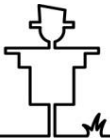


Deploying MBSE

Overview & Techniques





Why, hello there...

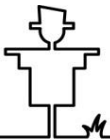
Prof Jon Holt

PhD, BEng, CEng FIET, FBCS CITP, FINCOSE

Director, Scarecrow Consultants Ltd

Professor of Systems Engineering, Cranfield University

Technical Director, INCOSE UK



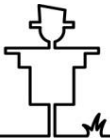
Overview

1. Introduction
2. The reason – why MBSE?
3. MBSE Evolution
4. MBSE Capability
5. Some techniques
6. Summary



Interlude

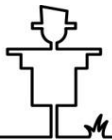
the origin of this presentation...



1996



Star Wars Tazos!



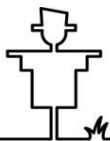
Star Wars Tazos!



Star Wars Tazos!



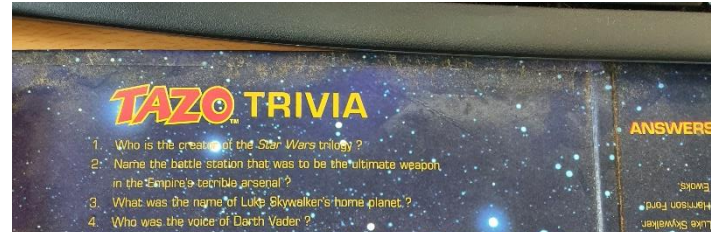
Limited Edition Collectors' Force Pack!



1. Who is the creator of the *Star Wars* trilogy?
2. Name the battle station that was to be the ultimate weapon in the Empire's terrible arsenal?
3. What was the name of Luke Skywalker's home planet?
4. Who was the voice of Darth Vader?
5. What was the name of Darth Vader before he turned to the dark side of the Force?
6. What connection is there between Luke Skywalker and Princess Leia?
7. The soundtrack for *Star Wars* was written by which famous composer?
8. Which planet was used to test the destructive power of the Death Star in *Star Wars*?
9. How many languages can C-3PO translate?
10. In which location do Ben and Luke meet Han Solo for the first time?
11. In which star system does Yoda live?
12. Where did Princess Leia hide the plans for the Death Star battle station?
13. Which old friend of Han Solo betrayed him in *The Empire Strikes Back* leading to his capture by the Empire?
14. How tall is Chewbacca?
15. Which singer from Shalamar played C-3PO?
16. Which former Hammer Horror star played the Emperor's right-hand man in *Star Wars*?
17. Who ends Obi-Wan Kenobi's life in *Star Wars*?
18. In *Return Of The Jedi*, the Rebel Star Line finds new furry allies on the Moon of Endor, what were they called?
19. What was the name of the starfighter Luke Skywalker piloted on his successful mission to destroy the Death Star?
20. What is the name of the notorious bounty hunter featured in *The Empire Strikes Back* and *Return of the Jedi*?
21. Who is Han Solo's co-pilot on the Millennium Falcon?
22. What species is Chewbacca?
23. Who kills Jabba the Hutt in *Return Of The Jedi*?
24. Who does Luke Skywalker have to confront to become a Jedi Knight?
25. Which crime lord does Han Solo owe money to?
26. In which year was *Star Wars* first released?
27. Who does Luke and C-3PO confront within the desert whilst looking for R2-D2 in *Star Wars*?
28. Which character from the trilogy has George Lucas named his Californian ranch after?
29. Name the actor who plays Han Solo?
30. Who lives on the Moon of Endor?

10. Ewacht
 9. Harrison Ford
 8. Luke Skywalker
 7. Sand People
 6. 1972
 5. Jabbu the Hutt
 4. Jabba the Hutt
 3. Princess Leia
 2. Wookiee
 1. Chewbacca
 0. Dooe Hatt
 X. Wang Lighten
 10. Ewacht
 9. Harrison Ford
 8. Luke Skywalker
 7. Sand People
 6. 1972
 5. Jabbu the Hutt
 4. Jabba the Hutt
 3. Princess Leia
 2. Wookiee
 1. Chewbacca
 0. Dooe Hatt
 X. Wang Lighten

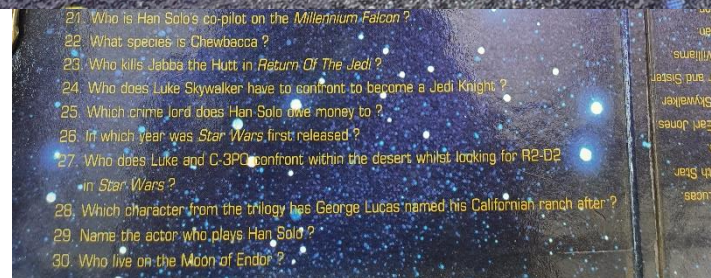
The Quiz



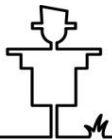
14. How tall is Chewbacca ?

