2EL5140 – Modeling for Systems Engineering

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Department: CAMPUS DE METZ
Language of instruction: FRANCAIS
Campus: CAMPUS DE METZ
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Engineering Sciences
Advanced level : Yes

Description

Complex systems involve many heterogeneous elements (mechanical, software, economic...). Systems engineering is an interdisciplinary approach allowing us to design, verify, and develop them in a controlled way. According to INCOSE (International Council on Systems Engineering), *research shows effective use of Systems Engineering can save 10-20% of the project budget. It is not hard to know when Systems Engineering fails, because when something important goes wrong it usually makes the news fast. People get hurt, programs are delayed and over budget*: from the problems encountered by the Hubble Space Telescope, to the crashes of Boeing's 737 Max airplane, and the construction of the Channel Tunnel which came 80% over-budget. *But when Systems Engineering goes right, no-one notices- which is just how it should be.* This course focuses on modeling, on which rely systems engineering methodologies and tools.

Quarter number
SG6

Prerequisites (in terms of CS courses)

Systems Modeling (ST5 course)

Syllabus

- Introduction
  - definition(s) of a model
  - system lifecycle
  - objective and fundamentals of MBSE (Model-Based Systems Engineering)
  - introduction to SysML
- Requirements Modeling
  - stakeholder identification

use case definition

requirements diagram

Functional and Structural Modeling

basis for structural decomposition, notions of interfaces

block definition, activities and states diagrams

allocation and traceability

model animation

Decision Making

matrix-based structural complexity management

trade-off analysis

Additional topic

an industrial point of view, topic may vary (example in 2020: the Modelica language, model exchange using the FMI standard)

Class components (lecture, labs, etc.)

The structure "6 labs + 16 lectures" is administrative because the elective is actually composed of sessions that include:

- a presentation of general concepts that can be reused by students in many contexts,
- an MCQ to check that the students have understood the key points,
- a guided practice exercise based on a common example,
- an application to a project developed in small groups.

Grading

Individual continuous assessment (50%) and project final group presentation (50%, which would be made personal in case the contributions are too different from one student to the next)

Re-take exam: oral examination including a practical exercise on a computer

Course support, bibliography

Guide to the SEBoK (*https://www.sebokwiki.org/wiki/Main_Page*)

INCOSE SE Vision 25 (*https://www.incose.org/docs/default-source/aboutse/se-vision-2025.pdf?sfvrsn=b69eb4c6*$_4$)

SysML Distilled, Lenny Delligatti, Addison-Wesley, 2014 (*https://app.ute.edu.ec/content/4915-114-4-1-6-19/SysML%20Distilled_%20A%20Brief%20Guide%20-%20Lenny%20Delligatti.pdf*)

Resources

Teaching staff: Virginie Galtier, and a guest speaker

Software: students are asked to install Cameo Systems Modeler on their PC according to the instructions and license provided in the first class; occasional use of other open-source and free tools

Note: Written material is mostly in English.

Learning outcomes covered on the course

At the end of this course, students:

- will be able to imagine a system modeling approach and will be familiar with a methodology (Magic Grid),
- will know the concepts of systems modeling,
- will be able to deploy a system model based on the different SysML diagrams,
- will be familiar with an industrial modeling tool (Cameo Systems Modeler),
- will be able to exploit some behavioral modeling techniques of a system in order to predict its behavior,
- will be able to integrate specific domain models using the FMI standard

Description of the skills acquired at the end of the course

- C1: Analyze, design, and build complex systems with scientific, technological, human, and economic components
- C2: Develop in-depth skills in an engineering field and a family of professions
- C4: Have a sense of value creation for his company and his customers