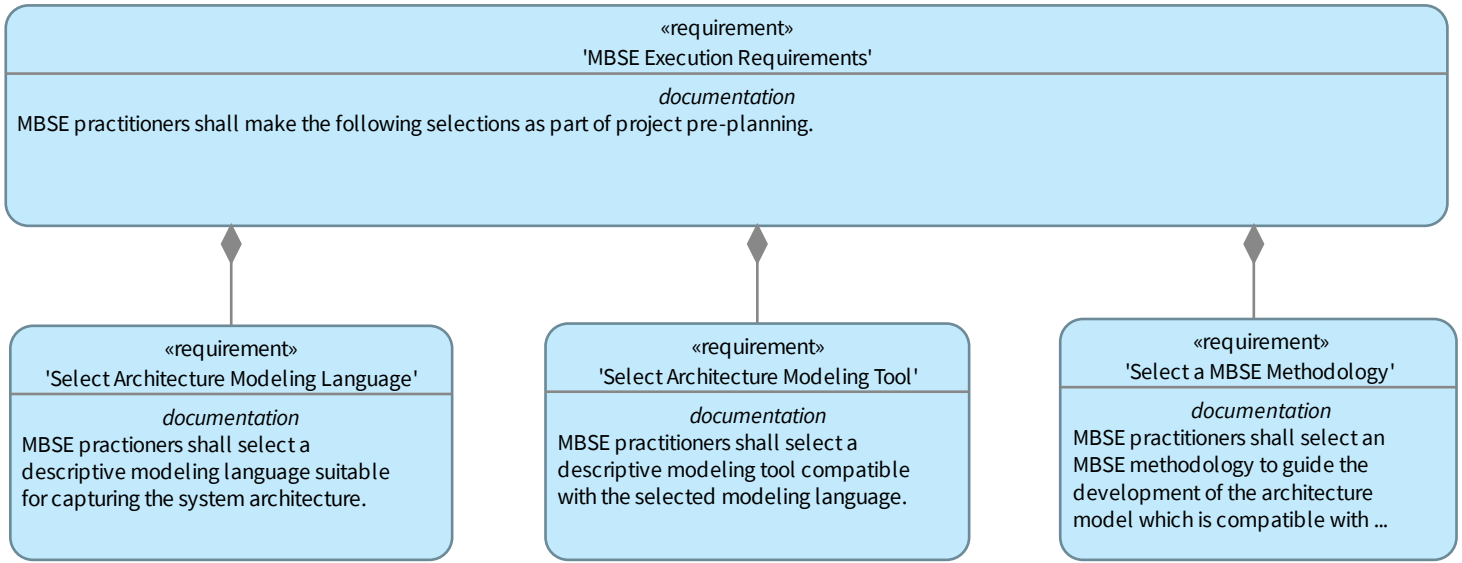
International Council on Systems Engineering
A better world through a systems approach

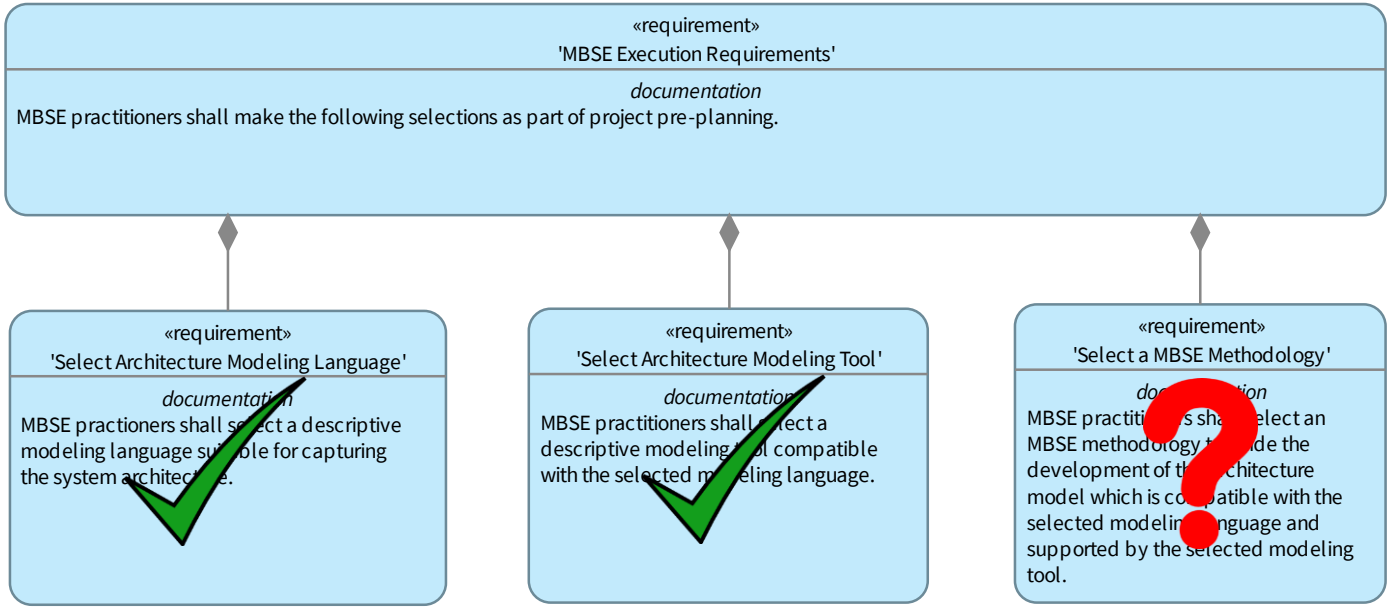
Using SysML v2 to Define a Digital Engineering Methodology

Bernard Dion, Fellow @ Ansys, part of Synopsys
J Simmons, Digital Engineering Consultant

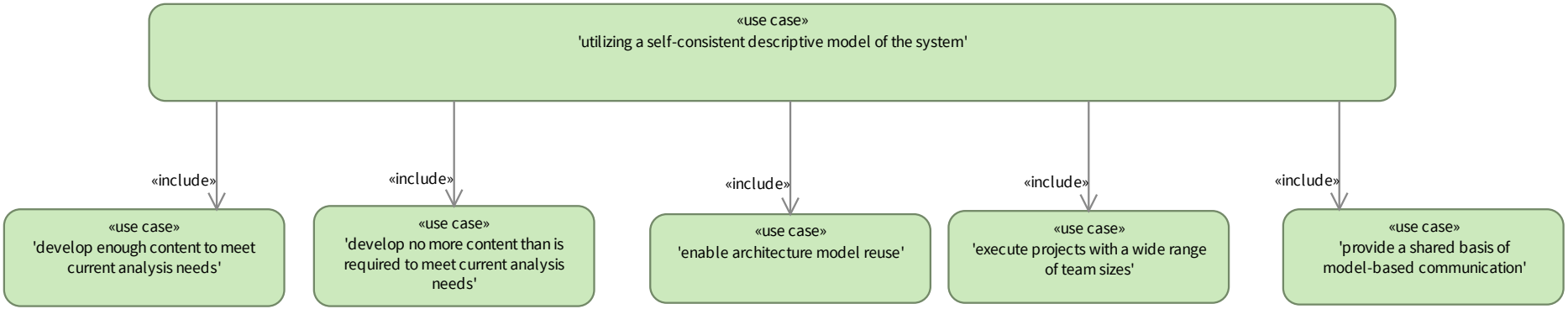
It Takes 3 Things to Execute MBSE



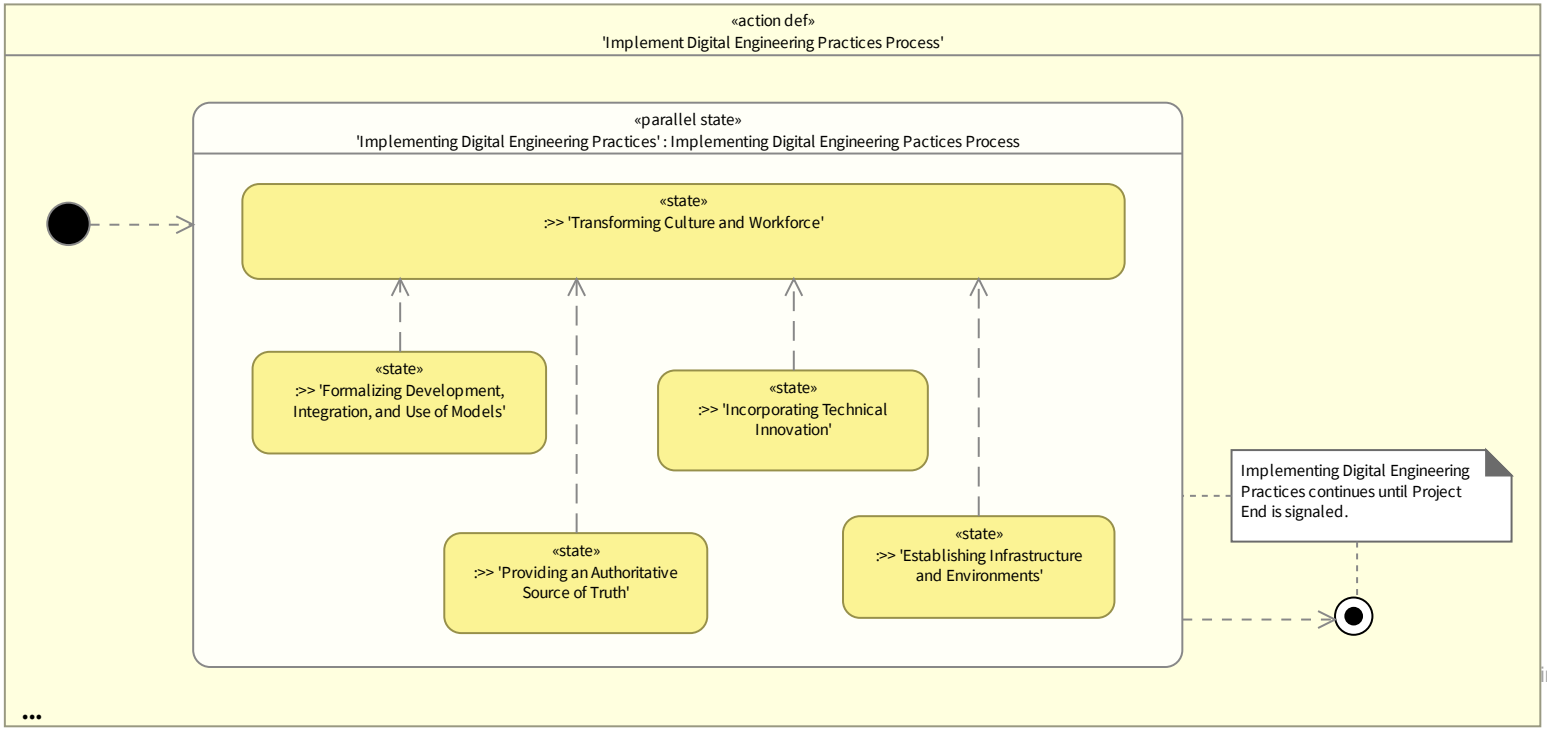
It Takes 3 Things to Execute MBSE



Formalizing the Use of the Architecture Model



The Need for a Methodology Is Even Stronger When We Zoom Out to the Level of Digital Engineering



Hello.

