ECSE, Efficient and Connected Systems Engineering

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1 Introduction

As defined by the INCOSE organisation (INternational COuncil fo Systems Engineering), the "Systems Engineering" practice is a "transdisciplinary and integrative approach to enable the successful realization of engineered systems.".

"Successful" : A first lock of the deployment of Systems Engineering in companies or in projects is a lack of System Thinking, a fear of changing habits by humans, a lack of proof of RoI (Return over Investment) or a lack of adoption of MBSE (Model Based Systems Engineering). The quest of the ECSE project is to define a more Efficient approach for Systems Engineering and Architecting to bring enough proofs of the added value of the approach to companies and projects.

"Transdisciplinary and integrative" : A second lock of the deployment of Systems Engineering is the silo work : each disciplinary is working alone with poor or asynchronous interactions with other practices. The quest of the ECSE project is to define a Connected approach, radiating around the system definition through interconnected processes, methods and tool chains.

Launched in 2018, ECSE (for Efficient and Connected Systems Engineering) is the Research and Innovation project of the SEA (Systems Engineering and Architecture) Center of Excellence of Capgemini Engineering, in charge to define and deploy Systems Engineering practices in several industries (aeronautic, automotive, railway, energy, defence, …).

2 Organisations

The ECSE is organised with several axis of research to cover both topics about Efficiency and Interoperability.

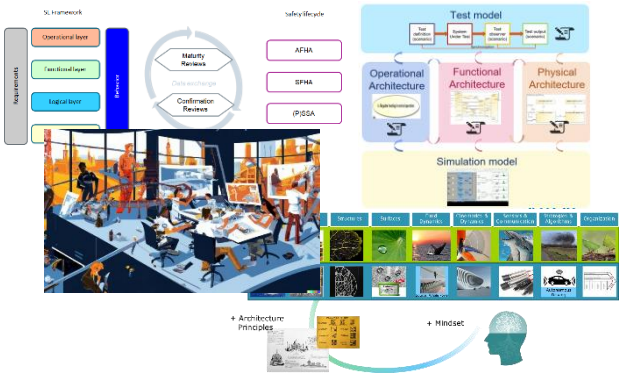
- Systems Engineering Deployment: organize a global approach for the deployment of System Engineering into various industrials contexts and projects
- Systems Engineering Architecture: share a common ontology or data model to support a common approach, methods and techniques to grasp, then formalise and share the information needed to have a common understanding of the considered system.
- Architecting Complex Systems: bridging the gap between architecting and systems engineering, and more particularly the transition between an architecture and MBSE will enhance the value of both architecting and engineering works.
- Value Driven MBSE: Model Based Systems Engineering must become a standard and classical practice to design systems and to produce all deliverables of designers and architects and improve their current deliverables value.

- Product Line Systems Engineering: manage a product line with a more efficient system engineering instead of the development of several parallel systems. The objective is also to identify relationships between internal and external variability.
- Reliable Systems Engineering: deploy a System Engineering considering the reliability including the definition of functional and dysfunctional (Safety Assessment) topics for more secure systems, considering failures during all phases of system engineering.
- Sustainable Systems Engineering: upgrade Systems Engineering Process, Methods and Tools, especially regarding Trade-Off Approaches and assets to ensure to take into consideration Value of Environment and Social Impacts for architecture decision making, in addition to current product performance criteria only.
- Artificial Intelligence for Systems Engineering: AI models capable of understanding natural language specifications and translating them into system architecture models. Combination of advanced techniques in automatic language processing, machine learning and knowledge representation.
- Digitalized Systems Engineering: Development of a frugal & efficient toolchain that supports the major Systems Engineering processes activities.

3 Results and mature assets

During the 7 years of the ECSE project and over the 9 Research and Innovation axis, about 50 topics were developed with results like innovative methodologies, reports, proof of concepts. Those results are generic and can be deployed into any kind of industries.
Several results of ECSE topics are grouped into mature and packaged assets that can be deployed into operational projects :

1. Tailoring for efficient Systems Engineering
2. Value Driven MBSE
3. MBSE Simulation
4. MBSE Dynamic Simulation
5. Product Line Engineering / Variabilty
6. EcoDesign for Value
7. Value-MBSE-LCA (Life Cycle Assessment)
8. Biomimicry
9. Architecting Lab
10. Architecture Setbased approach (Iron-Man PoC)
11. Close integration between SE and Safety
12. Model-Based Approach to support Co-Architecture



4 Partnerships and use cases

Some results of the ECSE project are applied on several use cases with the support of partnerships.

C-Pulse

5 Next steps and vision

On going and future activities will focus on new inovative topics like MBSE of the future, design frugal systems, psychological safety, innovative approaches for architecture, SE for extended enterprise, Artificial Intelligence as an enabler for SE, how to tailor SE for systems based on AI, …

Through the ECSE project, the Capgemini Engineering vision of the future of Systems Engineering and Architecting is to promote the efficiency with enablers like AI and value-oriented methods and tools. About interoperability, the vision is to promote collaborative and digital continuity between practices.