15. Which singer from Shalamar played C-3PO ?

16. Which former Hammer Horror star played the Emperor ?



Fast forward Tenby 2011!



The Las Vegas of Wales!



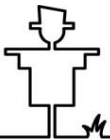
Tenby culture



The Coach and Horses

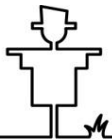


The voice in my head



The voice in my head

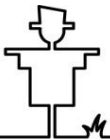
**Tell them
about C3PO**



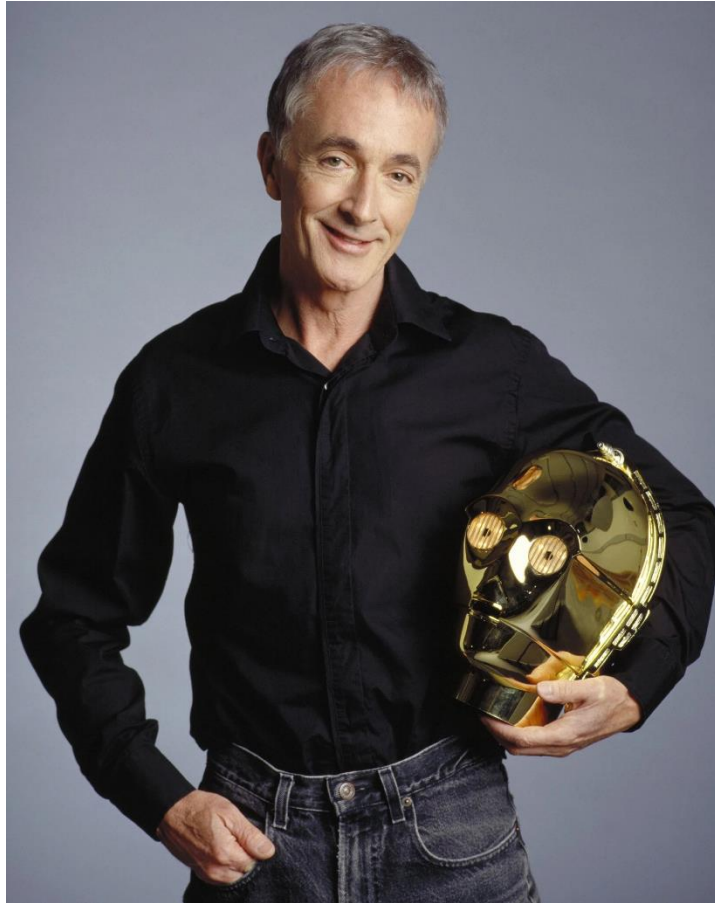
The voice in my head

**Tell them
about C3PO**

