OntologySummit2012: Session-03

"Ontology for Big Systems & Systems Enginering - I"

Model-based Systems Engineering (MBSE) Initiative

Slides by Henson Graves

Presented by Matthew West

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INCOSE MBSE Definition

"**Model-based systems engineering (MBSE) is 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.**"

INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02), Sept 2007

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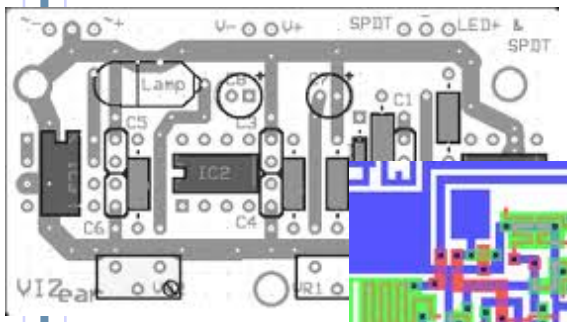
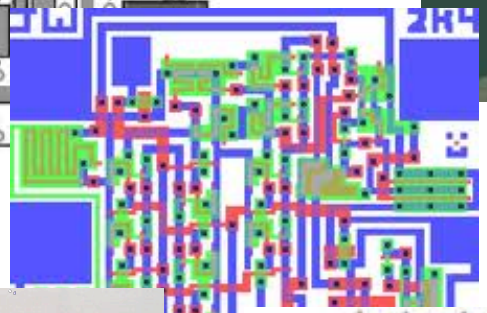
This requires

