



# AFIS Doctoral Symposium: New challenges and Advances in Systems Engineering at French Universities

David Gouyon, Hervé Panetto

## ► To cite this version:

David Gouyon, Hervé Panetto. AFIS Doctoral Symposium: New challenges and Advances in Systems Engineering at French Universities. INSIGHT - International Council on Systems Engineering (IN-COSE), 2021, New challenges and Advances in Systems Engineering at French Universities, 24 (4), pp.7-8. 10.1002/inst.12352 . hal-03507169

**HAL Id: hal-03507169**

**<https://hal.science/hal-03507169>**

Submitted on 3 Jan 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## New Challenges and Advances in Systems Engineering at French Universities

David Gouyon ([david.gouyon@incose.org](mailto:david.gouyon@incose.org))

Hervé Panetto ([herve.panetto@incose.org](mailto:herve.panetto@incose.org))

This special issue of INSIGHT section is dedicated to the ninth edition of the French Systems Engineering Academia-Industry meetings, organized by AFIS (Association Française d'Ingénierie Système), the French chapter of INCOSE, and supported by French universities as a regular series, usually every two years. Due to the COVID-19 crisis, this edition was held virtually in December 2020.

These meetings, which are composed of workshops and plenary lectures, provides the opportunity for both academics and industrials to:

- debate on systems engineering practices, education and competences development for professional situations,
- develop and promote research in systems engineering.

The first article of this special section, by Julien Le Duigou, Vincent Chapurlat and Jean-Luc Garnier, is dedicated to a presentation of the events that occurred during the meetings: a pre-forum, prospective workshops, plenary sessions, a doctoral seminar, and the AFIS PhD 2020 award. The other articles of this special issue are related to research works that have been presented during the doctoral seminar, aiming to provide an overview of the French research in the domain of Systems Engineering. For this special issue of INSIGHT, doctoral students and their supervisors have been invited to submit an extended version of their presentations in order to emphasize the research aspects of Systems Engineering. Ten research papers have been selected to be included in this edition in order to promote research on systems engineering approaches.

The first research paper, by Concetta Semeraro, Mario Lezoche, Hervé Panetto and Michele Dassisti is entitled *Modelling Cyber-Physical Systems using Data-driven Patterns*. In the context of the modelling of smart factories, which are characterized as large-scale distributed cyber-physical systems, the authors propose to define an approach using formal concept analysis to formalize data-driven patterns. The objective is to identify automatically, in the masses of data, invariant behaviours that can be modelled for the emulation of these cyber-physical systems and thus contribute to the digital transformation of industrial production companies.

The Cyber-Physical Systems are also the subject of the paper entitled *A semantic model framework for cyber-physical production system in system engineering perspective*, by Puviyarasu.SA and Catherine da Cunha. The authors identified the need for a generic semantic model framework to provide a unified description of all aspects and properties of the CPPS. The paper gives an overview and expected outcomes of such a semantic model framework.

In the third research paper, entitled *Using synthesis and analysis for design in systems engineering. An integrated approach*, by Sephora Diampovesa, Pierre-Alain Yvars and Arnaud Hubert, presents a general approach that relies on synthesis for the preliminary design of systems and on analysis for simulation. It can deal in particular with mixed type design problems and includes non-functional requirements like eco-design in a single process.

Synthesis models are constructed and solved using constraint programming and object-oriented modeling with the DEPS problem modeling language and the DEPS Studio environment. Dynamic behavior of the solutions found with DEPS Studio can be evaluated with Modelica and OpenModelica.

Yann Argotti, Claude Baron and Philippe Esteban propose a paper entitled *Qualimetry Essentials Applied to Embedded Software Development*. Within the initial objective to fill the gaps in quality definition, assessment, control, and prediction of embedded software in the automotive domain, including compliance constraints to standards and regulation, the authors conducted a three years research study. The numerous contributions to both theoretical and applied qualimetry defined a theoretical framework for quality control and monitoring of engineering and product development processes. This study was applied to embedded software and made these contributions have impact on all industrial sectors.

The Harmonica framework is introduced by Nicolas Six, Nicolas Herbaut and Camille Salinesi in the paper entitled *Harmonica: a framework for semi-automated design and implementation of blockchain applications*. Despite the growing interest in blockchain technology from academia and industry, there are still major obstacles for blockchain mass adoption, as it is difficult to integrate the technology into existing or new architectures and systems. Blockchain differs from conventional technologies through its unique characteristics, such as decentralization, immutability, or resilience. Thus, software architects may struggle with the complexity of selecting an adequate blockchain or designing blockchain-based software. The paper proposes an end-to-end framework for the design and implementation of blockchain applications.

Nuclear power plants are complex critical systems, and are the industrial context of various papers of this special issue of INSIGHT. The first of them, by Bourdon Jérémy, Couturier Pierre, Chapurlat Vincent, Plana Robert, Richet Victor and Baudouin Benjamin, is entitled *Towards a method to operationalize modelling, verification and evaluation of architectural solutions in the field of Nuclear Critical Infrastructure Engineering*. It proposes to evaluate architecture alternatives using the EVA-CIME method, which is composed of five sets of elements: concepts, languages, operational approach, tools and repository of knowledge and expertise.

