Course: MBSE: Model-Based Systems Engineering

Module 1: Systems Engineering

1.1.1 Tipos de Modelo

1.1.1.1 Waterfall Model

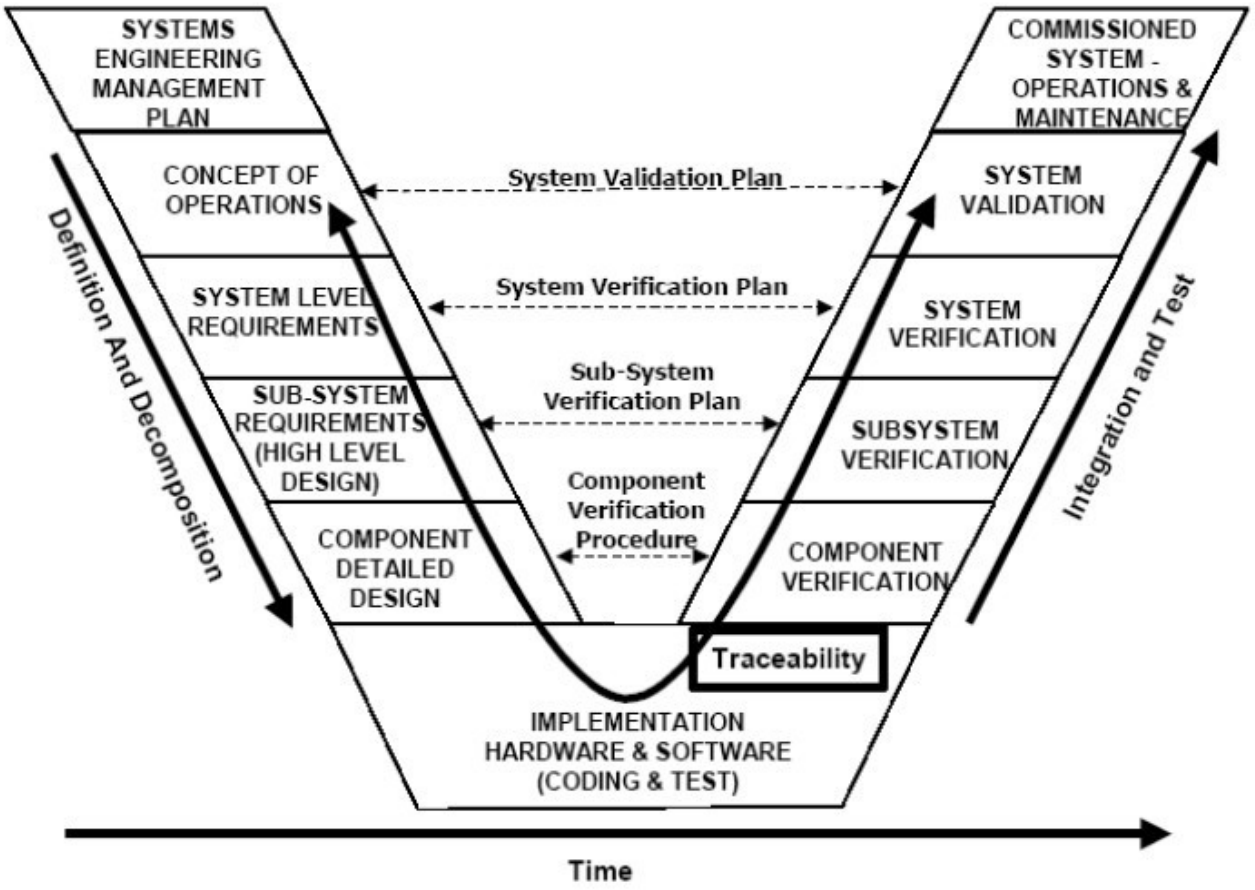
- A specified, sequential process that follows a predetermined sequence

1.1.1.2 Incremental and Iterative Methods

- Candidate designs are developed and assessed with respect to stakeholder expectations
- If acceptable, additional detail is developed
- If not, the process iterates, evolving a design that better matches stakeholder needs

1.1.1.3 Vee Model

- The design evolves over time from stakeholder requirements, to the system concept, and finally the elements of design



1.1.2 ISO/IEC/IEEE 15288 Standard

Processes:

- Agreement processes
- Organizational project enabling processes
- Technical management processes
- Technical processes

Each lifecycle process has strong relationships among its outcomes, activities and tasks.

The dependencies among the processes are reduced to the greatest feasible extent.

A process is capable of execution by a single organization in the life cycle.

1.1.2.1 Expected Outcomes of Agreement processes (*Agreement*)

Common understanding of "respective responsibilities of organization, project and technical functions"

1.1.2.2 Organizational project-enabling processes (*Resources*)

Resources needed to successfully accomplish the project goals:

- Environment in which the work is performed
- Project processes and lifecycle models in use
- Decision making about creating, modifying, or cancelling projects
- Resource availability (including human and financial) for a successful project
- Measures of project quality – from both internal and external perspectives

1.1.2.3 Technical management processes (*Planning*)

Managing the allocated resources to fulfil commitments made in agreements:

- Cost, timescale, and milestones
- Alignment of effort with plans and performance criteria
- Corrective action planning to overcome shortfalls

