MBSE – the natural evolution of Systems Engineering

INCOSE IS 2022 – Fundamentals Programme

ENDORSED TRAINING PROVIDER

SCARECROW CONSULTANTS

Why, hello there…

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Overview

1. The need for Systems Engineering
2. MBSE Evolution
3. Summary

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1. The Need for Systems Engineering

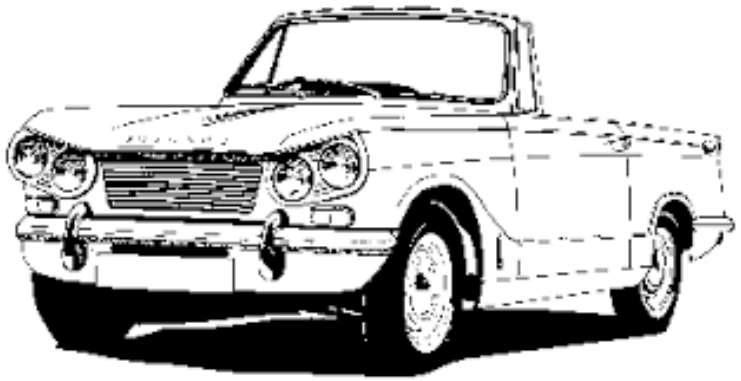
- Complexity
  - Accidental
  - Essential
- Communication
  - Common language
  - Different stakeholders
- Lack of understanding
  - Across life cycle

Model-based Systems Engineering

- The Model (noun) is about consistent information:
  - Across Systems, Notations, Tools, Processes, Standards
  - Enabled by a Framework
- To Model (verb) is about:
  - Managing complexity
  - Effective communication
  - Increasing understanding

Complexity - Consider a car

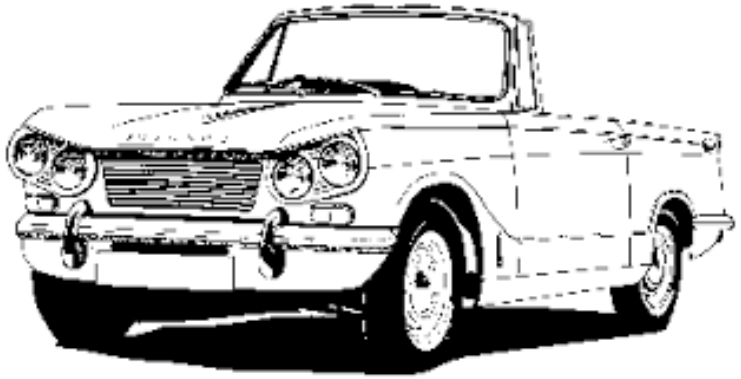
- The need: ***get us from A to B***
- Human-machine interfaces: ***steering wheel, gear control, pedals***