Bernard Dion, Ph.D.

Fellow @ Ansys, part of Synopsys

- Over 40 years of working in Safety-critical Embedded Systems
- Secretary of DO-330 Tool Qualification Subgroup (RTCA SC 205/DO-178C)
- Member of SAE G-34/EUROCAE WG-114 AI/ML in Aviation
- Supported the certification of dozens of Aircraft Systems (Airbus, Boeing, Embraer, General Electric, BAE Systems, etc.)
- Ansys Digital Engineering Methodology Co-lead

J Simmons, Ph.D.

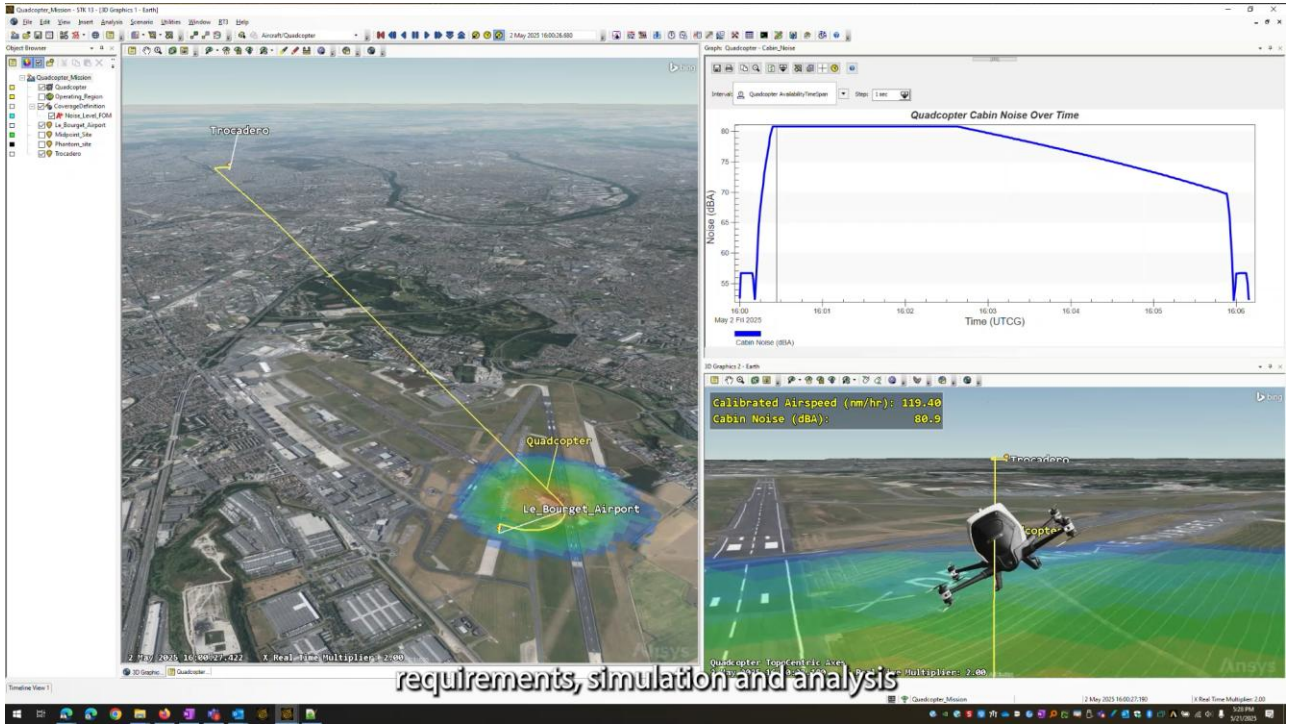
Digital Engineering Consultant

- Over 15 years in Digital/Systems Engineering
- Expert in M&S Automation for Multi-Disciplinary Analysis & Optimization
- Supported all corners of the US Aerospace Industry: US DoD, Air Force, Navy, Army, NASA, Northrop Grumman, Lockheed Martin, Boeing, etc.
- Ansys Digital Engineering Methodology Co-lead

The ‘eVTOL Air Taxi’ Use Case

John Macauley, M.Sc.

Senior Manager, Application Engineering, Ansys

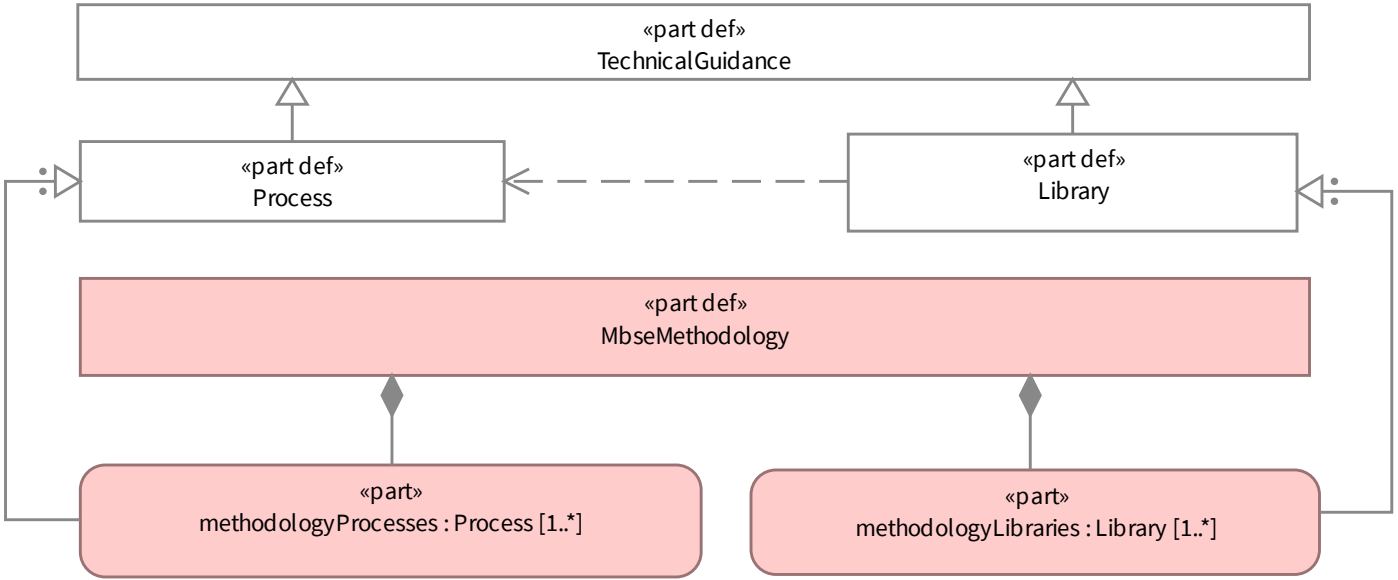


Today's Agenda

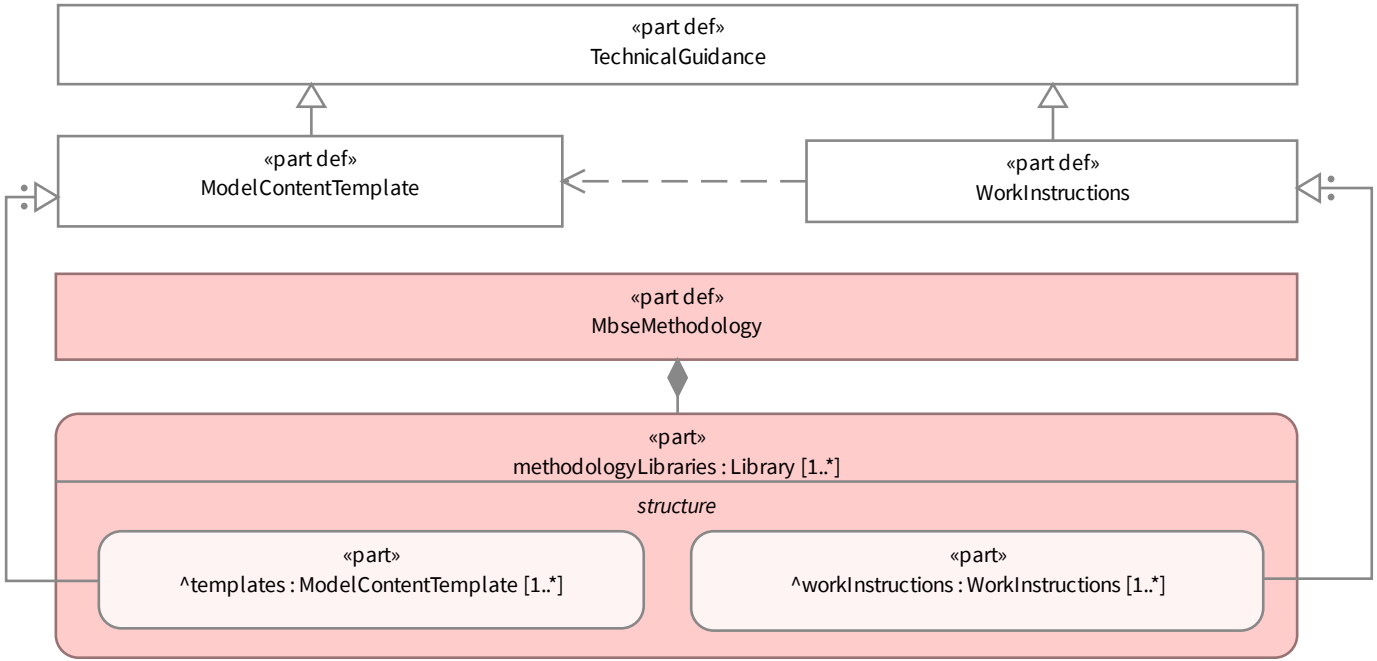
- What is a Well-Defined Methodology?
- Top-Level Requirements for Methodically Developing a Methodology
- How Does One Go About Developing a Methodology
- How We Used the Methodology to Develop the 'eVTOL Air Taxi' Example

