

Structural Modeling in Biomedical and Product Engineering

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Modeling Is Used In Biomedical and Product Engineering For

- Design of manufactured products
- Analysis and verification of system properties
- Classification of molecule structure
- Diagnosis of disease from symptoms



What Can Each Field Learn From The Other?

- Are there common best modeling principles, common pitfalls?
- How are they different?
- How well do the modeling tools used in each field work in the other field?
- Does comparison suggest any tool improvements for each field?



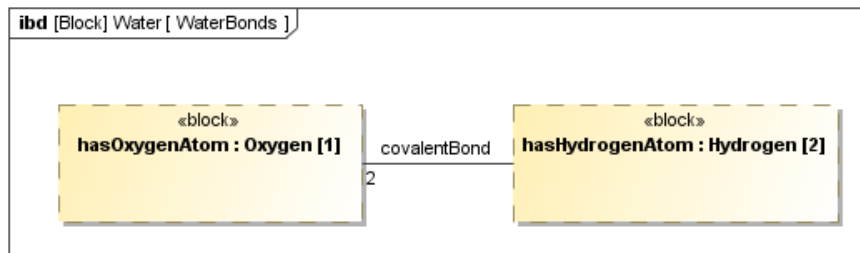
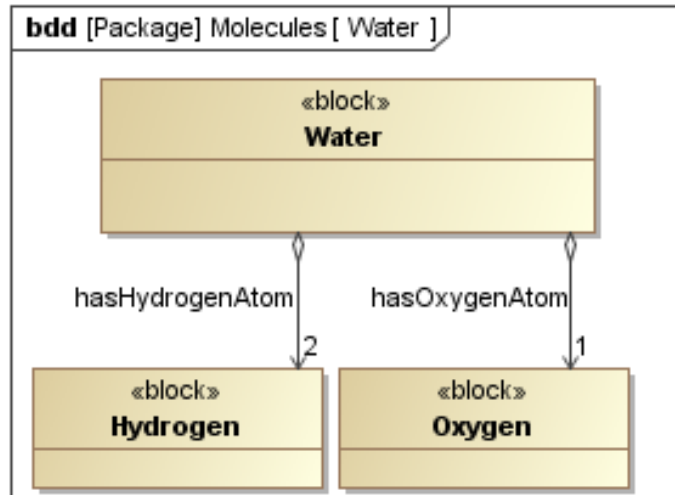
Informal Experiment (SysML vs OWL)

- Use SysML for modeling molecules & human heart
 - SysML is common for product modeling
- Use OWL to model an aircraft
 - OWL is commonly used for biomedical modeling



Model Of Water - Using SysML

A Top Level of Water Model



Used To

- Generate 3D Visualization of implementation
- Answer questions about mass, size, geometrical shape, ...



Model of Aircraft – Using Protégé (OWL)

The screenshot displays the Protégé interface for modeling an aircraft ontology. It is divided into three main panels:

- Asserted Class Hierarchy: PhysicalArtifact:** A tree view on the left showing the ontology structure. The hierarchy starts with 'Thing' at the root, followed by 'Entity', 'Event', 'Object', 'PhysicalObject', 'PhysicalArtifact', and several subclasses including 'AirVehicle', 'AirVehicleComponentPart', and 'AirVehicleFunctionalSubsy'. Other classes like 'Agent', 'Substance', 'SocialObject', 'Quality', 'Shape', 'Specification', 'Weight', and 'Region' are also visible.
- Class Annotations: PhysicalArtifact:** A panel on the right showing annotations for the 'PhysicalArtifact' class. It includes a 'comment' field with text: "This description is very, but does not aim to be, very general, i.e. including recycled objects, objects with an intentional functional change, natural objects that are given a certain function, even though they are not modified or structurally designed, etc. Immaterial (non-physical) artifacts can be modelled as situations, as collections, or as social object, depending on the task of an ontology project." and a 'label' field with the value "Artefatto"@it".
- Class Description: PhysicalArtifact:** A panel on the right showing the class description for 'PhysicalArtifact'. It lists 'Equivalent classes' (none shown), 'Superclasses' (PhysicalObject, isDescribedBy some Plan), and 'Inherited anonymous classes' (isParticipantIn some Event, hasRole only Role, isParticipantIn only Event, hasPart only Object, isPartOf only Object, hasPart only PhysicalObject, hasLocation only Entity, precedes only Entity).

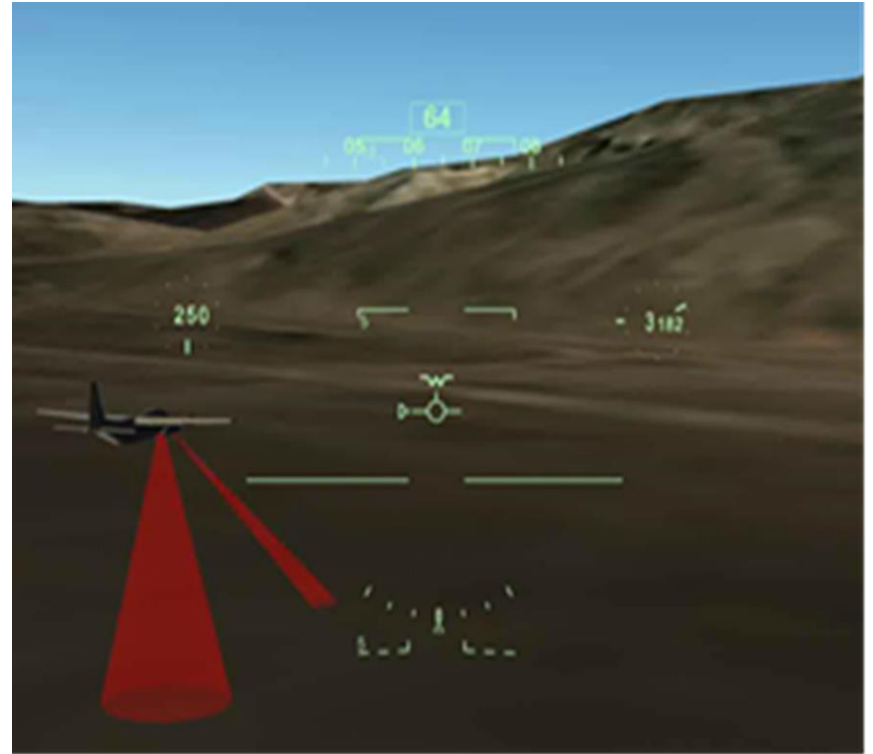
...use of a foundation ontology saves a lot of time

