Welcome to the 1st Annual IEEE International Symposium on Systems Engineering

A Message from the Chair

On behalf of the IEEE Systems Council and my co-chair, Dr. Paolo Carbone, I would like to extend a cordial and gracious welcome to all attendees to our new IEEE International Symposium on Systems Engineering here in this ancient and amazing city of Rome, Italy. This is the first edition of this Symposium, which we initiated after the success of our North American International Systems Conference just entering its 10th year, in order to provide our European and Asian friends and colleagues the benefits of the technical exchanges relative to systems engineering of complex systems that we have enjoyed over the past decade.

The key here is complex systems and the systems engineering and integration that is vitally needed to ensure their success, and as our modern world is becoming increasingly complex and highly dependent on technology, so must our systems thinking and systems engineering approaches become more competent and more sophisticated to enable us to conceive, design and build the complex systems for the modern world. And such systems are not just physical in nature as our banking and financial systems, our communications and information systems, our entertainment systems, our data processing and storage systems, are all becoming more and more complex by the moment. In the physical realm we have our transportation systems, our urban and sub-urban infrastructure systems, our military and defense systems, our commercial systems, our power and energy generation and distribution systems, and much more – all requiring heavy influences of systems thinking and systems engineering in order to be successful.

This symposium is intended to allow authors and participants alike to share their latest and groundbreaking experiences in the design, development and construct of complex systems along with the systems engineering philosophies and methodologies that enabled their accomplishments. We have a full two days of technical presentations and discussions in four separate tracks to allow for the maximum exchange of technical information and interactions among our guests and attendees.

We also hope you enjoy our Keynote Address, provided by the eminent Professor Pasquale Arpaia, of the TE Division of CERN, the Conseil Européen pour la Recherche Nucléaire (European Council for Nuclear Research) who will provide some insight into this amazing complex on the Franco-Swiss order near Geneva that has been around for 60 years – almost predating the modern concept of systems engineering but most definitely the result of the application of brilliant systems engineering. Amazing discoveries have recently been revealed as a result of the Large Hadron Collider, in operation at CERN since 2008, including proof of the theoretical Higgs Boson.

Our 2nd IEEE International Systems Engineering Symposium is currently being planned for fall 2016 in the beautiful and historic city of Edinburgh, Scotland; details will be forthcoming. And please enjoy the hospitality of this beautiful Marriott Hotel and do take advantage of the fact that the ancient and modern city of Rome is only a few short kilometers away. If there is anything that we may do for you, please contact one of your Chairs and we will be happy to try to accommodate your needs.

Bob Rassa, IEEE Fellow
Director, Engineering Programs, Raytheon SAS, USA
President, IEEE Systems Council

Prof. Paolo Carbone
University of Perugia
President-elect, IEEE Systems Council

2015 Symposium Committee

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Paolo Carbone, University of Perugia, Italy

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Jeffrey Smith, United States Army Research Laboratory, USA
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Ottorino Veneri, CNR - National Research Council of Italy - Istituto Motori, Italy
Ski (David) Wisniewski, Raytheon, USA
Sabeha Zedek, LAAS-CNRS, France
Jin Zhu, Florida International University, USA

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Tutorials - Monday, September 28

Software Engineering for Systems Engineers
Time: 08:00 - 15:00
Instructors:
Dick Fairley, Software and Systems Engineering Associates (S2EA) & IEEE Computer Society
Massood Towhidnejad, Embry-Riddle Aeronautical University