What is a Well-Defined Methodology?

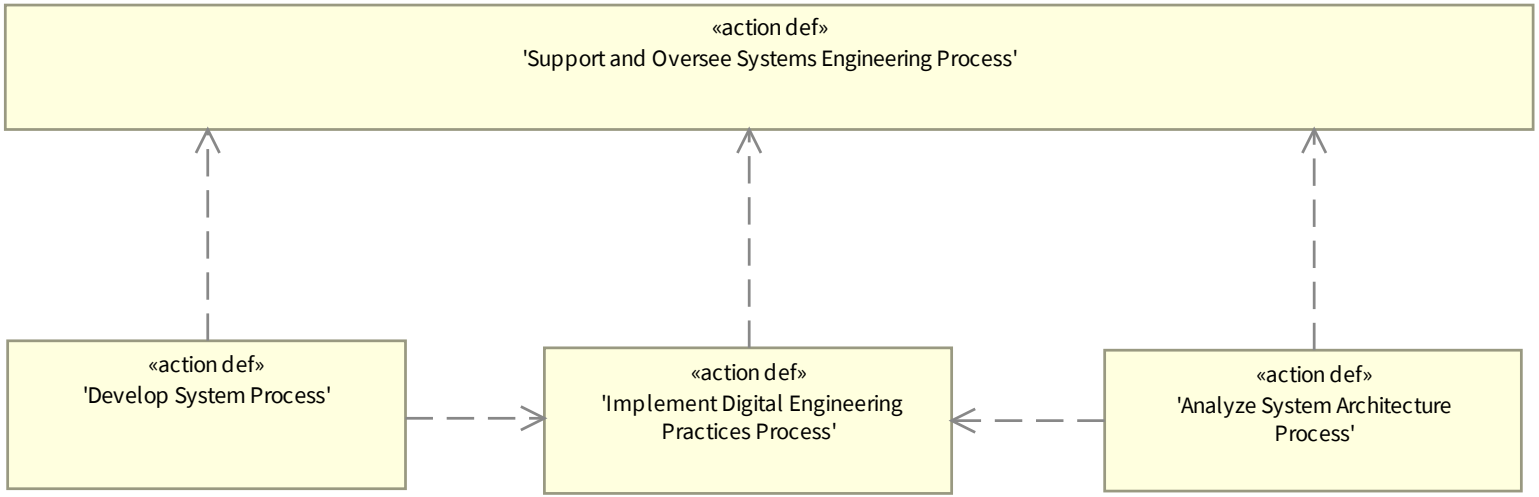
What Is a Well-Defined Methodology?



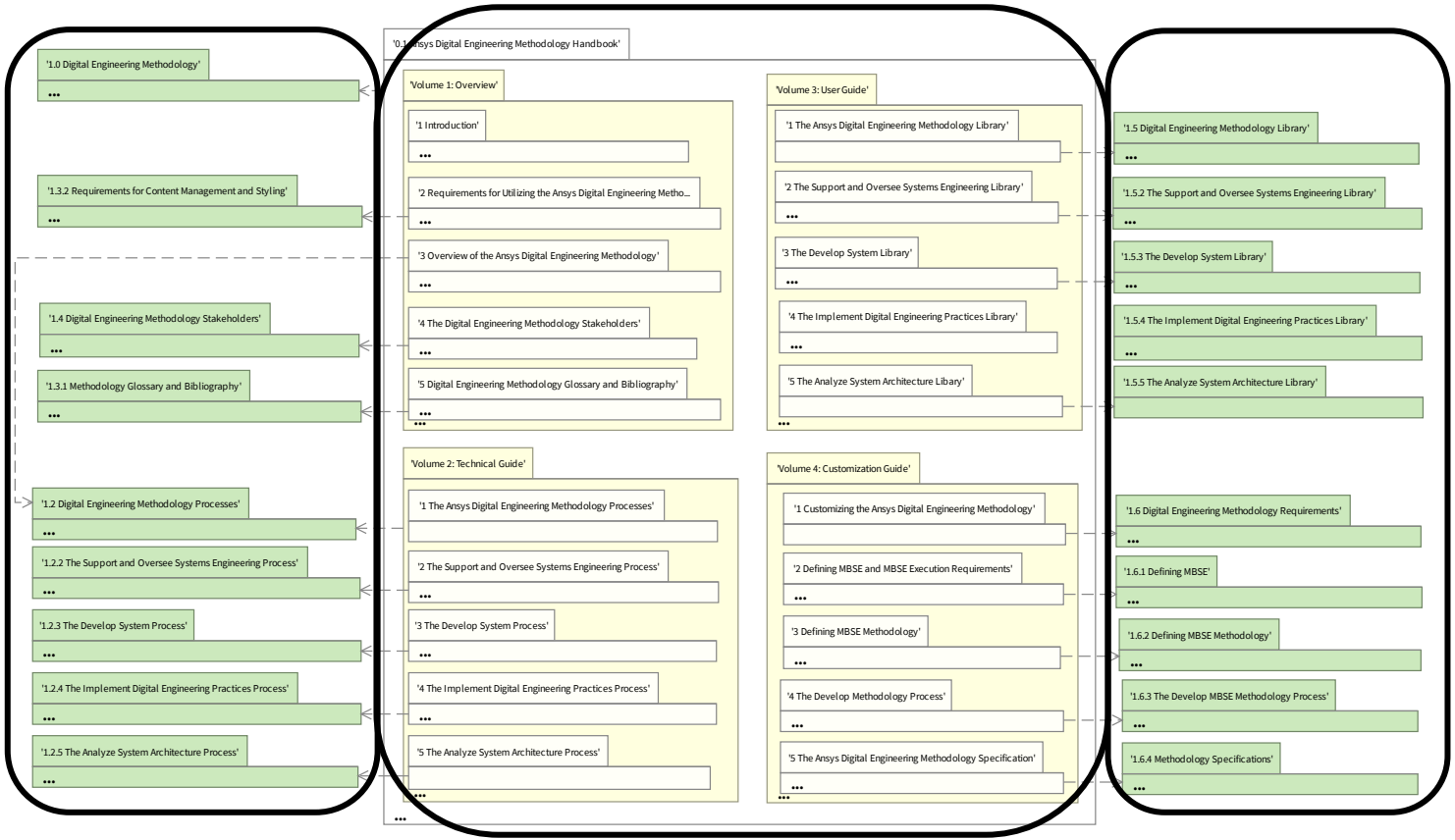
What Is a Well-Defined Methodology?