What Can Be Learned

- Full MBSE requires modeling system in context of operating environment
- Both fields can use upper ontologies to save work and integrate models
- Automated reasoning can be used to solve practical problems in both fields
- SysML and OWL each have features needed in both fields

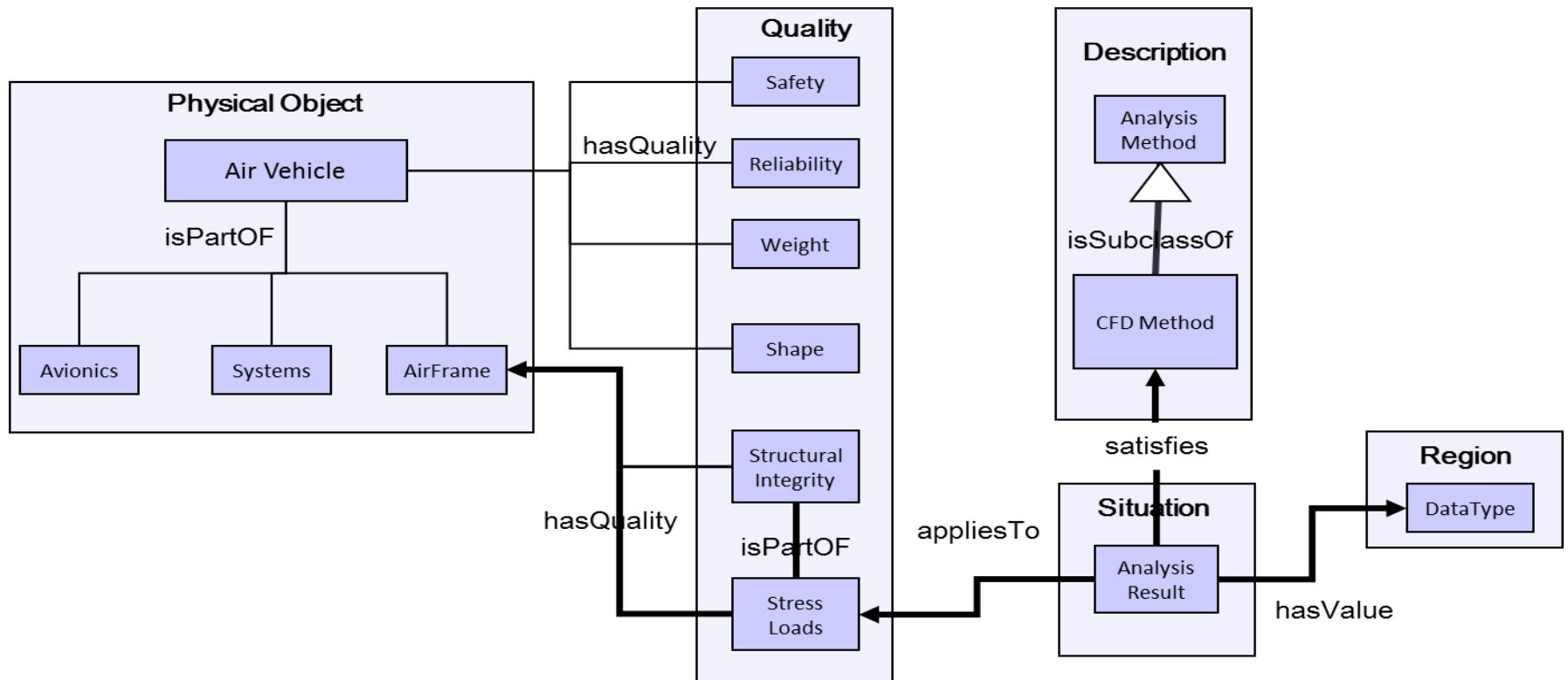


Full MBSE



Not just system models but integration with context of operating environment

Use of Upper Ontology



- Saves work through reuse
- Enables semantic integration of modeling from different groups & enterprises

Automated Reasoning (Both Fields)

- Need modeling languages integrated with automated reasoning
- Much analysis translates into logic questions that can be answered with automated reasoning



Tool Pluses And Minuses

- SysML

- Graphics
- Language constructions for parts and connections\
- Behavior constructions
- No formal semantics
- No integration with reasoning

- OWL

- Formal Semantics
- Integration with reasoning
- Integration with upper ontologies
- No Graphics
- Insufficient part and connection language
- No behavior constructions



Suggestions For Improvement

- Extend SysML
 - SysML is a much richer language than OWL
 - Include OWL class constructions
- Provide SysML with a formal semantics
 - Need this to integrate reasoning successfully
 - Build on OWL
- MBSE community needs to adopt upper ontology standards



Survey

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