

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 now and will have access to in the future 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. We will be looking how best to choose the right level of detail and attention to the varying aspects of our system to minimize modeling effort and maximize modeling impact.

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*-we 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. And

we will learn how to use this understanding to avoid resulting pitfalls – working around the gaps vendor strategy and organizational realities create for engineers as they model in real projects.

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

Getting the most out of the representations we will be working with requires a working grasp of these concepts. We will go over the material needed to apply these techniques 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 central 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 focusing on the emerging version 2 standard with particular attention to how the new version addresses existing barriers to the effective use of MBSE in industrial projects.

RDF, OWL, OSLC

SysML contains substantial 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 that spans the space between tool communities of practice. 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.

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.