**That's not
true!**

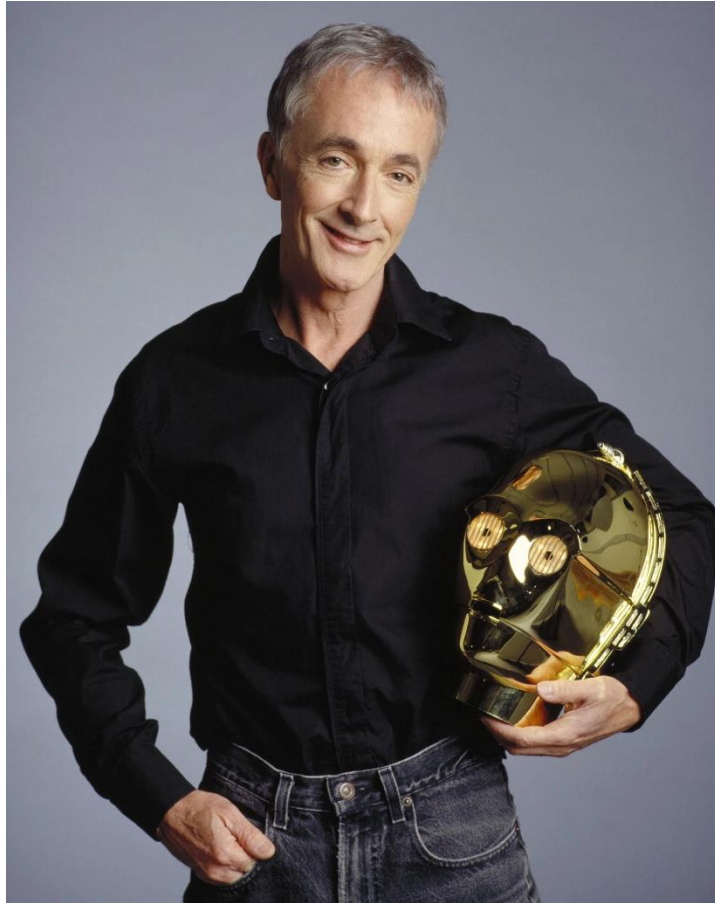


Will the real Mr Daniel(s) please stand up?



Anthony Daniels (C3PO)

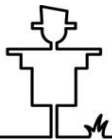
Will the real Mr Daniel(s) please stand up?



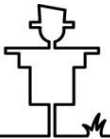
Anthony Daniels (C3PO)



Jeffrey Daniel (Shalamar)



*Just because you read it
somewhere, doesn't make it
true!*

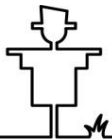
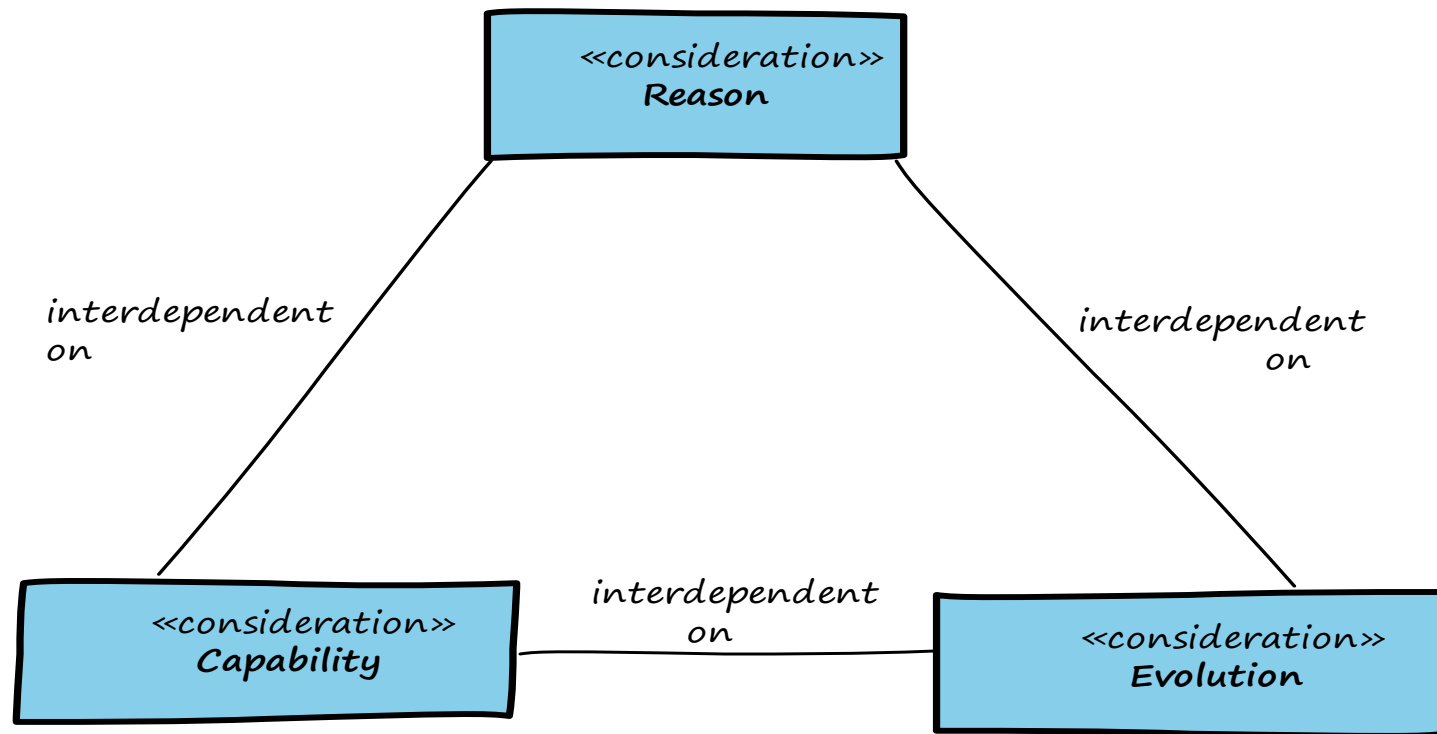