The Ansys Digital Engineering Methodology Is A Well-Defined Methodology

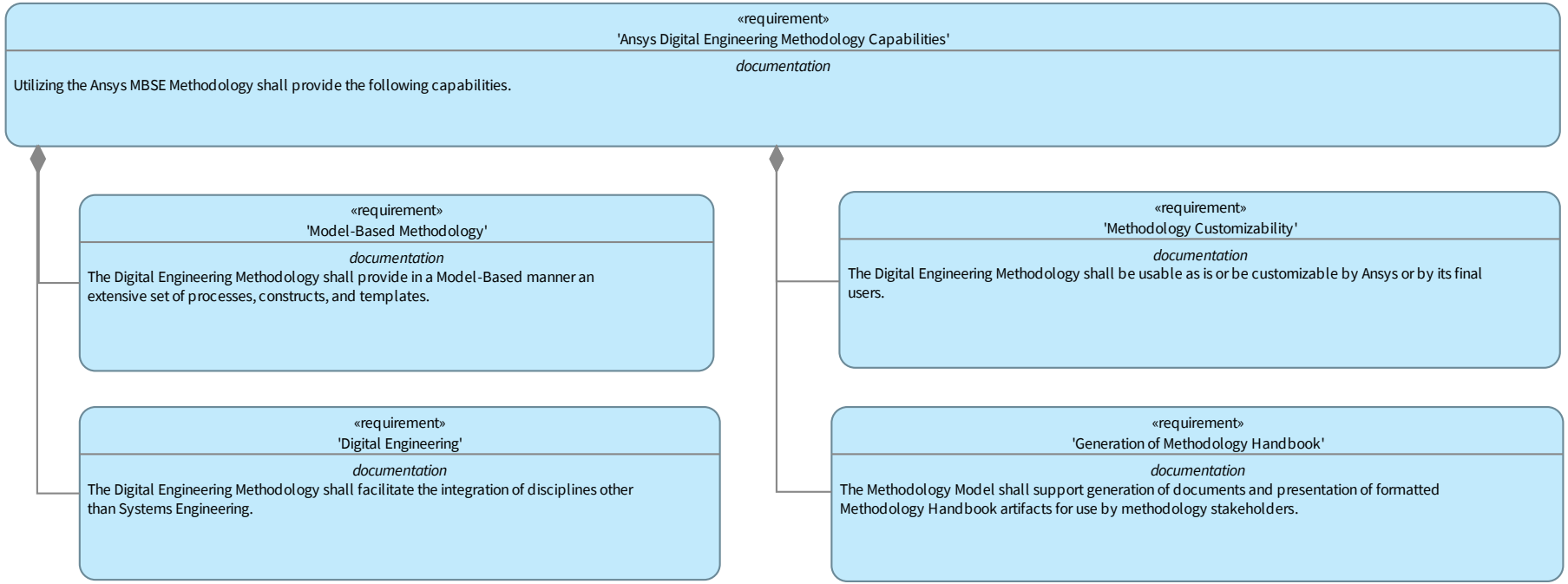


The Ansys Digital Engineering Methodology Is A Well-Defined Methodology



Top-Level Requirements for the Methodically Develop a Methodology Use case

Top-Level Requirements: Meeting Stakeholders Needs

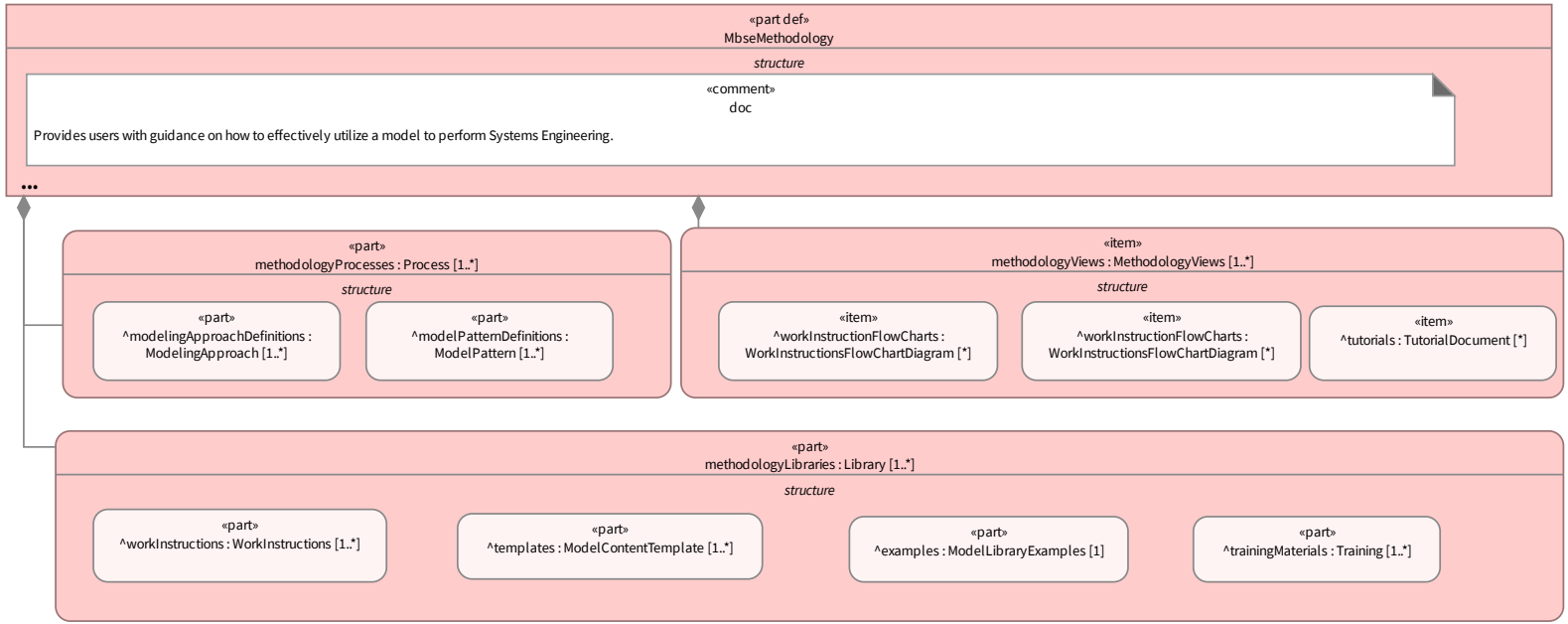


Model-Based Methodology

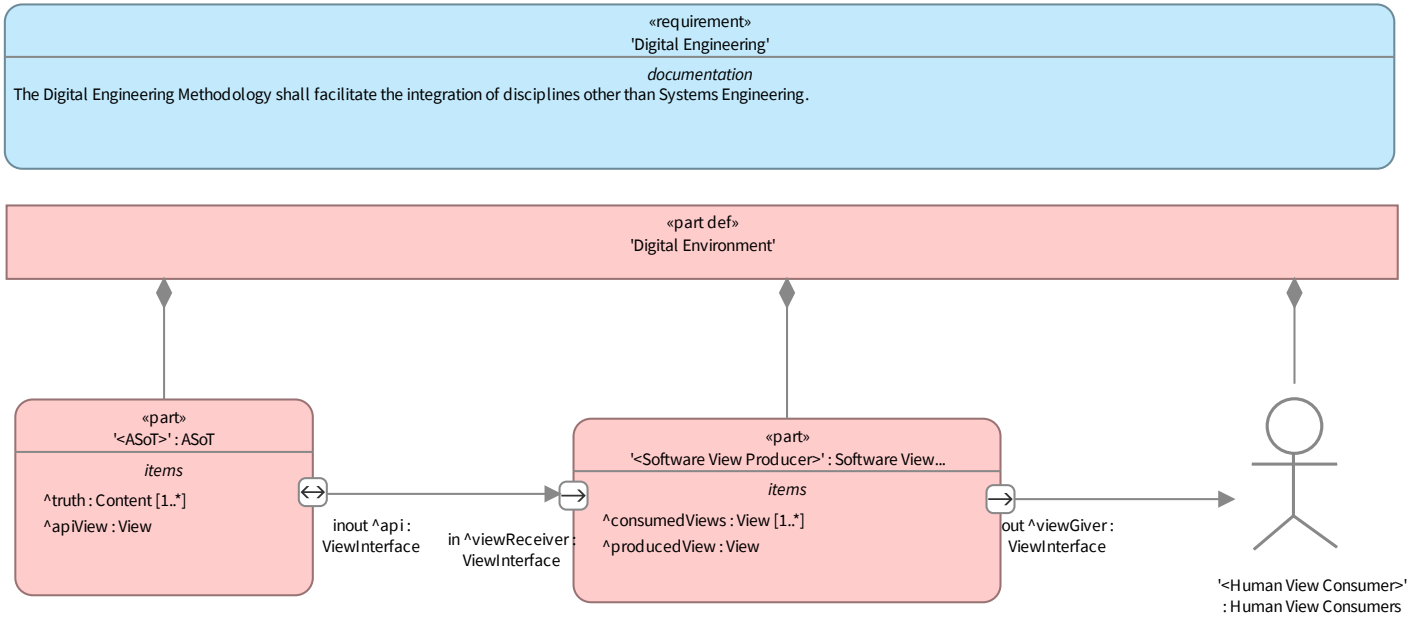
«requirement»
'Model-Based Methodology'

documentation

The Digital Engineering Methodology shall provide in a Model-Based manner an extensive set of processes, constructs, and templates.



Digital Engineering

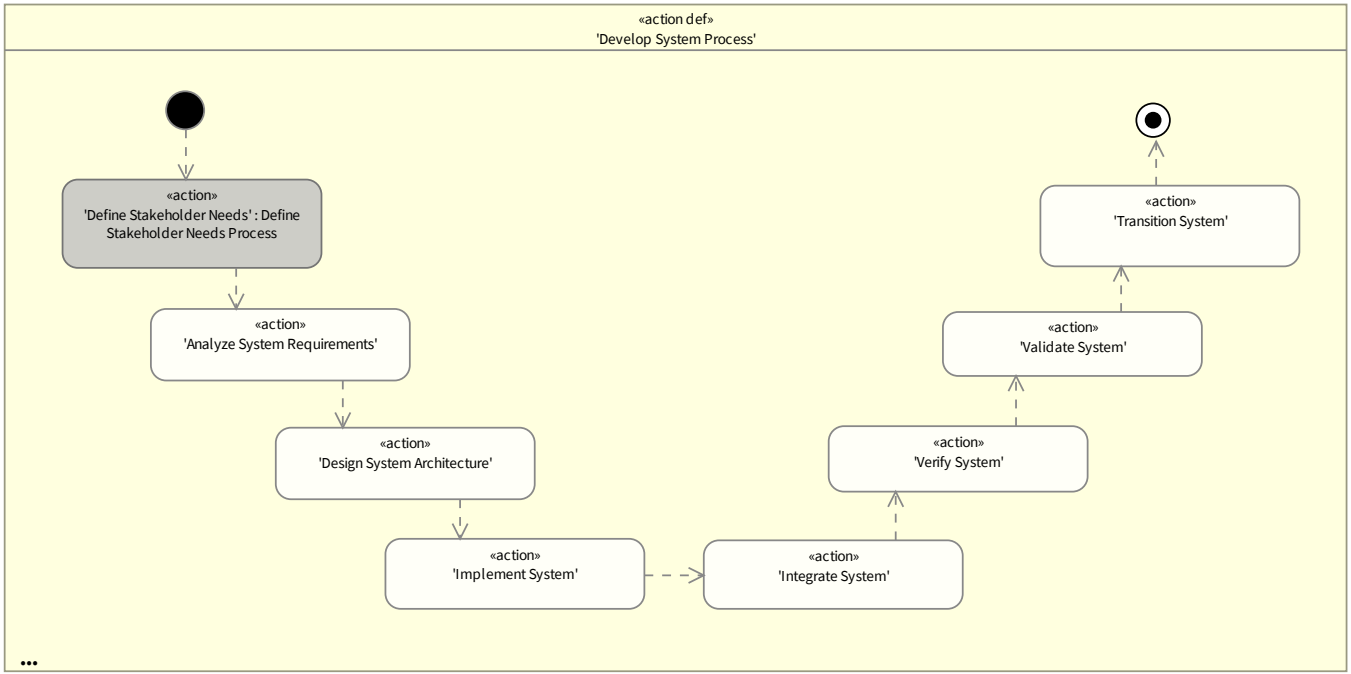


Creating a View with a Software View Producer from ASoT hosted Truth for Human Consumption