Abstract: Involvement of software engineers in projects and programs that involve development and modification of hardware, software, and manual operations is increasing as systems that depend on software become ever larger, more complex, and include more diverse kinds of components. It is well known that the majority of functionality and behavior of modern systems is provided by software, whether in health care, telecommunications, transportation, aeronautics, manufacturing, or military systems. This tutorial/workshop will cover some key areas that create problems when system engineers, software engineers, and other engineers work together on systems projects. Topics to be covered include: differences between physical artifacts and software: physical products versus logical products - and the consequences; differences in use of terminology for terms such as "performance," "verification," and "validation"; differences in approaches to component integration - discrete versus continuous; differences in approaches to problem solving - functional decomposition and quantified metrics versus associative decomposition and qualitative metrics; difference in processes - linear waterfall versus iterative agile; and differences personality traits - broad scope versus narrow scope; and differences between extroverts versus introverts. Techniques and strategies will be discussed on how systems engineers, software engineers, and other engineers can better understand their difference and integrate their work activities. Ample time will be allotted for discussions and interchanges of viewpoints.

Cyber Security for Systems Engineers
Time: 15:00 - 19:00
Instructor: Robert Swarz, Worcester Polytechnic Institute

Abstract: This tutorial will describe the basic techniques and technologies that can be used by systems engineers to assure the confidentiality, integrity, and authenticity of information exchanged across networks. After an overview of basic information security concepts, we will motivate the need for cyber security by outlining the threats impacting government, infrastructure, and industry and by describing case studies of some actual cyber attacks. Selected concepts will be expanded upon, such as TCP/IP-based network security principles, encryption, public key infrastructure, and authentication protocols, an overview of the legal, policy, and regulatory environment will be presented. We will conclude with a summary of common controls, as well as a discussion of principal sources of up-to-date information and guidance on cyber security threats.

Keynote Speaker

Tuesday, September 29
08:30 - 09:30

Instrumentation and measurements for systems engineering in the innovation of the largest machine ever built by the mankind: The Large Hadron Collider at CERN

Pasquale Arpaia
University of Naples Frederico II
CERN
Innovum Biomedical srl

Realizing, tuning, and innovating the Large Hadron Collider (LHC) at CERN, the largest machine ever built by the mankind, fostered a powerful challenge in advanced large-scale systems and systems-of-systems applications. A key aspect has been the measurement of several physical quantities in unexplored ranges, but above all, by unprecedented precision.

In this talk, some of most interesting results of this technological research effort, as well as its further most recent developments, are highlighted by paying specific attention to the engineering of complex systems. In particular, after a short survey on the Higgs boson hunting, the presentation highlights the ideas for the next-generation of gigantic accelerators under study at CERN, starting from the new experimental technologies for LHC upgrade, up to the new collider with a diameter of 100 km. Finally, the state of the art of CERN research on instrumentation and measurement that is mainly promoting these new developments of systems engineering is illustrated, by focusing on applications for magnets, power converters, high-temperature superconductors, and cryogenics plants.

Pasquale Arpaia took MD and PhD in Electrical Engineering at University of Napoli Federico II (Italy), where now is professor of Instrumentation and Measurements. He is also Team Leader at European Organization for Nuclear Research (CERN). He was also scientific associate at Engine Institute and Biomedical Engineering Institute of Italian Council of National Research.

He is Associate Editor of the Elsevier Journal Computer Standards & Interfaces, and in the past also of IEEE Transactions on Electronics Packaging and Manufacturing. He acted as scientific evaluator in several international research call panels. He has served as organizing and scientific committee member in IEEE and IMEKO Conferences. He was invited and keynote speaker to several international conferences. In the last years, he was scientific responsible of more than 30 awarded research projects in cooperation with industry and CERN, with related patents and licenses, and funded 4 academic spin-off companies.

His main research interests include high-precision digital instrumentation and transducers for measurements in particle accelerators, evolutionary diagnostics, distributed measurement systems, ADC modeling and testing. In these fields, he published 2 books, several book chapters, and more than 210 scientific papers in international journals and conference proceedings. His PhD students were awarded in 2006 and 2010 at IEEE I2MTC, and in 2012 at IMEKO World Conferences.