1. Introduction

- Deploying MBSE is increasingly more important
 - MBSE becoming more established
 - MBSE being widely adopted
- Trinity is a model-based approach for MBSE deployment
 - Based around exploring three key Considerations
 - Answers then form an evolutionary path on how to implement the MBSE deployment strategy



The Trinity of Considerations

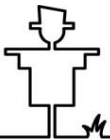
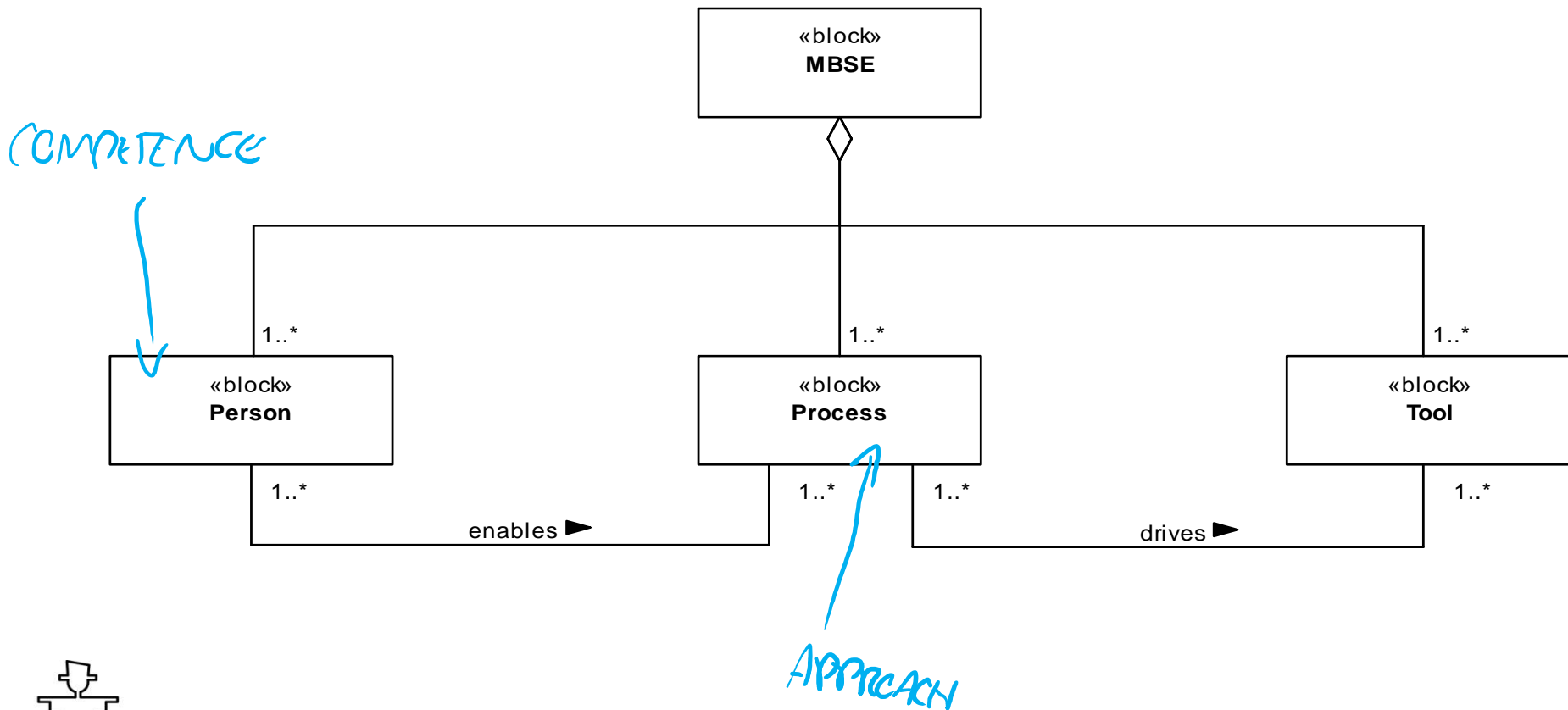