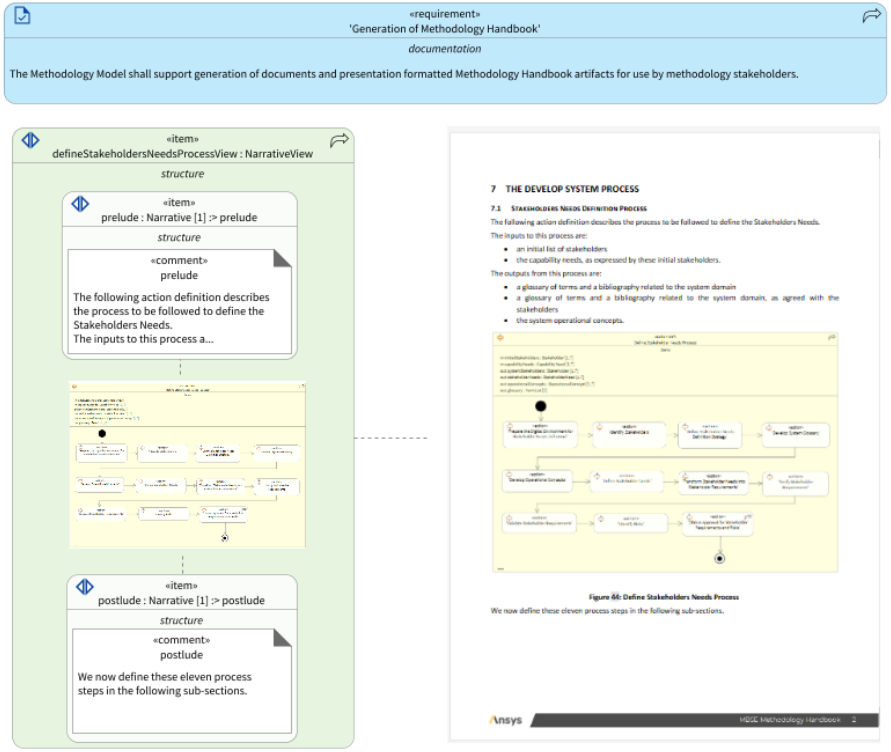
Methodology Customizability

«requirement»
'Methodology Customizability'

documentation
The Digital Engineering Methodology shall be usable as is or be customizable by Ansys or by its final users.



Generation of Methodology Handbook



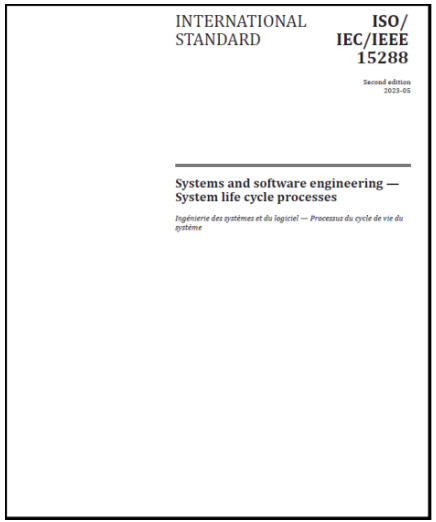
How Does One Go About Developing a Methodology

Following Industry Standards

«item»
'iso.se2023' : Reference [1]

attributes

:>> bibtexEntry = "organization = "International Organization for Standardization", title =...
:>> *type* = "*manual*"



INTERNATIONAL STANDARD

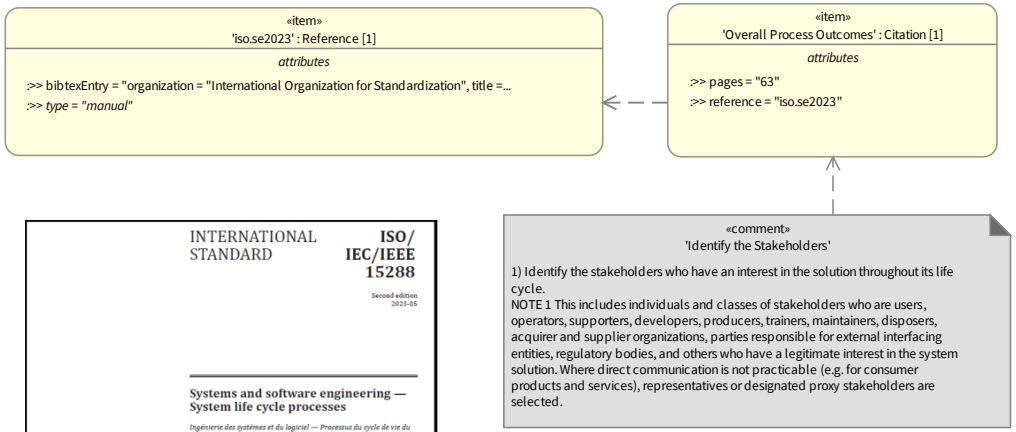
ISO/ IEC/IEEE 15288

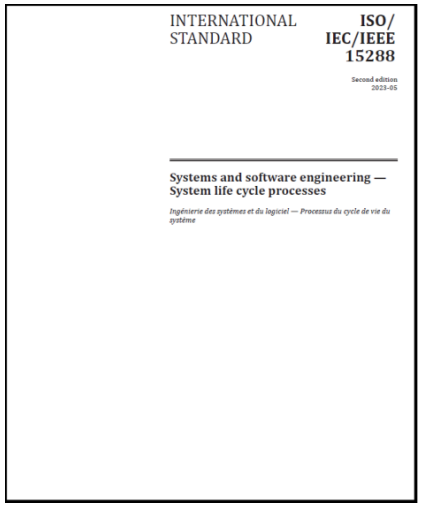
Second edition
2023-05

Systems and software engineering — System life cycle processes

Ingénierie des systèmes et du logiciel — Processus du cycle de vie du système

Taking Notes in the Methodology Model




INTERNATIONAL STANDARD

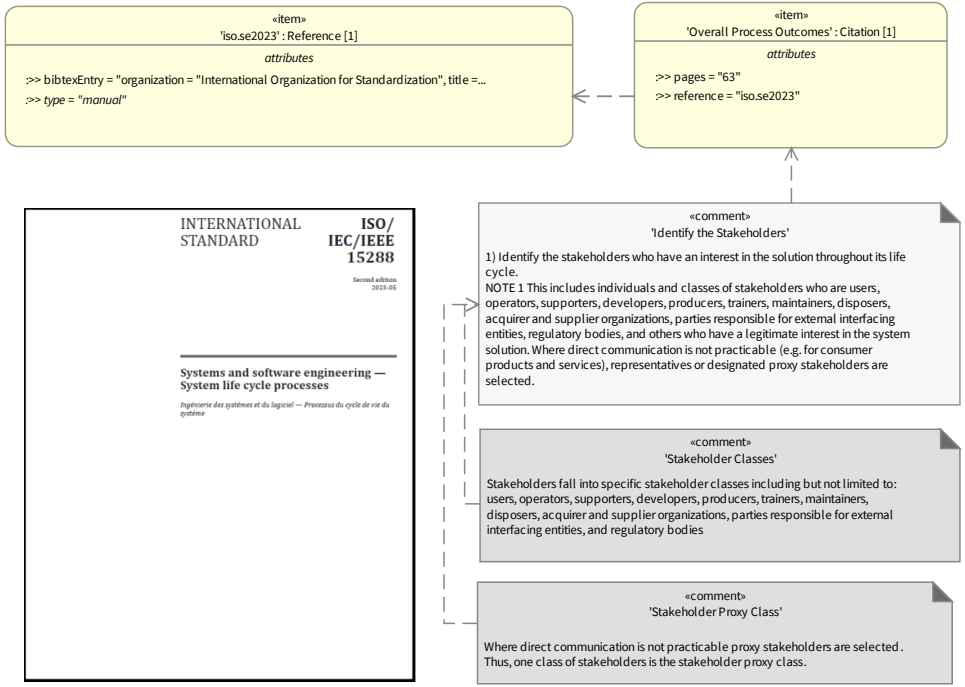
ISO/ IEC/IEEE 15288

Second edition 2023-05

Systems and software engineering — System life cycle processes

Ingénierie des systèmes et du logiciel — Processus du cycle de vie du système

Analyzing These Notes



Creating Methodology Content Based On This Analysis

«item»
'iso.se2023' : Reference [1]

attributes

:>> bibtexEntry = "organization = "International Organization for Standardization", title =...

