Editorial

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Biographical notes: Quoc Do received his BEng, MEng and PhD at the University of South Australia in 2000, 2002 and 2006 respectively. He is currently working at the Defence and Systems Institute (DASI), University of South Australia. His research interests are in the areas of mobile robotics (UAVs & UGVs), vision systems, systems engineering and systems integration research and education, and model-based systems engineering.

Stephen C. Cook is the Director of the Defence and Systems Institute at the University of South Australia. His career commenced with over ten years engineering experience in the telecommunications and aerospace industries after which he joined the Defence Science and Technology Organisation (DSTO) rising to Research Leader Military Information Networks. In 1997 he joined the university as the DSTO Professor of Systems Engineering and has led various defence research concentrations since. He is a Past President of the Systems Engineering Society of Australia and his research interests include systems modelling, defence capability engineering, and identifying the theoretical basis for systems engineering.

Todd Mansell has a BSc (H1) from Deakin University, and a PhD in artificial intelligence from The University of Melbourne. He has led Australia's Collins Class submarine and the Air Warfare Destroyer combat systems science and technology programs. In February 2005, he received the Minister's Achievement Award, for his "outstanding contribution to defence science in the fields of information fusion, network centric warfare experimentation and combat system engineering". His research interests include military system integration, combat system architectures, open system architectures, information fusion, artificial intelligence, counter terrorism, and missile defence technologies.

Roy S. Kalawsky received his BSc, MSc and PhD within a systems discipline from the University of Hull. He is the Director of the Research School of Systems Engineering at Loughborough University and the Technical Head of the Systems Engineering Innovation Centre based in the UK. Prior to joining Loughborough University in 1995 he spent nearly 18 years working for BAE Systems as a systems engineer being responsible for Advanced Crew Station Design across the whole of the Military Aircraft Division. His research interests include collaborative systems engineering, advanced visualisation, modelling and simulation, and model based systems engineering. He recently received the Da Vinci Award for his contribution to medial visualisation.

Rashmi Jain is an Associate Professor of Systems Engineering at Stevens Institute of Technology. She has previously worked on the design and implementation of large Information Technology (IT) systems. She has done invited Lectures at several overseas institutions. Currently, she is a Visiting Professor Keio University in Japan. Her teaching and research interests include systems integration, systems architecture and design, business process reengineering, systems engineering education research, and rapid systems engineering.

The formation of systems engineers traditionally followed a traditional experiential path. This journey commenced with an engineering degree in a traditional discipline, for example electrical engineering, followed by substantial industrial experience practicing that discipline. Usually after five or so, those destined to become systems engineers could be found in team lead roles and progressively in systems and project roles. Systems engineers largely learned their profession through an accumulation of substantial project experience acquired over many years.

The skill sets and knowledge of systems engineers are often described as 'T-shaped' – having in-depth knowledge of one or more disciplines and a breadth of knowledge covering all of the disciplines needed to succeed in technical projects. Given the duration of large-scale projects, and the need to experience several projects to acquire sufficient knowledge to become a successful systems engineer, the development of systems engineering competencies through the traditional experiential route is a necessary long process.

Increasingly, the design of engineering products extends beyond the scope of a single specialist engineering discipline. It is now common for even modest engineering developments to be undertaken by a multi-disciplinary project team overseen by a systems engineer. This has led to an increasing demand for systems engineers that is now outstripping the capacity of the traditional formation and competency

development pathways. In response, systems engineering undergraduate and postgraduate education programs have expanded to accelerate the formation and development of these highly sought after engineers.

The challenge for academic institutions is to provide an educational experience that achieves the same standard of formation and competency development as the traditional experiential approach but in far less time. This *Special Issue on Systems Engineering Education* captures a snapshot of two related areas, the first on systems engineering education programs and the other on systems engineering research.

The systems engineering education program section consists of four papers that cover a range of educational program levels from pre-college through Masters to PhD. Also covered are systems engineering competencies and their impact on systems engineering curriculum design and pedagogy:

- The first paper by Jain et al. reports on an innovative curriculum design and pedagogy for a systems engineering education program at the pre-college level in the USA. The program aims at increasing the interest of young people in pursuing engineering and science as a career. The program enrolls high school students from geographically distributed schools who collaborate with each other around the world to complete a given project. Students are introduced to systems thinking, system design, teamwork, and communication.
- The second paper by Campbell and Cropley describes the development of a Masters Degree in Military Systems Integration (MSI) to address the shortage in Systems Engineering expertise in Australia. Systems integration expertise has been highly sought due to the increasing desire to employ non-developmental items in defence acquisition and upgrade programs. The MSI program aims to accelerate the formation of systems engineering competencies among journeyman engineers from industry to enable them to fulfill systems integration roles.
- The third paper by Ferris reports a new systems engineering professional doctorate program. Unlike a traditional European PhD that emphasises research training, the professional doctorate program provides an opportunity for the candidate to achieve a PhD-level qualification through advanced coursework followed by research into the innovative practice of systems engineering in an engineering environment that would most often be the candidate's place of employment.
- The fourth paper by Squires and Larson describes an innovative, competency-based approach to systems engineering curriculum design. The papers show how the approach can be used to identify gaps in existing US-centric systems engineering courses and how to design new courses.

The systems engineering research section comprises three papers that analyses the characteristics of systems engineers and systems thinkers in the UK, report on a research and development program named *Microcosm Sandpit* for Systems Engineering research and education, and introduce a methodology for addressing research and development that involves or depends on the procurement of COTS and MOTS:

- The fifth paper by Gill outlines a research project that identifies the need for developing good 'systems people' in the UK, particularly in the Defence Science and Technology Laboratory (DSTL). The paper covers a seven years insight into the

effort that DSTL has taken to identify and train 'systems people' within the organisation through an Accelerated Systems Skills Programme (ASSP).

- The sixth paper by Collignon et al. is concerned with how to assist in the systems engineering of prototype software-intensive systems to be produced in research and development environments. In such environments, there is little knowledge or, indeed, appreciation of industrial systems and software engineering practices and most systems will be created through the integration of pre-existing commercial off-the-shelf components. This paper explains how an appropriate development methodology can be chosen and how its use can be supported through computer-aided tools.
- The final paper by Do et al. introduces an innovative research program, the *Microcosm Sandpit*, being undertaken at the University of South Australia. The paper describes the ambitious purpose of the *Sandpit* and the roles it is intended to perform and the resulting facility at the end of its first build stage. The paper concludes by describing how the *Sandpit* will be employed in later phases to investigate the potential of model-based systems engineering for systems integration projects.

The Guest Editors would like to express their greatest appreciation to the authors for their contributions to this *Special Issue on Systems Engineering Education*, to the referees for their valuable, insightful reviews and suggestions that have improved the quality of the selected papers, and to the Editor-in-Chief Professor Lakhmi Jain for his great support.