Model-based Systems Engineering (MBSE) Initiative
Ontology Action Team

INCOSE MBSE Workshop
21-22 January 2012
Jacksonville, Florida

Henson Graves
What’s New

• OAT participation in OntologySummit2012

• Integrating Reasoning With SysML
OAT participation in Ontology Summit2012

- The Ontology Summit is an annual event spanning several months culminating in an actual meeting in first quarter.

- It is co-sponsored by Onolog, NIST, NCOR, NCBO, IAOA, BCO_NITRD, ....

- This year integration with Systems Engineering is a major topic stated as: “Ontology solutions for Systems Engineering”

- I am serving as a co-champion for two tracks relating to systems engineering.
Topics Seeking Ontology Help On

• Potential for Upper Ontologies as MetaData model to organize and manage engineering data

• Use of ontology for modeling composite structures

• Development of specific hierarchies of domain ontologies for inclusion in SysML modeling

• Use of ontology results to construct good modeling principles for SysML modeling
Vision For Integration of Reasoning With System Engineering

Ontologies - General terminology reusable across multiple engineering domains

Ontologies specialized for domain specific applications

facts about specific applications

Knowledge Management & Reasoning System
  • Make/retract assertions about data
  • Answer queries
  • Check design consistency
  • Evaluate evidence for assertions

Requirements
  • Develop requirements specifications

Design
  • Develop design specifications

Implementation
  • Perform integration tests

Test & Verification
  • Verify implementation realizes design

Deployment
  • Perform verification tests

verify product satisfies requirements

... with great potential for reducing work and rework
Significant Research Results On Embedding SysML into Logics

SysML
- Classes & properties
- Composite structure
- Behavior

Class Diagrams

Composite Diagrams

OWL
- Classes & properties correspond to a fragment of FOL
- Decidability
- Rich class constructors
- Individuals

Type Theory

First Order Logic
- Quantifiers
- Nary-predicates
- Functions

FOL

Type theory
- Contains a higher order logic
- Set theory like abstraction
Reasoning Use Case Development

• Maintaining design consistency
  – Verifying adding component invalidates design

• Verifying design instances satisfy specified capability
  – Verifying aircraft loiter capability
  – Verifying target recognition capability
Use case 1: Maintaining Design Consistency During Development

• Components get added to designs during the course of design development, e.g. a pump

• May make the system design become invalid if design constraints are violated

• These problems are not apparent from manual model inspection

• Working with computer scientists to produce examples and feasibility studies
Use Case 2: Verifying System Capability for Target Recognition

- Using proposed design solution to decompose into component solutions
- Find physics and device assumptions needed to verify conclusion
- Preliminary analysis of reasoning issues
Plans Forward

• Continue prototyping reasoning use cases

• Hopefully the OntologySummit2012 will produce material that can be used in MBSE context

• Looking for members for OAT willing to take on responsibilities for tasks