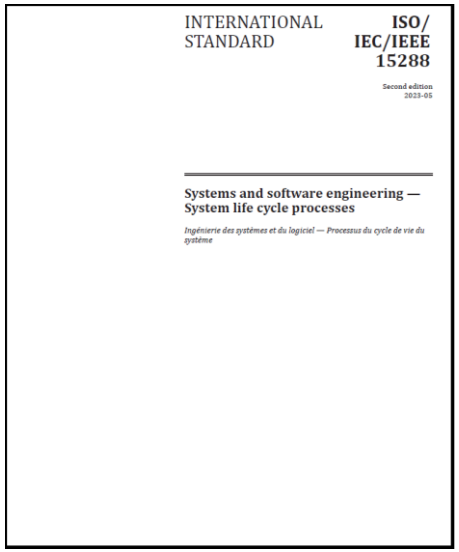
:>> *type* = *"manual"*

«item»
'Overall Process Outcomes' : Citation [1]

attributes

:>> pages = "63"

:>> reference = "iso.se2023"


INTERNATIONAL STANDARD

ISO/ IEC/IEEE 15288

Second edition 2023-05

Systems and software engineering — System life cycle processes

Ingénierie des systèmes et du logiciel — Processus du cycle de vie du système

«comment»
'Identify the Stakeholders'

1) Identify the stakeholders who have an interest in the solution throughout its life cycle.
NOTE 1 This includes individuals and classes of stakeholders who are users, operators, supporters, developers, producers, trainers, maintainers, disposers, acquirer and supplier organizations, parties responsible for external interfacing entities, regulatory bodies, and others who have a legitimate interest in the system solution. Where direct communication is not practicable (e.g. for consumer products and services), representatives or designated proxy stakeholders are selected.

«comment»
'Stakeholder Classes'

Stakeholders fall into specific stakeholder classes including but not limited to: users, operators, supporters, developers, producers, trainers, maintainers, disposers, acquirer and supplier organizations, parties responsible for external interfacing entities, and regulatory bodies

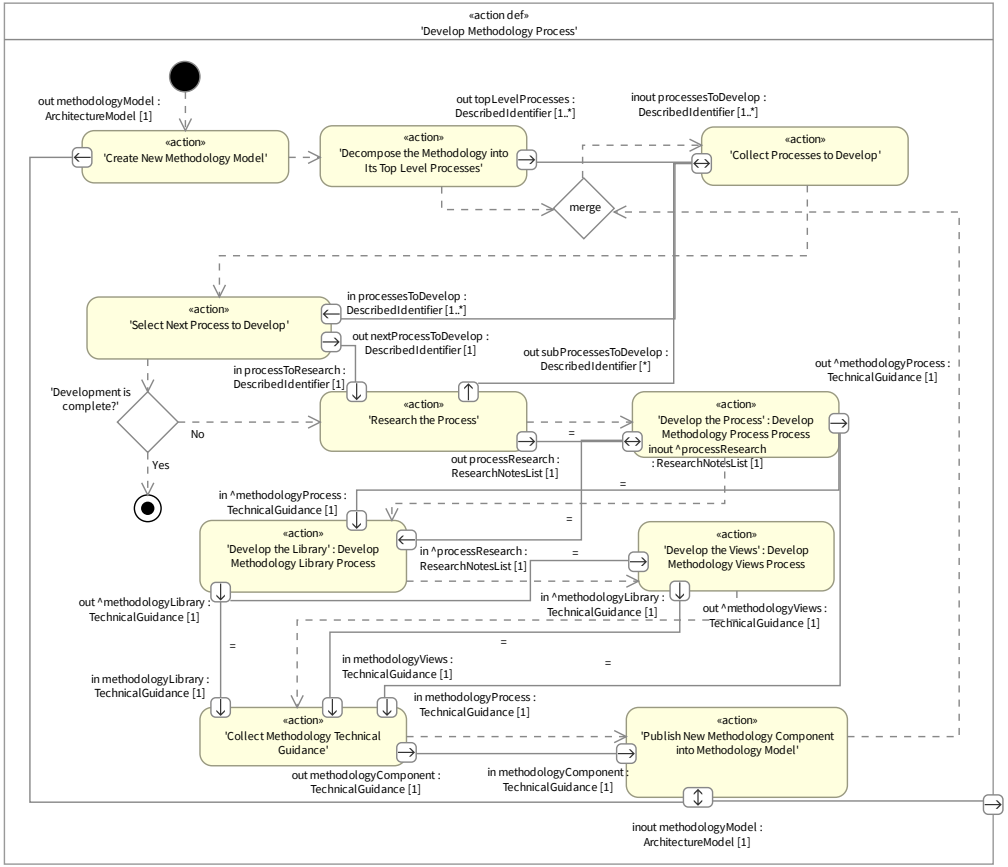
«part def»
AbstractStakeholders

«part def»
AbstractProxiedStakeholders

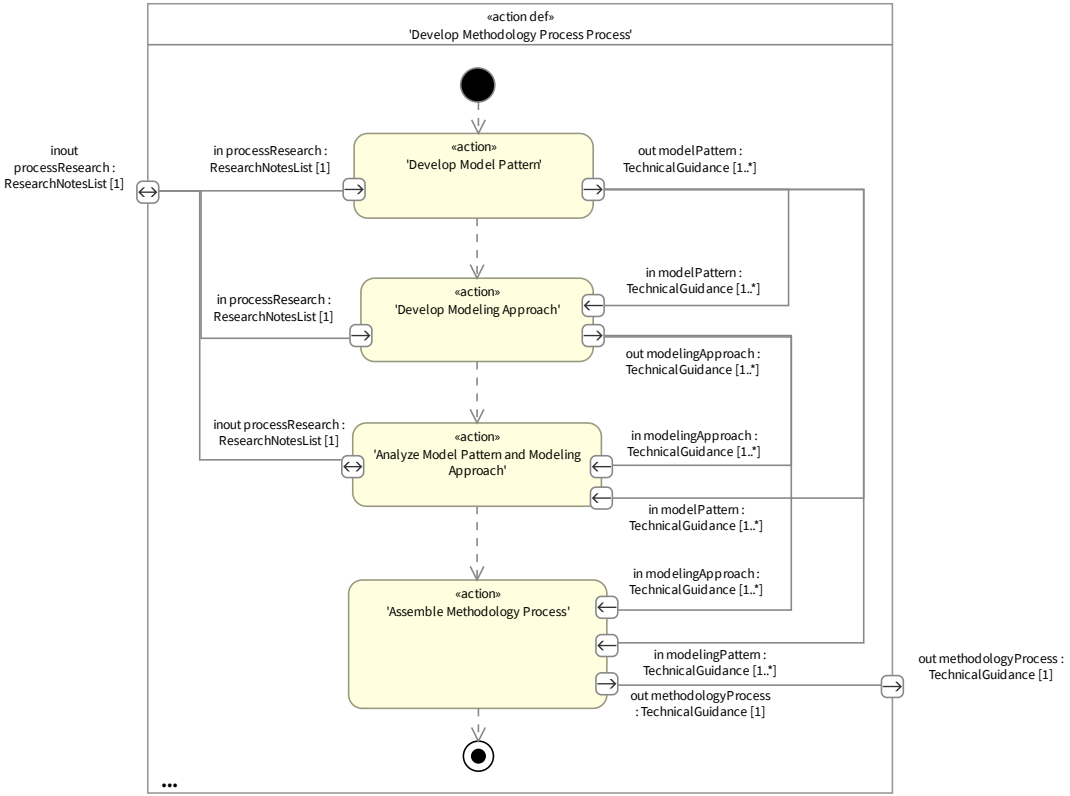
«comment»
'Stakeholder Proxy Class'

Where direct communication is not practicable proxy stakeholders are selected. Thus, one class of stakeholders is the stakeholder proxy class.