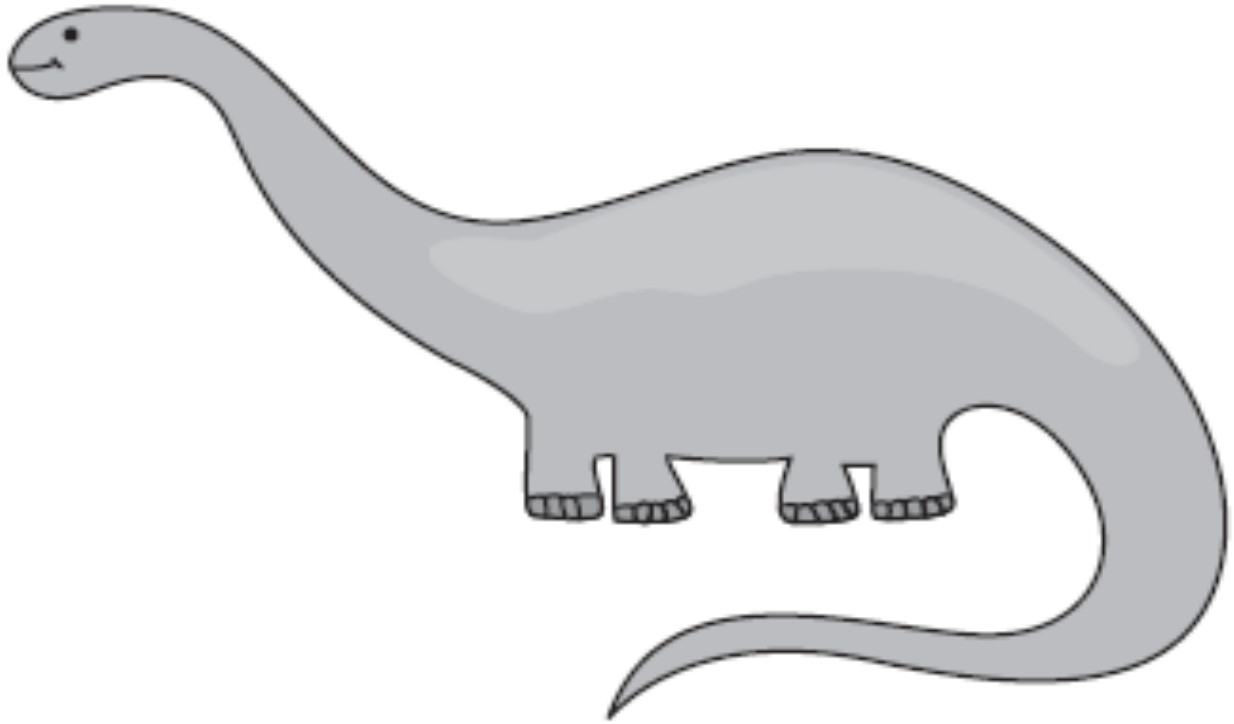
Complexity - Consider a car

Complexity evolves over last 50 years

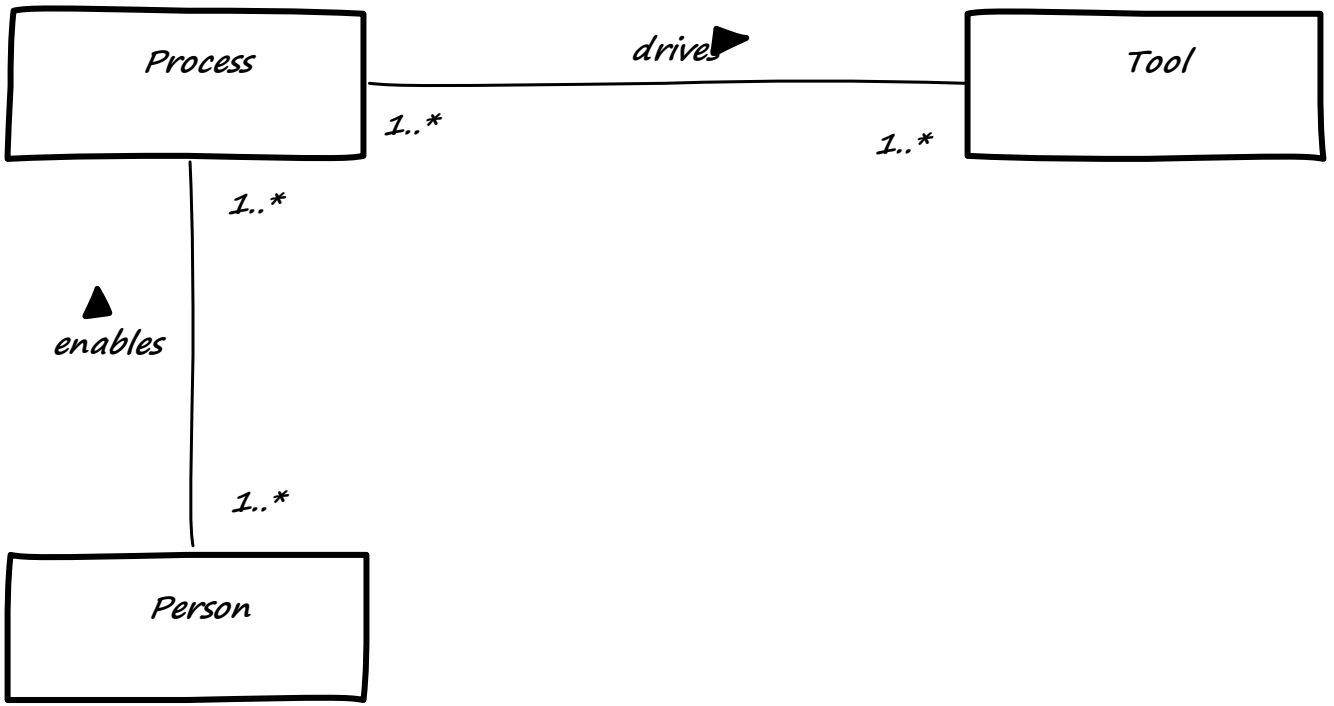
- System elements and interfaces (mechanical, electrical, electronic, software, networks, etc)
- Constraints (standards, legislation, stakeholder expectations, safety, security, etc)
- Systems of systems (part of a wider, connected world)
- Complexity shift (technology, responsibility of system, etc)