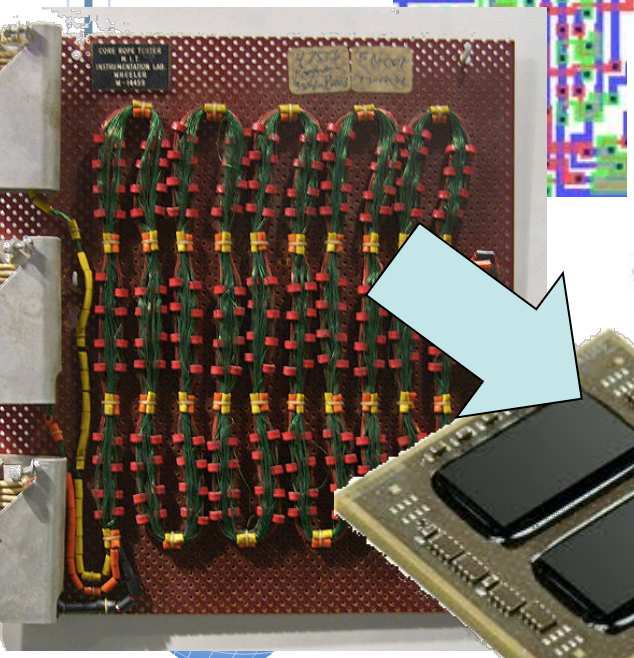
Documents

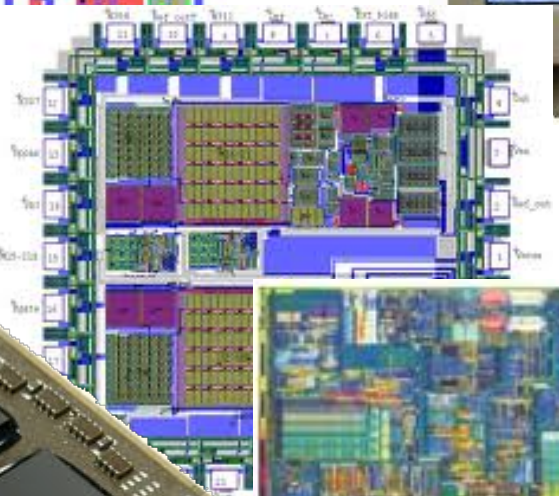


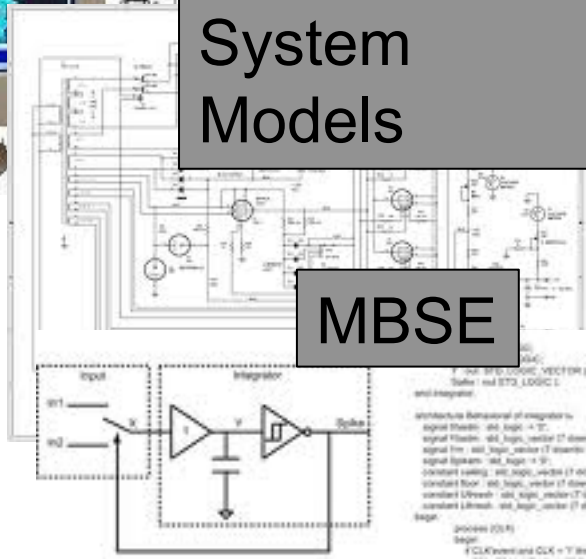


Document Generation

Disconnected System Models

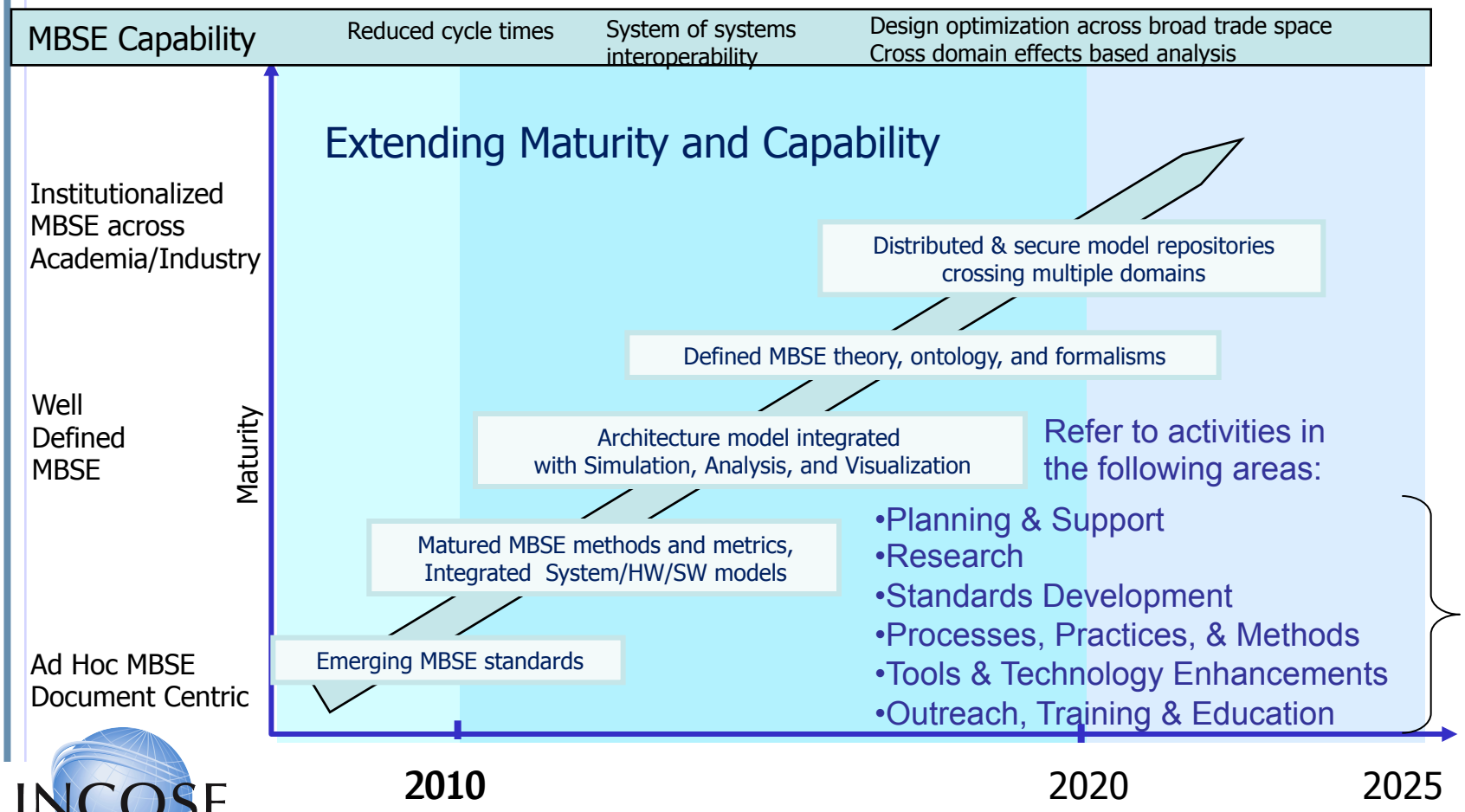






MBSE

INCOSE MBSE Roadmap



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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

