

PhD Thesis

“Coordination of complex products development: Integration of Systems Engineering approach and SCRUM method”

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Professor Merlo is professor at ESTIA Institute of technology; he has advised 8 PhD students. He has been studying Design Engineering for 20 years: coordination of design development processes, design project management, human knowledge modelling and product lifecycle management. He focuses on systems engineering and agile approaches for 5 years, by:

- developing teaching modules (50 hours for Systems Engineering and 24 hours for Agile Approaches);
- coordinating workshops on both systems design and agile approaches (Agile Pays Basque in September, each year since 2017);
- and managing design projects in partnership with companies for prototyping connected systems in robotics or health domains (connected pillbox). He presents the results of the connected pillbox in several conferences: 2nd IFAC Conference on Cyber-Physical & Human-Systems, Dec 2018, Miami, United States; 16th national Workshop of S-mart network, Karellis, France, April 2019; then 22nd Int. Conference on Engineering Design, Delft, Netherlands, august 2019.

Professor Baron is professor at INSA Toulouse; she has advised more than 20 PhD students. She has been studying the systems engineering and project management integration for many years and has very strong background for this thesis. She supervised a PhD thesis untitled “Agility as a Tool for the Management of Systems Engineering Projects” that was defended by Diego Diaz Vargas in January 2019.

Keywords

Systems Engineering, Agile management, Product development, Collaborative Design, SCRUM method

Description of the subject:

Product design greatly evolves for years, due to the increasing complexity of products, from simple monodisciplinary products to complex mechatronics products such as cyber-physical systems. Teams involved in the development of such product/systems are strongly interdisciplinary and require adequate engineering design methods to manage mechanical parts, electronics components and embedded software. Systems engineering, as defined by INCOSE, is an interdisciplinary approach that proposes a global framework for managing all development stages from customer needs to detailed design and system validation and a SYSML formalism for improving stakeholder’s collaboration. Systems engineering is often described as a very sequential approach dedicated to large products/systems. Considering software design and development, Agile approaches are very flexible approaches that

consider the customer as a main stakeholder. They propose to manage all development stages in an iterative and incremental way. The objective of the proposed subject is to study how to integrate systems engineering approach and SCRUM method in order to take both advantages of proposing a framework dedicated to complex but small products/systems, with an iterative and flexible way of working. Case studies and experiments are scheduled to support scientific work.

Previous works

Several avenues have thus been explored to improve the management of engineering projects; among them, some recent ones:

- ⇒ the alignment of processes (PhD R. Xue)
- ⇒ the formal association by engineering process models, of project management and the roles of actors involved in these processes using model-driven engineering (PhDs A. Jakjoud)
- ⇒ the using of lagging indicators and leading indicators for predicting the risks in the engineering projects (PhD L. Zheng)
- ⇒ the introduction of agility into systems engineering projects based on Scrum method (PhD D. Diaz Vargaz)

Bibliography related to this thesis

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- Q. Zhang, I. Deniau, E. Caillaud, C. Baron "Process modeling in innovative design using System Engineering", *International Council on Systems Engineering journal (INSIGHT)*, pp. 31-32, Vol. 14, n°4, décembre 2011.
- Jared G, Merlo C., Legardeur J, Pol G, "CoCa: A tool for Analysing Collaborative Practices to Improve Design Process Management", *International Journal of Manufacturing Technology Management*, Vol. 22, No.3, pp. 247-258, 2011

Prerequisite

Good level of (spoken, read and written) English. Notions of French (A2 at least).

Background required from the applicant

A background and strong interest in systems engineering and project management is expected

Having learnt product/system design methods, project management techniques

Having achieved projects, if possible, design projects

If possible, having an experience of projects or jobs made into a company

Laboratories details

ESTIA Research-UPR RSNR



The ESTIA Research laboratory groups more than 35 researchers from the ESTIA (School of Advanced Industrial Technologies) Institute of Technology. ESTIA trains multi-technological and trilingual engineers (800 students / year), as well as Bachelor of Technologies and Master's students. ESTIA and ESTIA research have developed several research

collaborations and a strong partnership with Bordeaux University recognizes the quality of the research achieved in ESTIA, e.g. by identifying ESTIA Researchers as Bordeaux University members. ESTIA Research has defined a global and long-term scientific project that can be titled as “Smart and Empowering Interfaces for Engineering”. Four axes of investigation correspond to this project: Technological and Human systems, Tangible interaction, Energetic transition, Sustainable development. The aim is to define methods and tools to analyze, design, develop and prototype technological and complex systems considering human beings as the kernel of such systems: e.g. cobots development, cyber-physical systems design and prototype, human-system integration, user-centered interfaces, connected systems, etc.

Biarritz City - Overview



ESTIA is located in Biarritz, an internationally known city on the Atlantic coast and in front of Spain. Biarritz, an elegant seaside town on the Basque coast in southwestern France, has been a popular destination since the crowned heads of all Europe



chose it as a holiday resort in the 1800s. It is also popular with surfers for its great beaches and surf schools. The ‘rock of the Virgin’, emblem of Biarritz, is a rocky outcrop surmounted by a statue of the Virgin Mary. Accessed by a footbridge, the rock offers a panoramic view of the Bay of Biscay.

LAAS-CNRS



The Laboratory of Analysis and Architecture of Systems (LAAS, <http://www.laas.fr/>) is a CNRS research unit associated with the University of Toulouse. LAAS' research activities fall within the domain of Information Sciences and Technologies and address complex systems at different scales, to devise theories, methodologies and tools for modeling, designing and controlling them. Research, innovation and transfer are tied. The lab has a history of strong relationships with industry and works in a large number of collaborative projects with international, national and regional industries of

all size. The systems considered in our research are of different kinds: integrated systems, embedded systems with real time and safety requirements, distributed systems, mobile systems, autonomous and robotics systems, micro and nano systems, biological systems. They fall in various application domains such as aeronautics and space, telecommunications, transports, production, services, security and defense, energy management, healthcare, environment and sustainable development.

Toulouse City - Overview

The capital of the Midi-Pyrenees region in southwest France, Toulouse, the 'Pink City' (thus named because of the colour of the brick many of its buildings are made of), is a city at the crossroad between tradition and modernity. Today this modern city counts almost 500,000 inhabitants and is driven by its



leading aeronautical industry and 'sky tourism' (the Cité de l'Espace <http://www.cite-espace.com/> is one of Toulouse's most popular attractions).

Toulouse has a big student population (the second in France after Paris), and this means it is a youthful, energetic city with a vibrant nightlife. Toulouse is famous for its aeronautical and space achievements, its university founded in 1229, its laboratories

and research centres.

Toulouse is also a green city to live in, with many parks, gardens and squares in which to enjoy its warm Mediterranean sunshine (over 2,000 hours a year on average). Going for a stroll along the River Garonne, or for a cycle along the Canal du Midi maybe, are great ways to spend an afternoon before tucking into some of the hearty local cuisine.