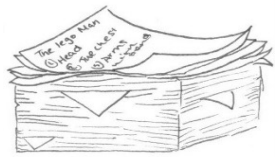
The Brontosaurus of Complexity



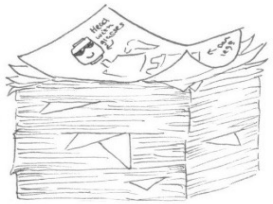
The MBSE Mantra



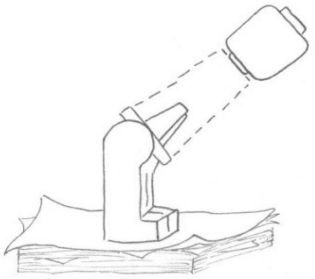
2. MBSE Evolution



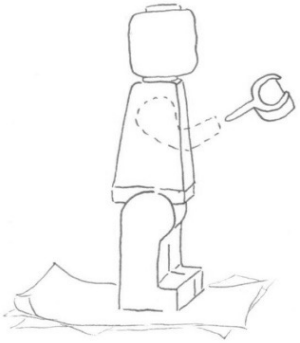
Stage 1:
Document-based



Stage 2:
Document-centric



Stage 3:
Model-enhanced

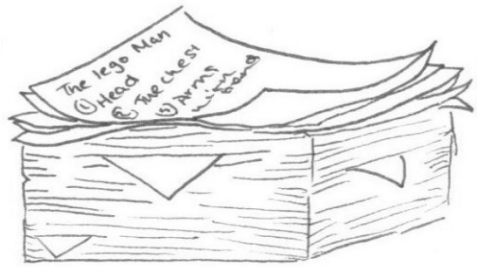


Stage 4:
Model-centric

Stage 5:
Model-based

Stage 1: Document-based Systems Engineering - Outcomes

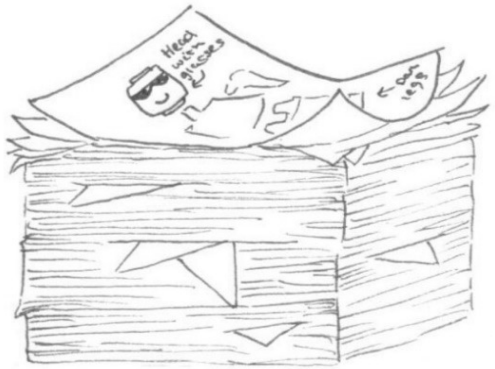
- Knowledge owned entirely by documents



- People
  - SE competence
- Process
  - All artefacts documents
  - Tables, lists, graphs etc.
- Tools
  - Office tools – spreadsheets, word processors

Stage 2: Document-centric Systems Engineering - Outcomes

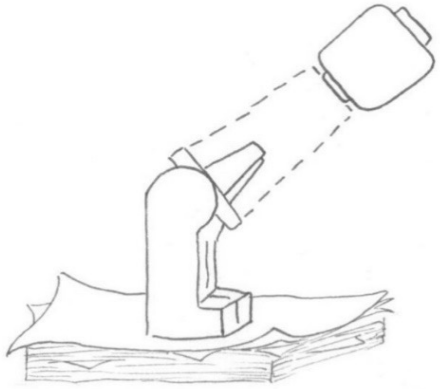
- Knowledge owned entirely by documents



- People
  - SE competence
  - Informal notational skill
- Process
  - All artefacts are documents
  - Tables, lists, graphs etc.
  - Some pictures
- Tools
  - Office tools – spreadsheets, word processors, drawing packages