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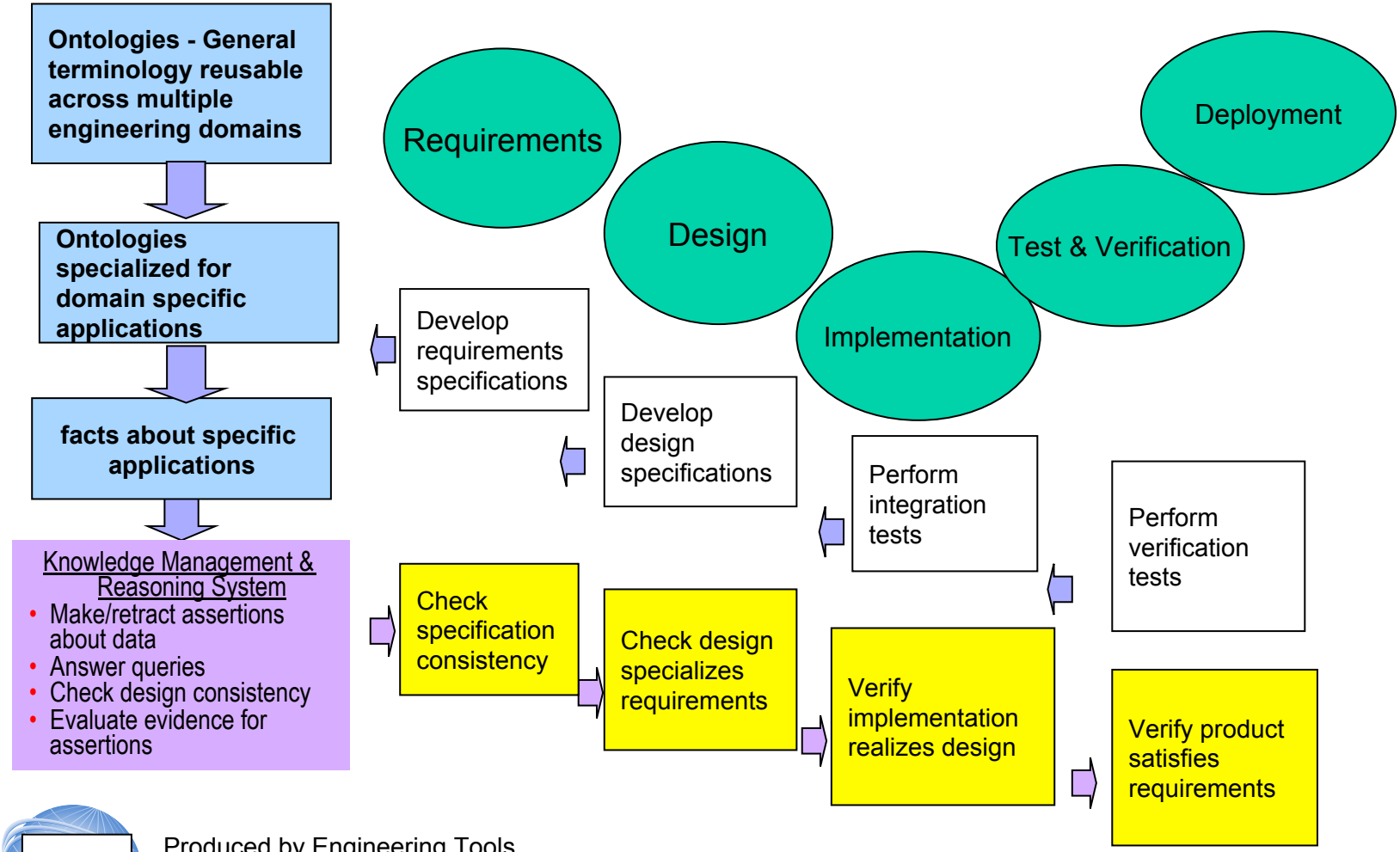
Vision For Integration of Reasoning With System Engineering