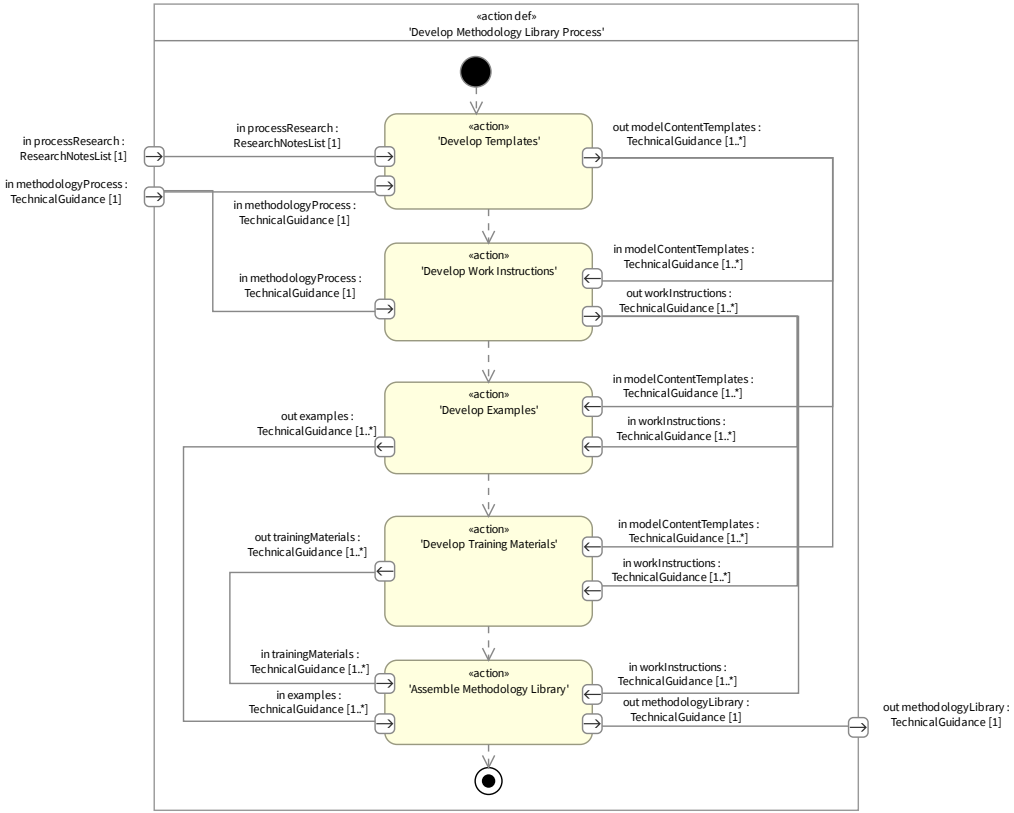
The Develop Methodology Process



The Develop Methodology Process Process

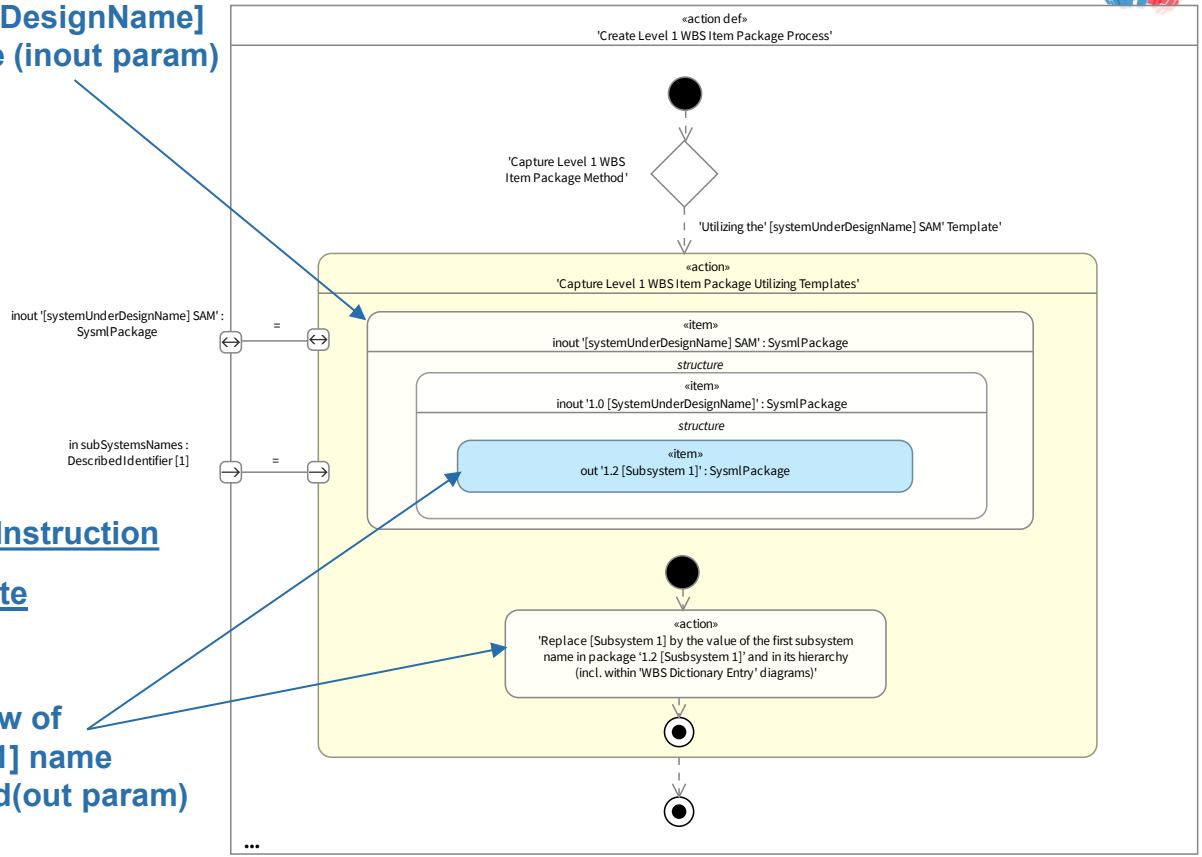


The Develop Methodology Library Process



Example Work Instruction Based on Utilizing a Template

graphical view of [systemUnderDesignName] SAM Template (inout param)



'Initialize Package Hierarchy' Library

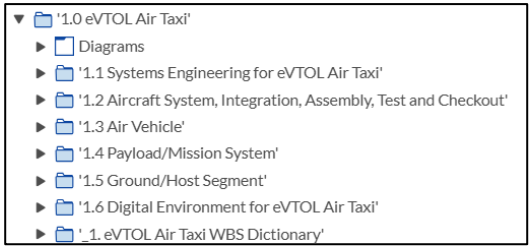
'Create Level 1 WBS Item Package' Work Instruction

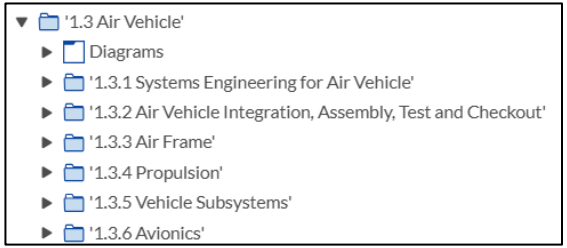
'[systemUnderDesignName] SAM' Template

graphical view of [Subsystem 1] name to be updated(out param)

How We Used the Methodology to Develop the ‘eVTOL Air Taxi’ Example

The Work Breakdown Structure (WBS) Approach for 'eVTOL Air Taxi' (1/2)





Using 'Initialize Package Hierarchy' Library

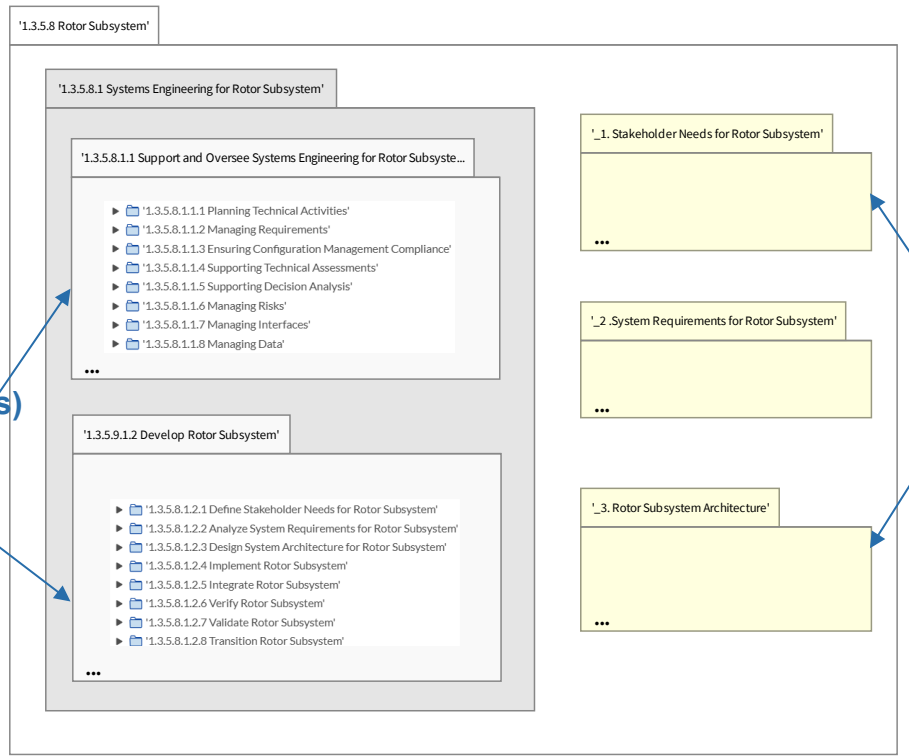
and MIL-STD-881f Appendix A

The Work Breakdown Structure (WBS) Approach for ‘eVTOL Air Taxi’ (2/2)

- '1.3.5 Vehicle Subsystems'
  - Diagrams
  - '1.3.5.1 Systems Engineering for Vehicle Subsystems'
  - '1.3.5.2 Vehicle Subsystems Integration, Assembly, Test and Checkout'
  - '1.3.5.3 Flight Control Subsystem'
  - '1.3.5.4 Auxiliary Power Subsystem'
  - '1.3.5.5 Electrical Subsystem'
  - '1.3.5.6 Crew Station Subsystem'
  - '1.3.5.7 Environmental Control Subsystem'
  - '1.3.5.8 Rotor Subsystem'
  - '1.3.5.9 Drive Group'

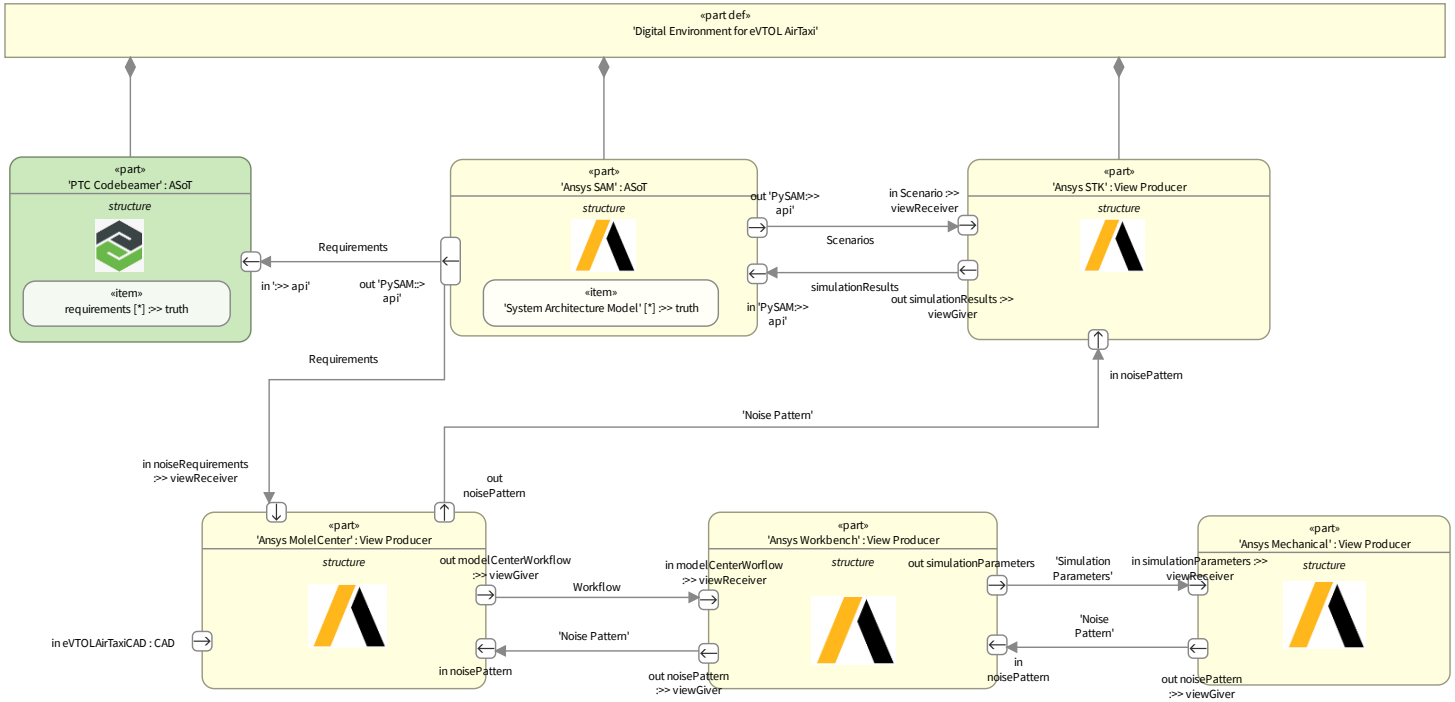
Agile Systems Engineering (User Stories)