Stage 3: Model-enhanced Systems Engineering - Outcomes

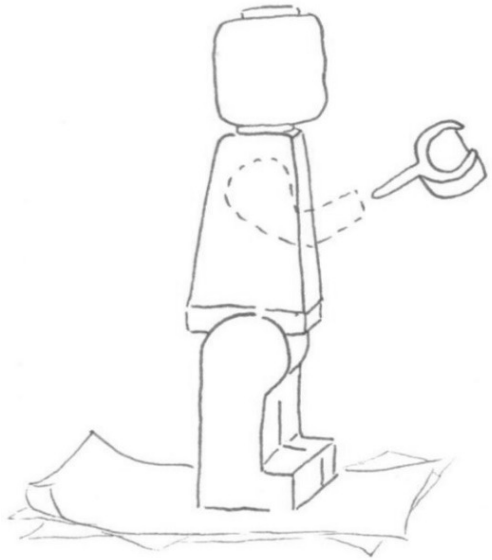
- Knowledge owned by documents and Model



- People
  - Notational competence
  - MBSE awareness
- Process
  - Models start to emerge
  - Documents and models
  - Small pilot project
- Tools
  - Multiple candidate tools

Stage 4: Model-centric Systems Engineering - Outcomes

- Knowledge owned by Model and (few) documents



- People
  - MBSE competence
  - Tool competence
- Process
  - Initial ontology, framework, processes
  - Measurement and assessment of pilot
- Tools
  - Tool(s) selected

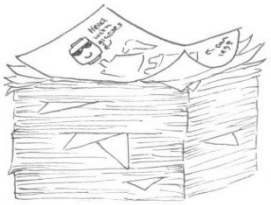
Stage 5: Model-based Systems Engineering - Outcomes

- Knowledge owned by Model

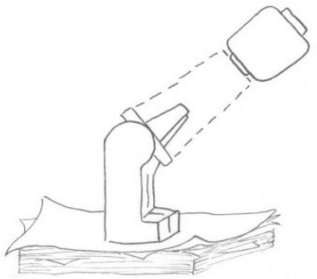
- People
  - MBSE competence
- Process
  - Mature ontologies, frameworks, process sets
  - Patterns, applications
  - Company roll-out
- Tools
  - Integrated toolsets
  - Profiles
  - Automation

MBSE Evolution – Transition Between Stages

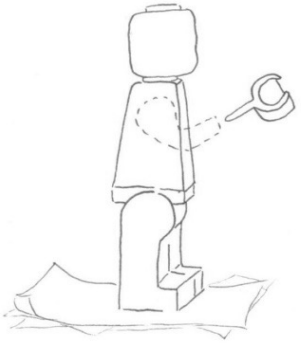
Stage 1: Document-based



Stage 2: Document-centric



Stage 3: Model-enhanced



Stage 4: Model-centric

Stage 5: Model-based

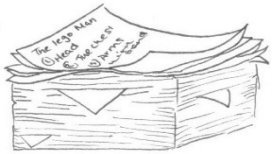
MBSE Evolution – Stage 4-5 - Activities

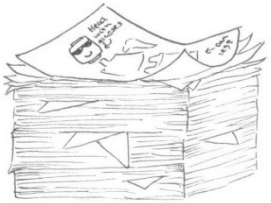
Assessment
Identify goals
MBSE by stealth

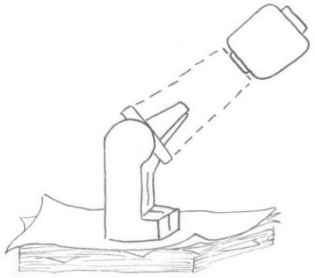
Notation training
Tool evaluation

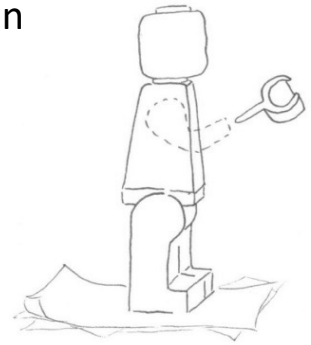
MBSE training
Process definition
Tool selection
Tool training
Framework & ontology definition

Advanced applications
Competency assessment
Model maturity
Process maturity
Tool tailoring









Stage 1: Document-based

Stage 2: Document-centric

Stage 3: Model-enhanced

Stage 4: Model-centric

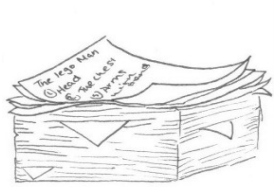
Stage 5: Model-based

3. Summary

As the complexity of our Systems evolves over time….

….so must our approach to Systems Engineering….