Panels

Title: *The Systems Engineering Body of Knowledge*
Time: Tuesday, September 29, 13:00 - 14:45
Room: Bramante 11

Panelists:
Dr. Dick Fairley, Systems Engineering Associates (S2EA) & IEEE Computer Society, US (Panel Chair)
Senior lecturer Rick Adcock, Cranfield University, UK, SEBoK Editor-in-Chief
Dr. Emma Sparks, Cranfield University, UK, SEBoK Editor Part 5

Abstract:
Systems Engineering is a young discipline in the history of engineering, and it is still in the process of establishing its knowledge area when compared to many other engineering disciplines. Establishing the knowledge not only involves gathering the knowledge of the discipline, both also the establishment of methods for capturing, processing and disseminating the knowledge. A body of knowledge is all about capturing and presenting knowledge such that is can be made easily available and shared. The Systems Engineering Body of Knowledge (SEBoK; www.sebokwiki.org) is a relatively new endeavour to create a guide to the breadth and depth of Systems Engineering related knowledge. Published in 2012 in a Wiki format, the SEBoK is currently being actively reviewed and updated by the professional societies with an interest in the discipline of SE. This includes both INCOSE and the IEEE. This session will provide a brief overview of the Systems Engineering Body of Knowledge and via a panel debate cover the following topic questions:

- What is the current state of the SEBoK and what is its role in larger context of Systems Engineering?
- How do you see the relationship between the SEBoK and the INCOSE Systems Engineering handbook and the ISO/IEEE Standard 15288. Are they complementary, cohesive, or conflicting?
- What is the future of the SEBoK and what are the imminent aspects to focus on?

Title: *Systems Engineering and Software Engineering*
Time: Wednesday, September 30, 13:45 - 15:30
Room: Bramante 11

Panelists:
Dr. Dick Fairley, Systems Engineering Associates (S2EA) & IEEE Computer Society, US (Panel Chair)
Massood Towhidnejad, PhD
Mary Jane Willshire, PhD

Abstract:
Systems engineers increasingly interact with software engineers as systems project and programs become ever larger, more complex, and more dependent on software. Issues of concern about collaboration are addressed in the systems engineering body of knowledge (sebokwiki.org), the graduate reference curriculum for systems engineering (GRCSE: bkcase.org), the software engineering competency model (SWECOM: http://www.computer.org/web/peb/swecom), ISO/IEC/IEEE Standard 15288 (systems engineering) and ISO/IEC/IEEE Standard 12207 (software engineering), and other relevant standards and guidelines. This panel session will focus on the role of software engineering in systems engineering as presented in the cited standards and guidelines, and in practice. Strategies and techniques will be discussed on how systems engineers and software engineers can better integrate their work activities.

Special Sessions

Title: *Research at INCOSE Italy*
Time: Wednesday, September 30 11:00 - 12:45
Room: Bramante 14

The main objective of the special session is to collect the research contributions of the academic members affiliated with the Italian Chapter of INCOSE (International Council on Systems Engineering), so as to give a picture of what is going on in Italy in the systems engineering research field.

INCOSE is an international not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems.

The INCOSE Italy Chapter groups most of the researchers and industry practitioners who carry out research and development activities in the systems engineering field.
The Chapter has organized the First INCOSE Italia Conference on Systems Engineering (CIISE 2014), which has been held at the University of Roma "Tor Vergata" on November 24-25, 2014.

The Chapter has also been strongly involved in the setup and the organization of the postgraduate Master Degree in Systems Engineering, established at the University of Roma "Tor Vergata" since 2012, as well as in the organization of similar ongoing efforts.

The proposed special session aims to collect significant research contributions that have been given to the systems engineering field in various research domains, from ICT-based engineering to mechanical and aerospace engineering, thus providing an opportunity of exchanging and discussing relevant experiences.

