of scheduling research missions on ships. This raises the question whether a collaborative effort amongst maritime researchers will help create a collection of images from many ships. We hypothesize that social collaboration platforms that allow image sharing can be an effective tool for sharing images amongst designers and researchers. In this work we present a simple structure for sharing and presenting images through the use of online services like ‘Flickr’ and ‘Google images’ to store and share images. We expect that by offering an online image library of a certain type of Ship Bridge would spur interest from other parties to not just view and use them but also contribute images to add to the sample size. As a larger question we ask whether social media needs to be considered as a platform that allows researchers and designers to dramatically expand their realm of collaboration. We hypothesize such an expansion is akin to a community driven innovation and thus will naturally lend to holistic approaches in design in the maritime sector.

VIRTUAL INTEGRATION FOR SHIP AND OFFSHORE SYSTEMS DESIGN
Wenjuan Wang, Ian Whitfield, Alex Duffy, Iain Boyle
DMEM, University of Strathclyde, UK

In ship and offshore systems design, a systems engineering approach has been adopted to bring together all the disciplines involved and represents a unified view of the project. A variety of tools are used in systems engineering to manage the complexity of projects, including requirements analysis, modelling and simulation, optimisation, and scheduling. Interactions among the tools are complex. Especially when the system itself becomes more complex, the amount of data and variables to be exchanged will be increased, requiring significant effort to ensure error-free interactions. A Virtual Integration Platform (VIP) has been developed in the University of Strathclyde within two EU FP6 projects – VIRTUE and SAFEDOR, to address integration challenges faced in ship systems design. The VIP provides a holistic collaborative environment, with features product and lifecycle management, project/process management, data/knowledge management to ensure error-free interactions, distributed tools Integration to address complexity, and version management to deal with multiple concepts. In addition it provides functions of risk-based design and global optimisation. In previous studies, it has enabled MARIN (Maritime Research Institute Netherlands) in Netherlands to reduce the working time for one process by 67%. In the case of HSVA (The Hamburg Ship Model Basin) in Germany, the platform has enabled some processes, that initially could only be performed by a specific expert, to be enacted by non-specialist users without errors. The VIP is being used in an EU FP7 project, EuroVIP, to promote collaboration among European maritime small and medium enterprises.

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