….MBSE is the natural evolution of Systems Engineering



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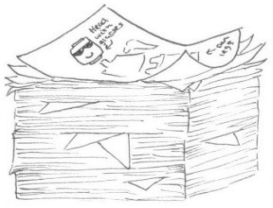
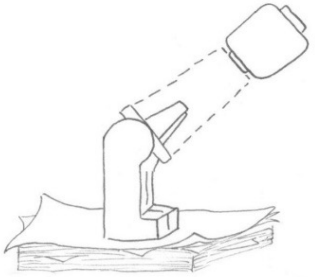
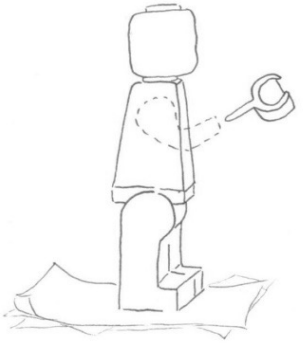
Document-based



Stage 2:
Document-centric



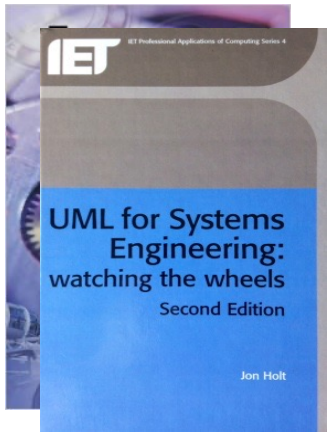
Stage 3:
Model-enhanced

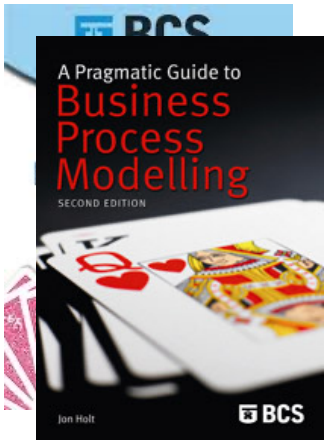


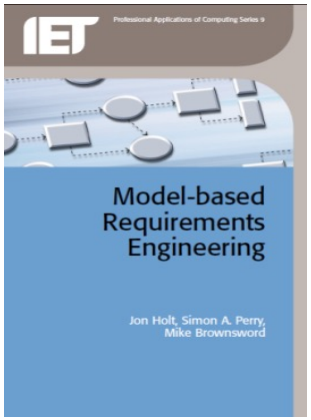
Stage 4:
Model-centric

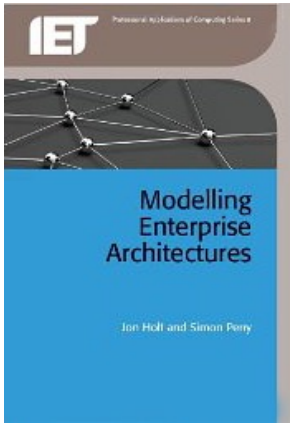
Stage 5:
Model-based

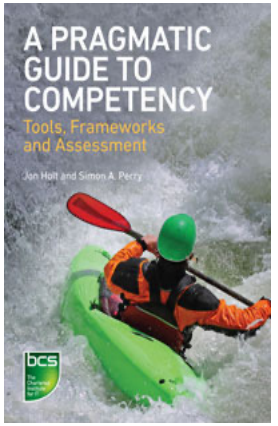
Shameless self-promotion

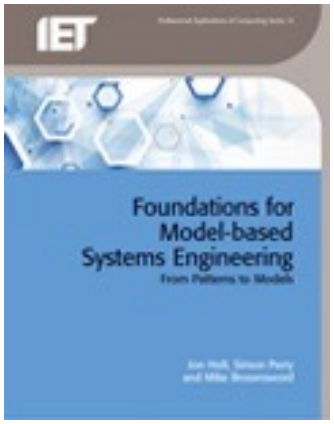


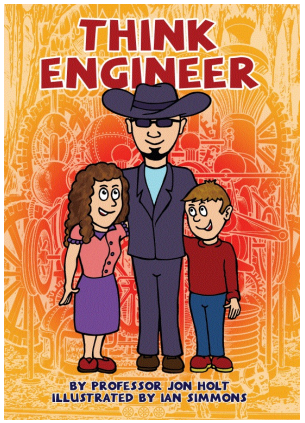


