

Model Based Representations for Systems Engineering

Who this class is for

Engineers who are currently working or plan to work in organizations adopting a Model-Based Systems Engineering (MBSE) approach to designing complex products and want to more effectively use the tools they have and will have access to in order to accomplish their tasks.

The International Council on Systems Engineering defines Model-Based Systems Engineering as “the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.” MBSE is replacing traditional document-based approaches that have dominated in the past as organizations aim to improve quality, accelerate schedules, and avoid technical debt in their engineering projects.

By the end of this class students will have finished a team project using SysML to describe a system design.

Prerequisites

The class is expected to be largely self-contained - we will cover the basic knowledge that is required to understand the representations that will be discussed. It will be helpful to have programmed at least at a beginner level in some programming language (e.g. JavaScript, Python, C, etc.) as the representations that are the focus of the class are similar to programming languages in many ways. To accomplish the project work, it will be helpful to have worked with version control systems such as git, though we will review the necessary basics here also.

Topics

Context: Systems Engineering Basics and Why We Model

We will review the basic elements of systems engineering to contextualize our study of Model Based Systems Engineering. Focus will be on the *what* as opposed to the *how*-will be looking for what systems engineers are trying to accomplish when they interact with large projects.

We will examine the motivations for modeling in systems engineering both from a tool vendor and tool user perspective. We will focus on these motivations from two main perspectives: what they tell us about the goals of an individual engineer working in an organization (large or small) and what they reveal about the likely constraints and affordances of the tools that engineer will have available to them.

Data Structures, Graph Theory, and Parsing in the Modeling Context

The representations we will be working with require a working grasp of these concepts. We will go over the material necessary in order to apply these areas in our context. We will not be diving into these

concepts in depth, but rather gleaning the essentials we will need order to effectively utilize our core representations in our applications.

SysML

As the main systems engineering modeling language, SysML will be the core representation for the class. We will dive into the underlying structure of this modeling representation and see how its various facilities enable the goals we identified earlier. We will be looking at the emerging version 2 standard as well as the current edition with particular attention to what new capabilities the new version promises to enable.

RDF, OWL, OSLC

SysML contains basic support for representing the structure of datatypes. In large organizational contexts, however, a need has arisen for more expressive power-especially in the context of metadata. The RDF, OWL (Semantic Web) and OSLC (Product Lifecycle Management) standards have been adapted to address this need in the context of MBSE. We will look at how these standards help connect our systems engineering models to the larger organizational information ecosystem.

AADL

There is an old saying that you don't really understand your native language until you learn a second one. The Architecture Analysis and Design Language (AADL) is an additional systems engineering focused modeling language that still is used in some important contexts. We will compare and contrast this modeling representation to SysML with an eye to what it can teach us about opportunities for improving our modeling practice.

Coursework and Grading

Coursework in the class will be project focused. Students will work in teams to create MBSE-based designs of systems using the representations taught in the class. Project outputs will be staged with deliverables due throughout the class schedule. Grades will be based on these deliverables with particular attention to the final version of the project.