Using ‘Utilize Agile Development Methodology” Library

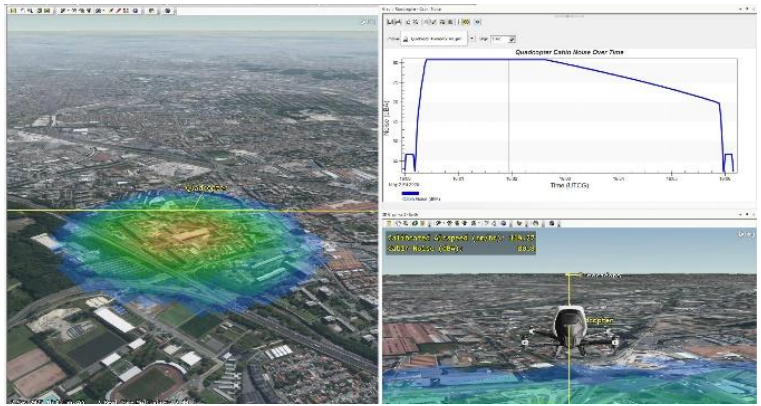


Published Architecture Model Elements

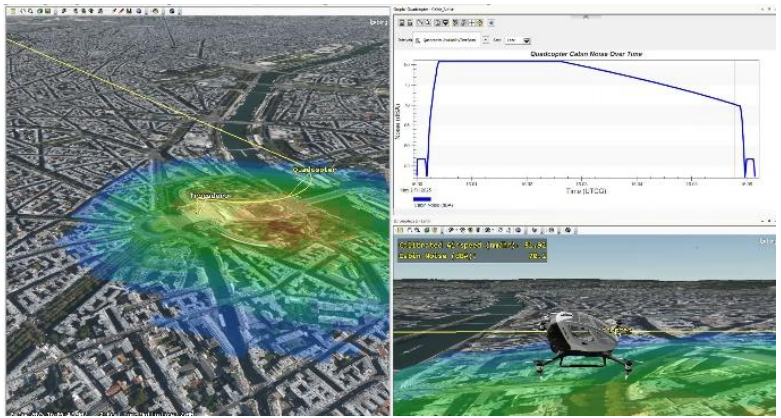
Verifying that Rotor Noise Complies with Environmental Regulation (1/2): Digital Environment



Verifying that Rotor Noise Complies with Environmental Regulation (2/2): NVH Analysis

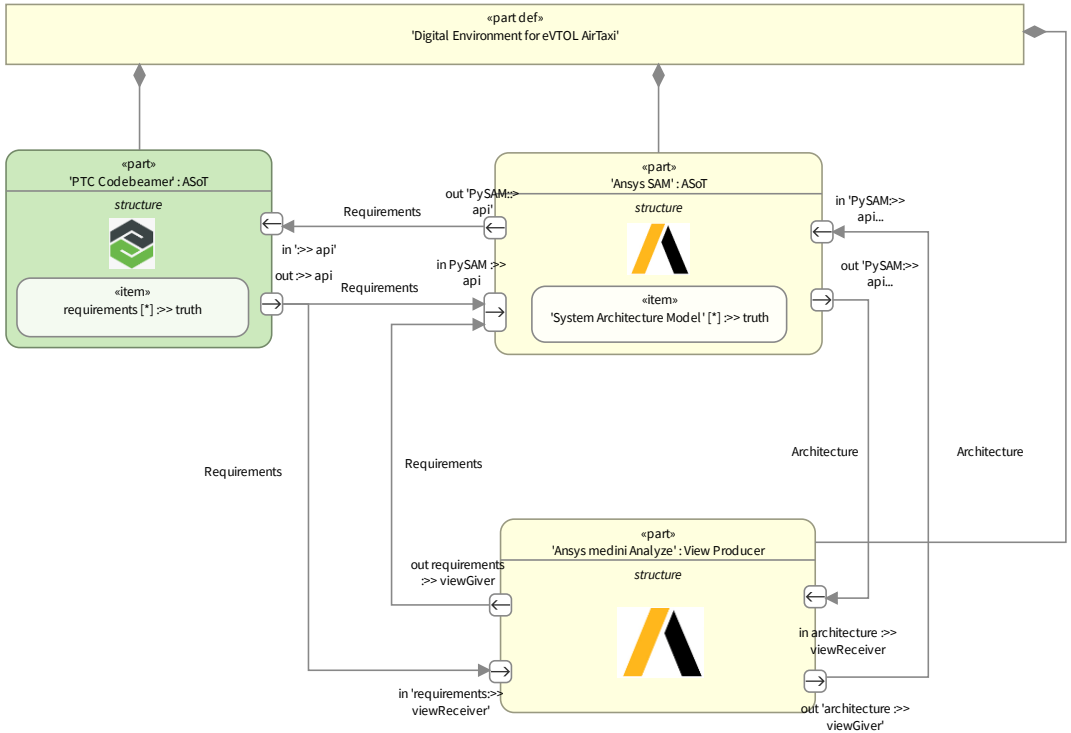


Cabin and Ground Noice at Cruise

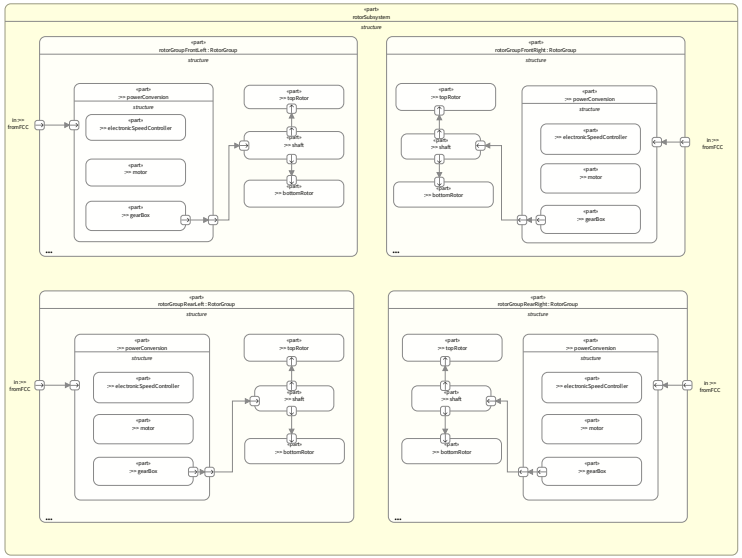


Cabin and Ground Noice at Landing

Verifying that the Rotor Subsystem Complies with Safety Regulation (1/2): Digital Environment



Verifying that the Rotor Subsystem Complies with Safety Regulation(2/2): Preliminary System Safety Assessment



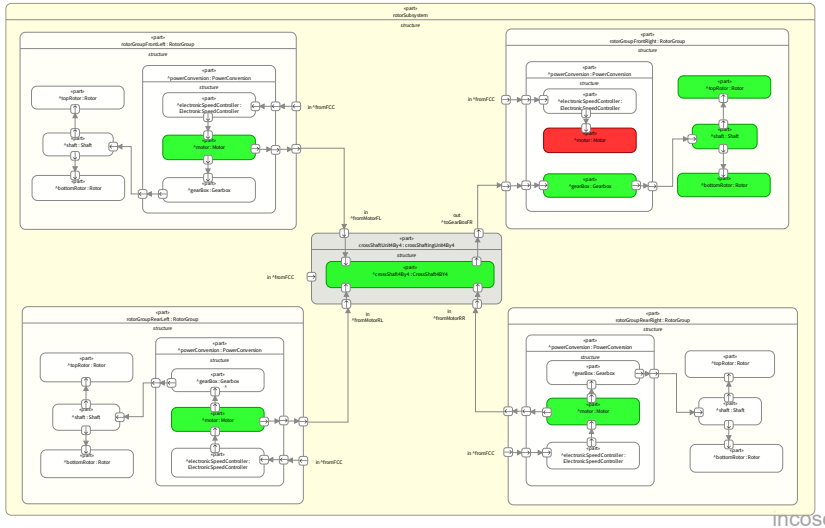
From Here (independent Root Groups)

«requirement»
<013> 'Single Cat Lift Loss Rate'

documentation
Loss of lift unit in a critical phase shall not occur at a rate higher that 1E-09 per flight hour.

«requirement»
<014> 'Cross Shaft Unit'

documentation
Lift system shall support a cross-gearbox to mechanically connect the shaft of the 4 rotor groups.



to Here (Root Groups Connected by Cross shaft)

Feedback welcome

35th Annual INCOSE international symposium

hybrid event

Ottawa, Canada
July 26 - 31, 2025