Organizers:
Eugenio Brusa, Politecnico di Torino, Torino, Italy
Andrea D'Ambrogio, Università degli Studi di Roma "Tor Vergata", Roma, Italy
Alfredo Garro, Università della Calabria, Rende (CS), Italy
Carlo Poloni, Università di Trieste, Trieste, Italy

Title: *Instrumentation systems under harsh environments*
Time: Tuesday, September 29 15:15 - 17:00
Room: Bramante 14

Environmental monitoring based on distributed sensors are widely used in high risk applications such as nuclear sites, aerospace vehicles or underwater installations. The proposed session seeks submission of recent research progress in sensor instrumentation and acquisition electronics for systems and environmental monitoring under harsh environment. With the increasing systems complexity, the need for monitoring of physical parameters has never been greater in aerospace, nuclear and defence industries driving research towards new challenges. Requiring versatility, modularity and powerful processing capabilities, new instrumentation systems are leading the change to older more rigid architectures.

Furthermore, it is increasingly difficult to satisfy the ever more stringent legal requirements that are imposed in terms of radiation monitoring for example in nuclear fields or in terms of reliability insurance in aerospace domain. Therefore, beside the technical capabilities, it is more and more necessary to fulfill performance of auto tests, remote diagnostics, reliability, safety, maintainability and risk assessment.

Organizer:
Dr. Hamza Boukabache
hamza.boukabache@cern.ch
CERN - European Organisation for Nuclear Research

Title: *Methods and Tools for Mechatronic Systems Engineering*
Time: Part I: Tuesday, September 29, 15:15 - 17:00
Room: Bramante 11

Time: Part II: Wednesday, September 30, 08:45 - 10:30
Room: Bramante 14

Designing mechatronic systems involves multidisciplinary engineering teams to deal simultaneously mechanics, electronics, automatic control and computer science. The integration of all these domains generates multi-physics couplings such as thermal effects, electromagnetic compatibility and vibrations that can affect the overall system behavior. In order to deal with this huge diversity and preserve consistency and efficiency, new dedicated methodologies with relevant design framework are compulsory to support mechatronic modeling and simulation tools and languages. Moreover, most of the mechatronic systems are critical systems (aircraft, automotive, medicine…) and safety considerations are often to be taken into account. Thus Model-Based System Engineering seems to be a reasonable candidate for managing mechatronic systems design, provided that some developments are undertaken and tailored for mechatronic design. This special session will mainly focus on issues about integration in MBSE of multi-physics modeling and safety assessment (MBSA) for mechatronic systems design.

Organizers:
Jean-Yves Choley, Supméca, Paris, France
Stanislao Patalano, University of Naples Federico II, Naples, Italy
Faïda Mhenni, Supméca, Paris, France
Moncef Hammadi, Supméca, Paris, France

Title: *Theoretical Foundations of System Engineering (THEFOSE)*
Time: Part I: Wednesday, September 30, 13:45 - 15:30
Room: Bramante 12

Time: Part II: Wednesday, September 30, 16:00 - 17:45
Room: Bramante 12

System engineering has experienced multiple successes over the years in various industrial projects with a strong emphasis in defense and aerospace. Recently, system engineering have gained several contributions from theory however the field still lacks a strong theoretical foundation. This request for more theoretical foundations come from both academia and industry in order to make the best of system engineering practices and experience in increasingly multidisciplinary projects. Several research topics need to be addressed such as formal definitions of system engineering terms and concepts, systems semantics, model composability, category theory and system engineering, complexity theory of multidisciplinary systems , formal analysis of system engineering processes and standards but also all theoretical computer science impacts on languages (e.g. SysML) and tools used by system engineers. This session contributors will also provide papers discussing the integration of quantitative methods into MBSE methods and processes. Examples of quantitative methods include formal methods, value driven design, petri-nets, design space optimization. This session will also deal with issue on the integration of the quantitative methods into SysML and its variants. Finally, the session will also call for papers proposing new research directions and tutorial papers in the theoretical foundations of system engineering.