2. Reason – why MBSE?

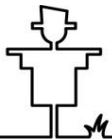
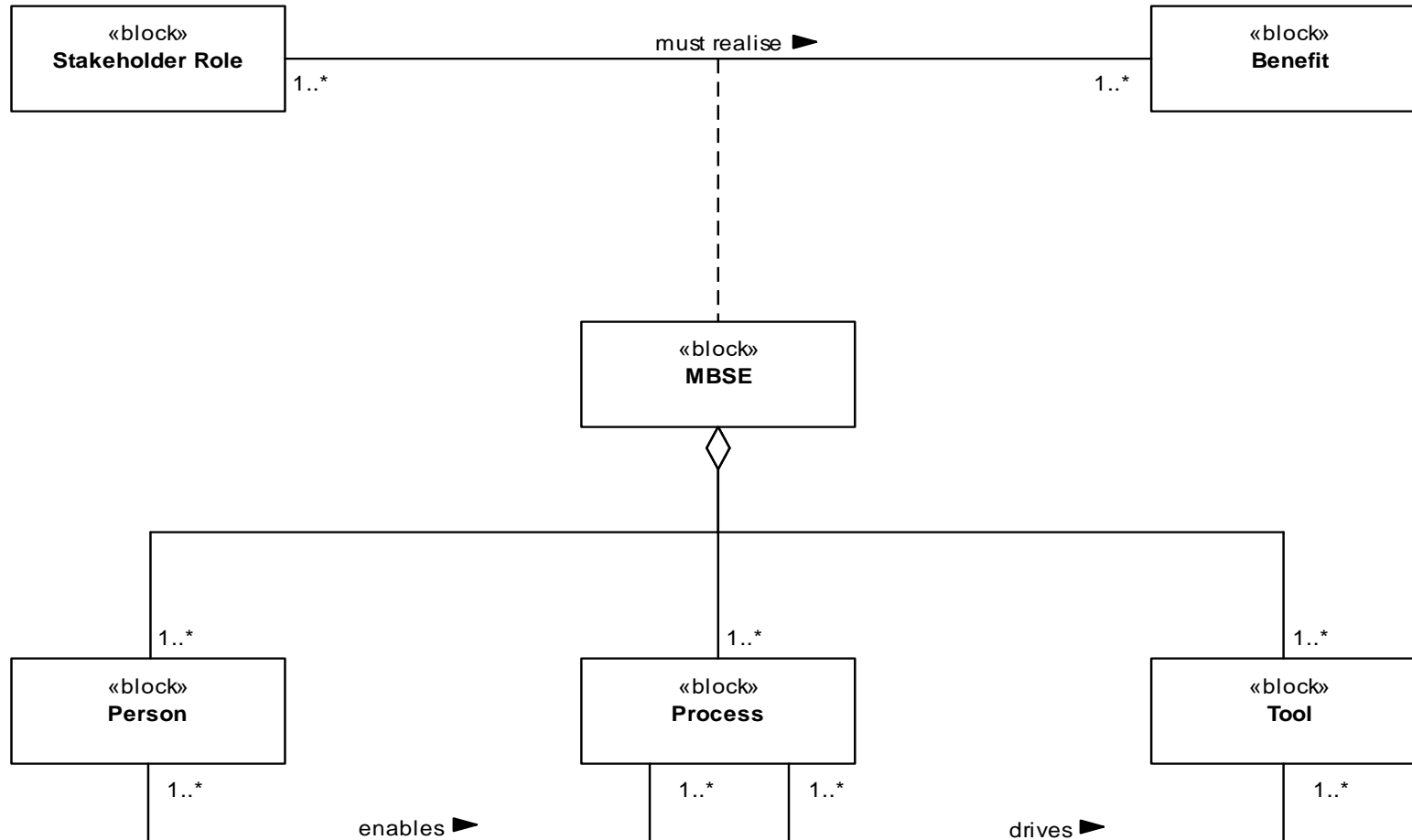
- *Why* does the organisation want to implement MBSE?
- Knowing ‘why’ is essential
- ‘Why’ will depend on context
 - Different stakeholders have different needs
 - Different stakeholders want different benefits
- If you don’t know why, then don’t do it!