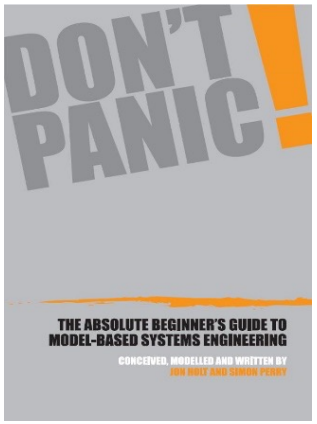


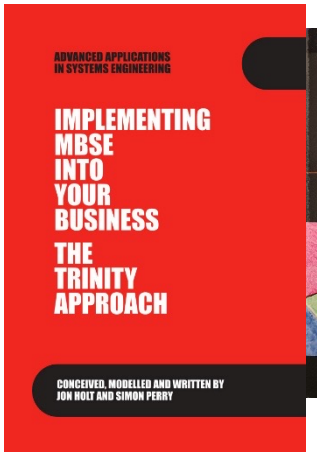


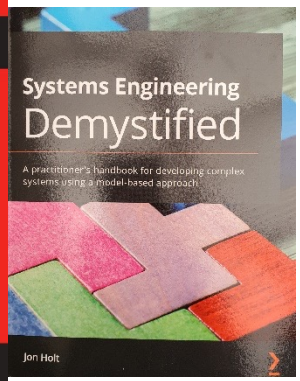












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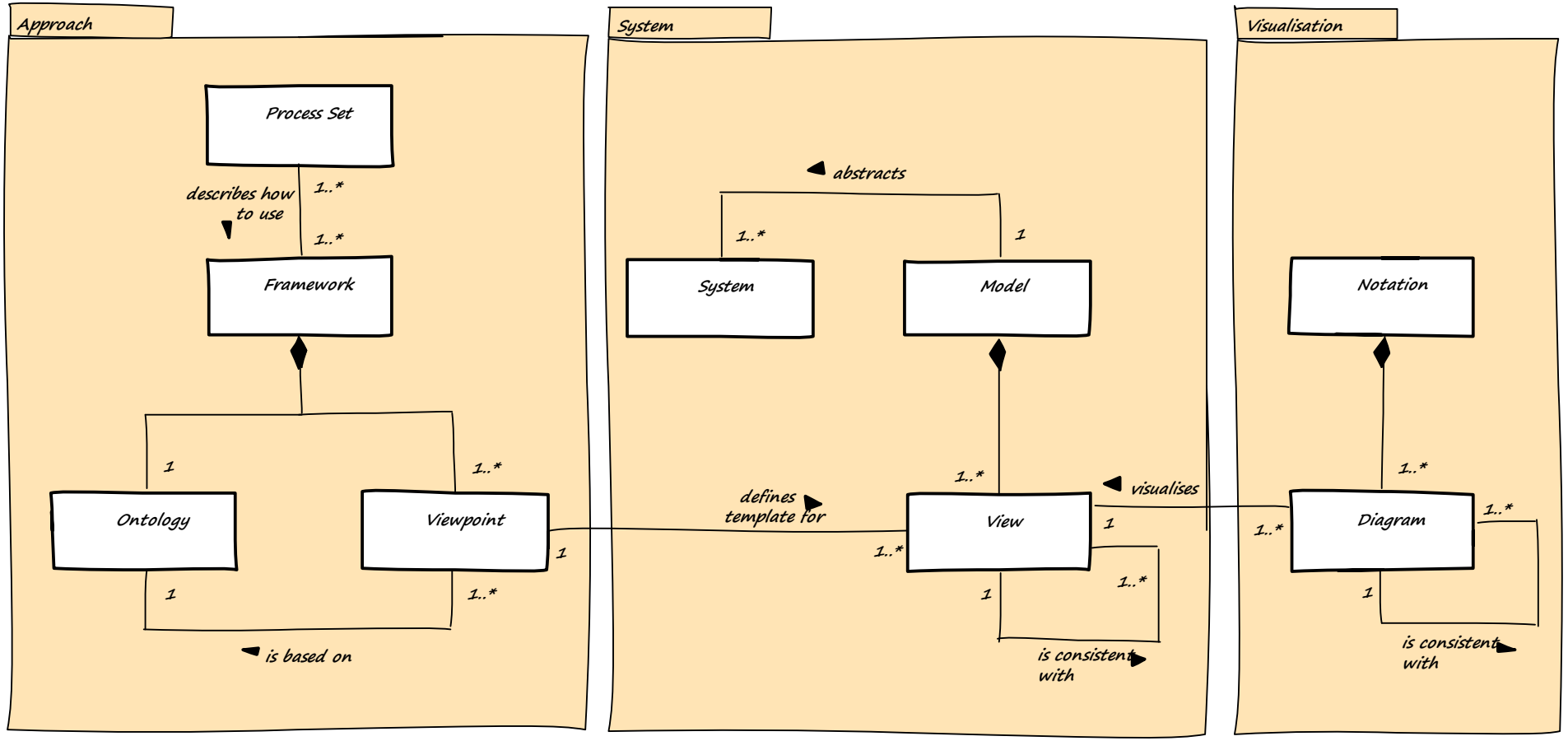
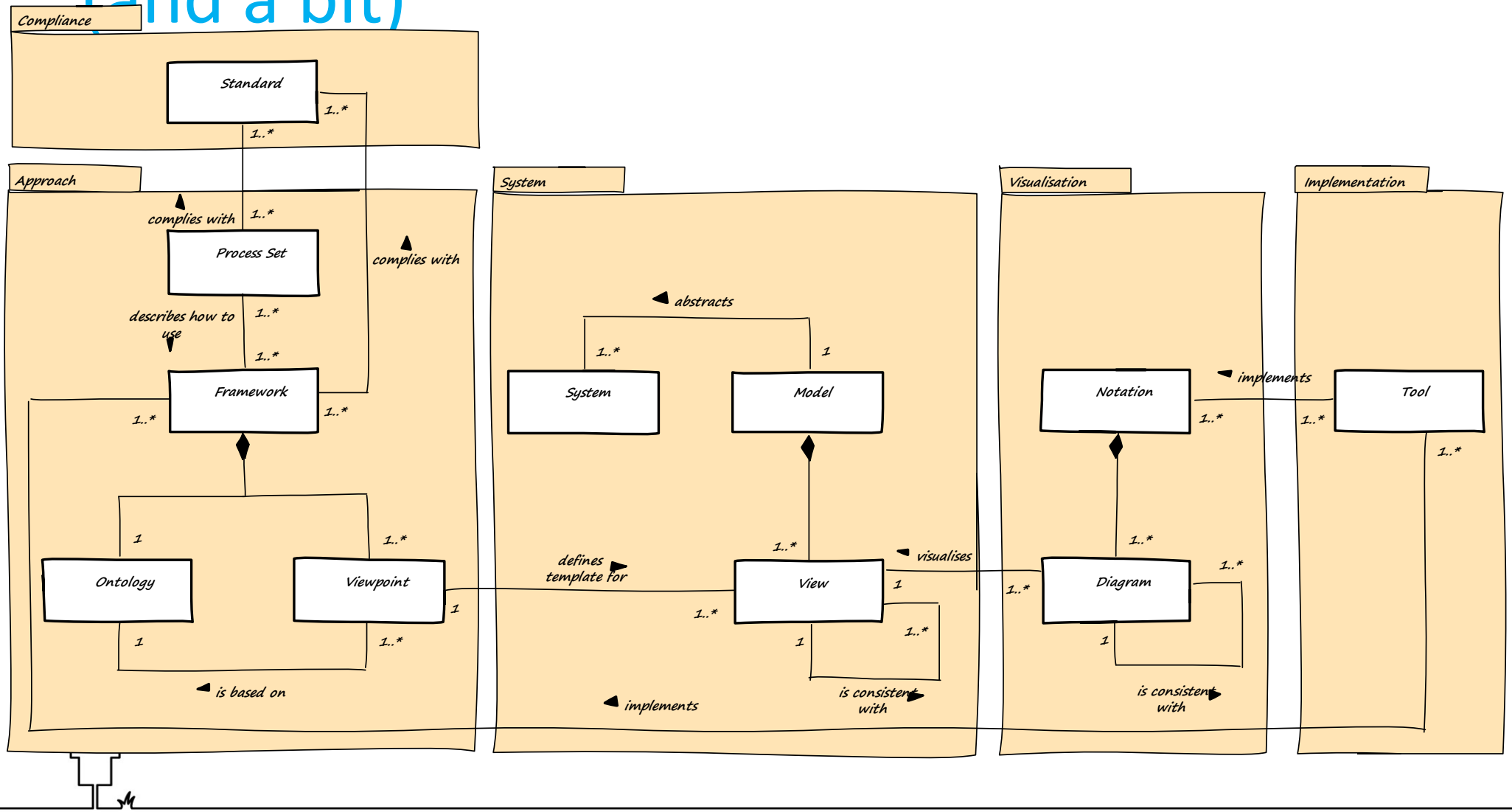
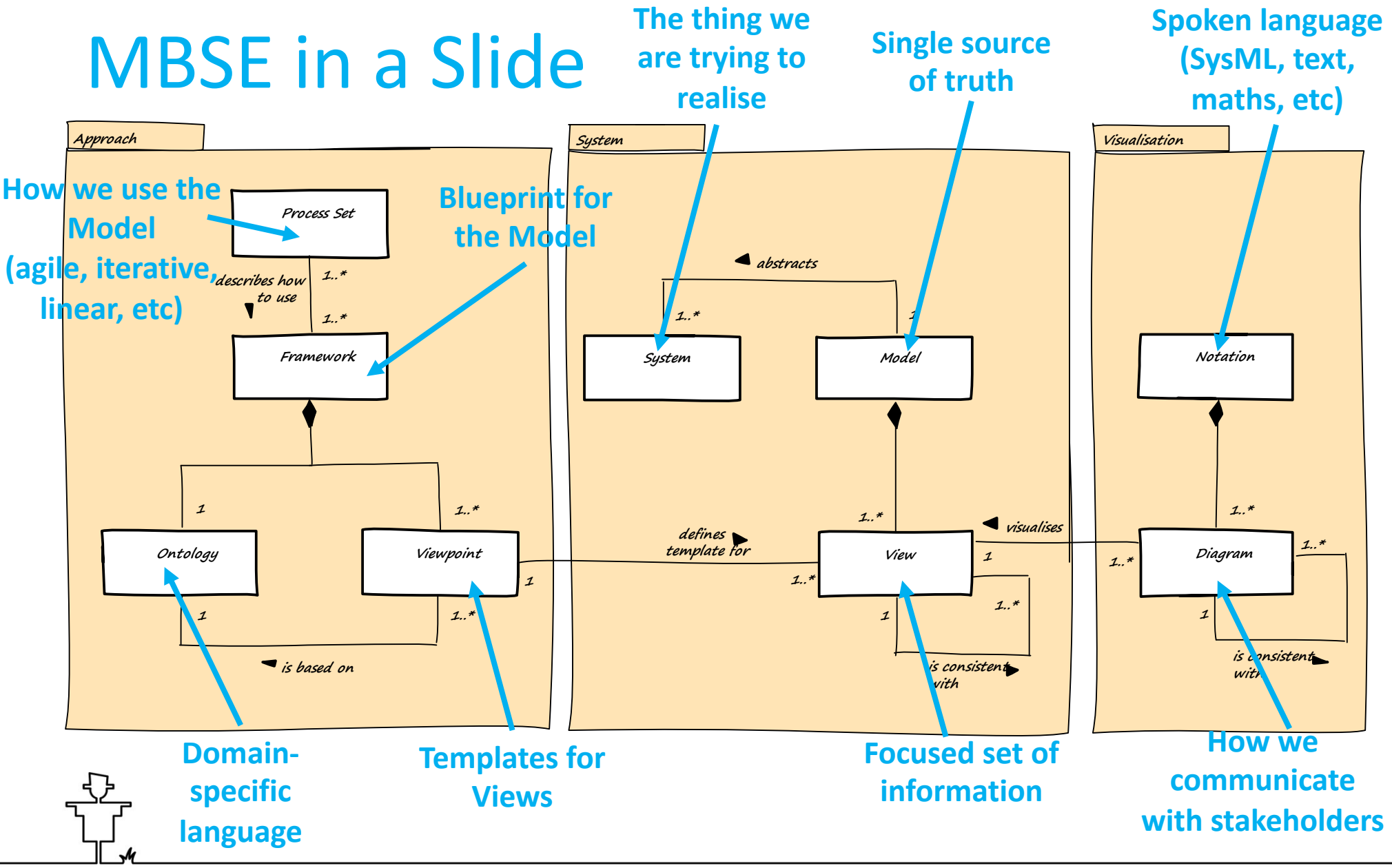
Additional information – MBSE in a Slide



Additional information – MBSE in a Slide (and a bit)



MBSE in a Slide



MBSE in a Slide (and a bit)

How we demonstrate compliance (standards, legislation, certification, etc)

How we implement the model (SysML tools, mathematical tools, simulations, CAD, management tools, etc