Organizers:
Professor Omar Hammami, ENSTA PARISTECH, France
Dr. William Edmonson, NC A&T State University, National Institute of Aerospace, USA

PROGRAM SCHEDULE - Monday, September 28, 2015	
07:00 - 18:00	**REGISTRATION - Gallery near Bramante 10**
Room	**Bramante 15**
08:00 - 10:00	1A1 - Tutorial: Software Engineering for Systems Engineers *Instructors: Dick Fairley, Software and Systems Engineering Associates (S2EA) & IEEE Computer Society Massood Towhidnejad, Embry-Riddle Aeronautical University*
10:00 - 10:15	**COFFEE BREAK**
10:15 - 12:00	1A1 - Tutorial: Software Engineering for Systems Engineers (Continued) *Instructors: Dick Fairley, Software and Systems Engineering Associates (S2EA) & IEEE Computer Society Massood Towhidnejad, Embry-Riddle Aeronautical University*
12:00 - 13:00	**LUNCH**
13:00 - 15:00	1A1 - Tutorial: Software Engineering for Systems Engineers (Continued) *Instructors: Dick Fairley, Software and Systems Engineering Associates (S2EA) & IEEE Computer Society Massood Towhidnejad, Embry-Riddle Aeronautical University*
15:00 - 17:30	1B1 Tutorial: Cyber Security for Systems Engineers *Instructor: Robert Swarz, Worcester Polytechnic Institute*
17:30 - 18:00	**COFFEE BREAK**
18:00 - 19:00	1B1 Tutorial: Cyber Security for Systems Engineers (Continued) *Instructor: Robert Swarz, Worcester Polytechnic Institute*

PROGRAM SCHEDULE - Tuesday, September 29, 2015				
Room	**Bramante 11**	**Bramante 12**	**Bramante 14**	**Bramante 15**
07:00 - 17:00	REGISTRATION - Gallery near Bramante 10			
08:15 - 08:30	Opening Remarks			
08:30 - 09:30	**Keynote Speaker:** Pasquale Arpaia, University of Naples Frederico II; CERN; Innovum Biomedical srl			
09:30 - 10:00	COFFEE BREAK			
10:00 - 12:00	2B1 - Systems and Sensors I	2B2 - Optimization I	2B3 - Model-based Systems Engineering I	2B4 - Modeling and Simulation I
12:00 - 13:00	LUNCH			
13:00 - 14:45	2C1 - Panel 1: The Systems Engineering Body of Knowledge	2C2 - Systems and Sensors II	2C3 - Model-Based Systems Engineering II	2C4 - Modeling and Simulation II
14:45 - 15:15	COFFEE BREAK			
15:15 - 17:00	2D1 - Special Session: Methods and Tools for Mechatronic Systems Engineering I	2D2 - Optimization II	2D3 - Special Session: Instrumentation Systems Under Harsh Environments	2D4 - Systems and Sensors III
17:00 - 18:00	Welcome Reception - Bramante 10			

Room	Bramante 11	Bramante 12	Bramante 14	Bramante 15
08:00 - 18:00	REGISTRATION - Gallery near Bramante 10			
08:45 - 10:30	3A1 - Reliability and Risk Management I	3A2 - Systems and Energy	3A3 - Special Session: Methods and Tools for Mechatronic Systems Engineering II	3A4 - System Architecture I
10:30 - 11:00	COFFEE BREAK			
11:00 - 12:45	3B1 - Reliability and Risk Management II		3B3 - Special Session: Research at INCOSE Italy	3B4 - System Architecture II
12:45 - 13:30	LUNCH			
13:45 - 15:30	3C1 - PANEL 2: Systems Engineering and Software Engineering	3C2 - Special Session: Theoretical Foundations of Systems Engineering (THEFOSE) I	3C3 - Systems Engineering I	3C4 - System Architecture III
15:30 - 16:00	COFFEE BREAK			
16:00 - 17:45	3D1 - Systems Thinking and its Impacts	3D2 - Special Session: Theoretical Foundations of Systems Engineering (THEFOSE) II	3D3 - Systems Engineering II	3D4 - System Considerations

PROGRAM SCHEDULE - Wednesday, September 30, 2015