The nuclear safety is the main issue addressed in the paper entitled *Contribution to Nuclear Safety Demonstration through System Modelling and Artificial Intelligence*, by Emir Roumili, Jean-François Bossu, Vincent Chapurlat, Nicolas Daclin, Jérôme Tixierand and Robert Plana. It presents a methodology that mixes and takes advantages of Artificial Intelligence techniques and Model-Based Systems Engineering. The aim is to guide and support engineers to improve their vision, their knowledge and vocabulary, and their capacities in terms of safety requirements elicitation and demonstration.

The commissioning of nuclear plants is the subject of the paper entitled *Model Based Commissioning, a new methodological approach for commissioning of Nuclear Basic Facilities*, by Alan Gaignebet, Vincent Chapurlat, Grégory Zacharewicz, Robert Plana and Victor Richet. The authors introduce a method called COGuiNF (Commissioning Guidelines of Nuclear Facilities) which aims at allowing to prepare in relation with MBSE processes then drive relevant activities for the commissioning of Nuclear Facilities.

The use of Model-Based Systems Engineering and early Verification & Validation through simulations offers an effective way to manage the complexity of real-world industrial

development projects. In this context, Renan Leroux-Beaudout, Jean-Michel Bruel, Ileana ober and Marc Pantel, propose the paper entitled *Simulation system design methodology in Extended Enterprise Context*. The authors consider that modeling and simulation activities are often conducted in parallel, based on a common core of requirements. This can lead to a product model that does not conform to the simulation model, and vice versa, due to potential misinterpretation of requirements. To fill this gap and meet the objective of the simulation conformed to the model, they propose a new approach that considers communication between stakeholders of the Extended Enterprise and also between the simulation platforms.

The last research paper, by Nancy Prioux, Jean-Pierre Belaud and Gilles Hetreux, is entitled *Intensive data and knowledge-based approach for sustainable and circular industrial systems*. The paper focuses on the creation of a methodological framework centered on intensive data and knowledge for an economically viable and ecologically responsible design of industrial processes or systems. Composed of five steps, this approach is oriented towards offering decision support for the researcher or R&D engineer during systems requirements and high-level design steps of V-model. It is implemented within the domain of pre-treatment processes for corn stover.

We are grateful to the authors for their impressive contribution and to the reviewers for their valuable assistance to the scientific relevance of this issue of INSIGHT.

David Gouyon, Université de Lorraine, CNRS, CRAN, France  
[david.gouyon@univ-lorraine.fr](mailto:david.gouyon@univ-lorraine.fr) ; [david.gouyon@incose.org](mailto:david.gouyon@incose.org)

Hervé Panetto, Université de Lorraine, CNRS, CRAN, France  
[hervé.panetto@univ-lorraine.fr](mailto:hervé.panetto@univ-lorraine.fr) ; [hervé.panetto@incose.org](mailto:hervé.panetto@incose.org)

### The Editors

**Dr. David Gouyon** is an associate professor in Systems Engineering at the University of Lorraine, where he oversees work-linked training within a master's degree on Complex Systems Engineering. He is within the Nancy Research Centre for Automatic Control (CRAN), and his research interests are Systems and Automation Engineering, mainly with models (MBSE). He is a member of the French chapter of the International Council of Systems Engineering, and Associated Systems Engineering Professional.

**Dr. Hervé PANETTO** is a Professor of Enterprise Information Systems at University of Lorraine, TELECOM Nancy. He teaches Information Systems modelling and development, and conducts research at CRAN (Research Centre for Automatic Control), Joint Research Unit with CNRS where he is managing a research project on the use of ontology for formalising models related to the interoperability of production systems, and mainly their enterprise information systems. He has been elected member of the Academia Europaea in 2018.

He received his PhD in production engineering in 1991. He has strong experience in information systems modelling, semantics modelling and discovery, and database development. His research field is based on information systems modelling for enterprise applications and processes interoperability, with applications in enterprise modelling, manufacturing processes modelling, furniture data modelling. He is working in ERP and MES integration from a Business to manufacturing perspective. He is expert at AFNOR (French National

standardisation body), CEN TC310 and ISO TC184/SC4 and SC5. He participated in many European projects including IMS FP5-IST Smart-fm project (awarded by IMS) and the FP6 INTEROP NoE (Interoperability Research for Networked Enterprises Applications and Software). He is editor or guest editor of books and special issues of international journals. He is author or co-author of more than 150 papers in the field of Automation Engineering, Enterprise Modelling and Enterprise systems integration and interoperability. He is member of INCOSE and the AFIS French Chapter on Systems Engineering. He is Chair of the IFAC Coordinating Committee 5 on “Manufacturing and Logistics Systems” since 2014. He received the IFAC France Award 2013, the INCOSE 2015 Outstanding Service Award and the IFAC 2017 Outstanding Service Award. He is co-organiser of the yearly OTM/IFAC/IFIP EI2N workshop on “Enterprise Integration, Interoperability and Networking” and General Co-chair of the OTM Federated conferences.