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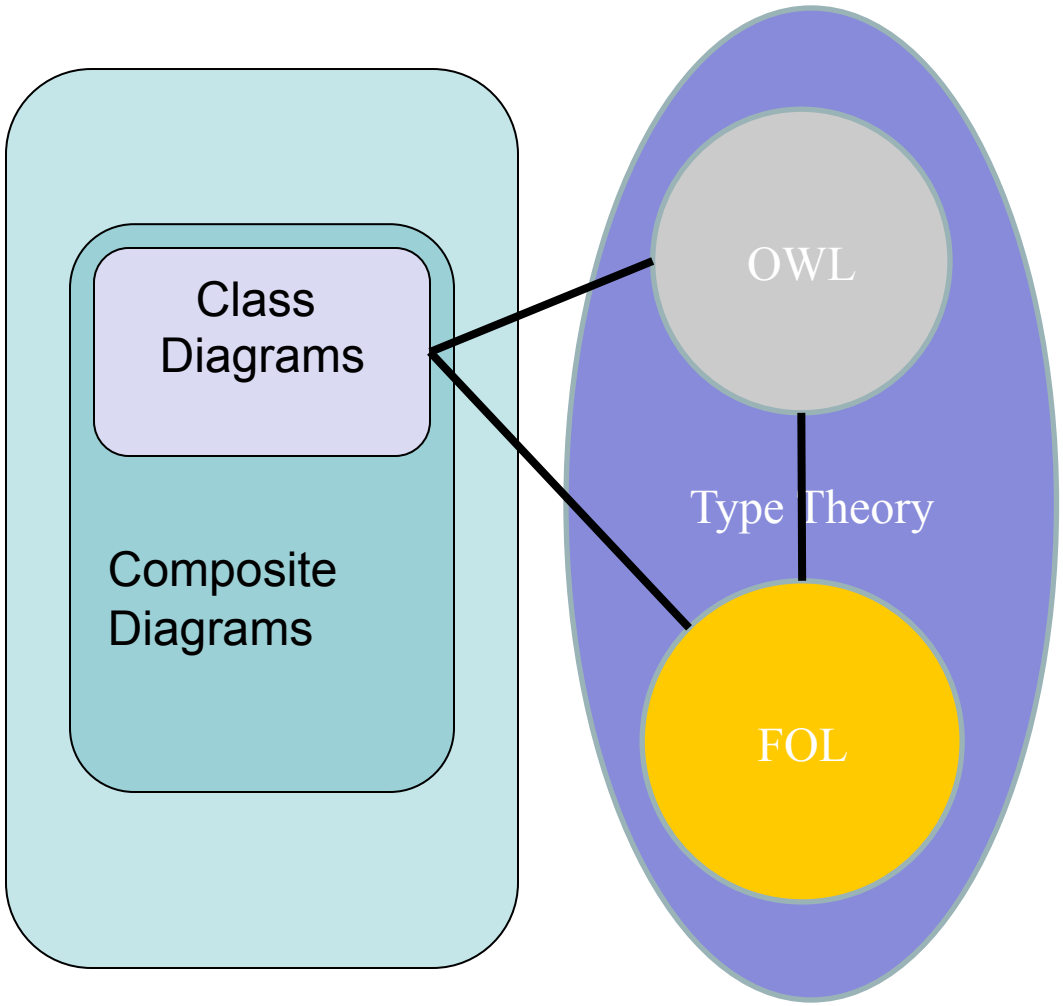
… with great potential for reducing work and rework

Significant Research Results On Embedding SysML into Logics

SysML
- Classes & properties
- Composite structure
- Behavior



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

First Order Logic
- Quantifiers
- Nary-predicates
- Functions

Type theory
- Contains a higher order logic
- Set theory like abstraction

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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

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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

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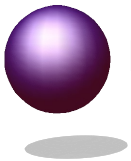
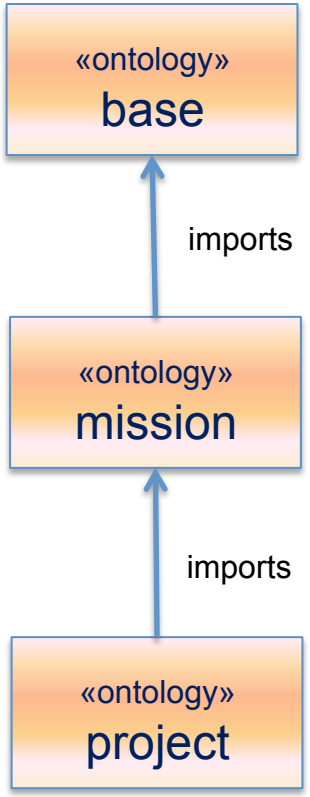
Quick Review of Objectives

- We want to use the formalism of ontologies to represent knowledge in fields of interest to us:
  - Space flight in particular
  - Systems engineering in general
  - Fundamental phenomena underlying the above: physics, chemistry, economics, psychology, politics, probability, etc.
- We want these knowledge representation conventions to be stable and durable: independent of particular programs, projects, organizations, and software tools
- We want to customize or adapt our modeling and analysis tools to support our knowledge representation conventions
  - At least to translate to/from internal representations
  - At best to teach the tool to operate on our concepts and properties as extensions or specializations of its native counterparts



A Simplified View of JPL Ontologies

- Divided into three main categories:
  - Foundation
    - General concepts and properties
    - Examples at right
  - Discipline
    - Specializations for electrical, mechanical, etc.
    - Mostly about describing properties
  - Application
    - Specializations for cross-discipline use cases (e.g., orbiter, lander, observatory, etc.)
- Each ontology may import other ontologies



The strange life of System Components