1.1.2.4 Technical processes (*Technical tasks*)

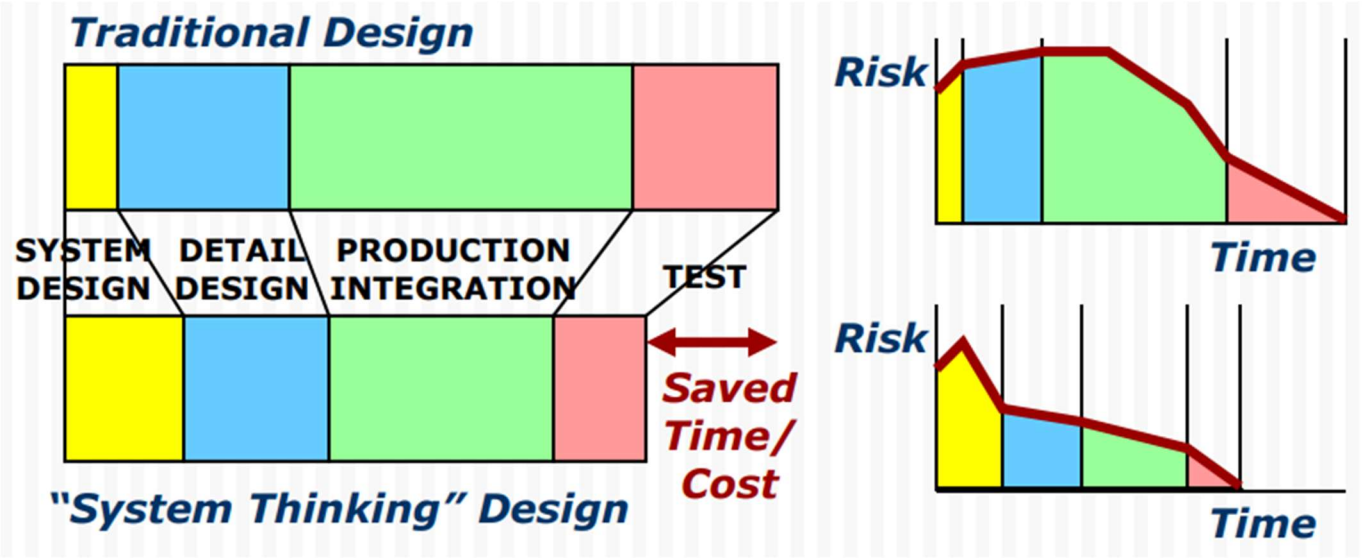
Technical tasks at any point of the lifecycle:

- Realize and apply the processes to create and use a system that meets stakeholder requirements and provides customer satisfaction

1.1.3 Business Impacts

Systems engineering return on investment is guaranteed, because it leads to better design:

- Better system quality/value
- Lower cost
- Shorter schedule



Systems engineering helps to effectively manage complexity and change:

According to an investigation carried by Haskins in 2004, the **cost of corrective actions at the Requirements stage** is:

- 3 to 8 times less than in the **Design phase**
- 21 to 78 times less than in the **Testing phase**
- 29 to 1615 times less than in the **Operation phase**

Module 2: Model-Based Systems Engineering

1.1.4 Model-Based Definition

A complete 3D Digital Product Definition created at the beginning of the product lifecycle to be used throughout the enterprise, reducing costs, improving system performance, and enabling future systems upgrades.

What makes up a model

- **Representation** (attributes that describe an object)
- **Presentation** (the way those attributes are communicated)

Verification VS Validation

Verification	Validation
Ensures you built the system right	**Ensures you built the right system**
Is the determination that each element of the system meets the requirements of a documented specification	Is the determination that the entire system meets the needs of the stakeholders Only occurs at top level of the system hierarchy
The process of determining that a computational model accurately represents the underlying mathematical model and its solution	The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model

Verification is to ensure that the model represents the desired product. While validation is to ensure that model represents accurately enough the real world in order to use it in the design of the product.

Data Singularity helps Design Teams to:

- Understand design change impact
- Communicate design rationale and intent
- Predict system performance

Reasons & Purpose of the model

- Characterize an existing system
- Formulate and evaluate mission and system concepts
- Synthesize system design and requirements flowdown
- Support system integration and verification
- Use for training
- Capture knowledge for system design evolution

Benefits of the model

- Improve reuse of system models
- Improve design team communication

Impact/Consequences of MBSE

- Improved product quality
- Reduced time and cost of system test and integration
- Overall reduction in time, cost, and risk associated with developing a system

Keep in mind that MBSE is not static. It is in a constant maturation process, with new capabilities emerging on a regular basis. And even though MBSE tools do not yet fully support model and data interchange, that capability will soon be a reality.

W2.L3

- What is SysML?
  - SysML is a graphical modelling language developed to support systems engineering (specification, analysis, design, verification, and validation of systems)
- What is the difference between physical models and abstract models?
  - Physical models are concrete versions of a system that can be seen and touched. While abstract models are conceptual representations of a system expressed in some form of modelling language.
  - Models can take many different forms. One perspective is to focus on what is being modeled. So for physical models, physical models are concrete versions of a system that can be seen and touched.
  - There's also abstract models. Abstract models are conceptual representations of a system or system element expressed in some form of modeling language
- State at least two structural modeling techniques
  - Data structure diagrams, Entity relationship diagrams and Object modelling techniques.

W2.L4

- Explain the concept of the MBSE analysis framework.
  - MBSE analysis framework provides the guiding structure to implement analysis throughout the lifecycle of the product. Besides, it helps to check for errors as well as to determine if a design meets the product development requirements.
  - In order to fulfil this purpose, it connects a variety of simulation tools in such a way that outputs of one analysis provide the input for subsequent analyses without human intervention, and it is provided with an execution engine or control mechanism to iterate the analyses until a stable solution is reached for a particular design point.
- Explain about Phoenix Integration ModelCenter.
  - Phoenix Integration ModelCenter creates and automates simulation workflows, allows the integration of models from standalone application, and runs multi-disciplinary simulation processes. In this way, the MBSE pack of ModelCenter enables integration with Doors or No Magic to connect requirements to model-based simulation results closing the loop in system design.