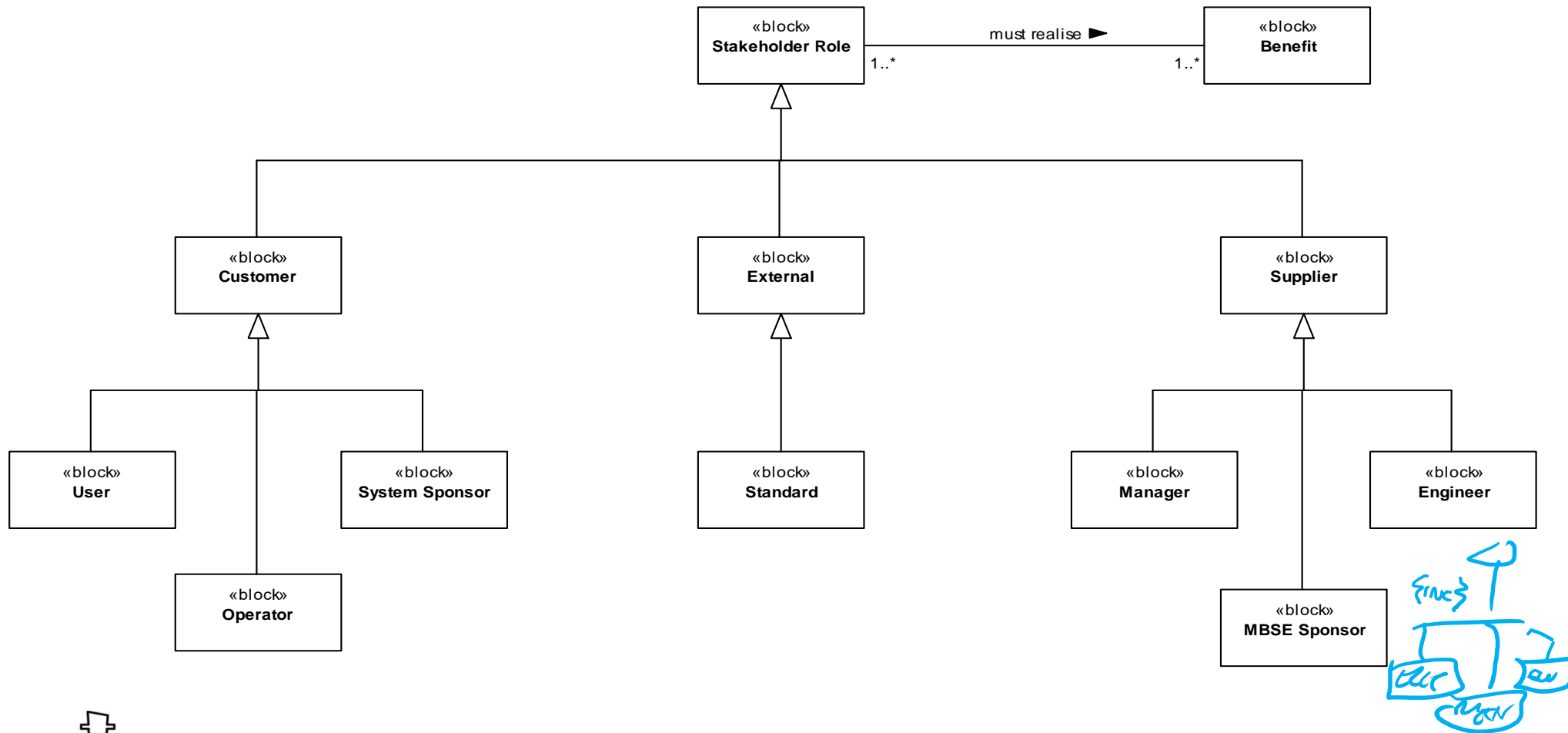
Realising MBSE



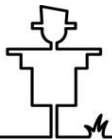
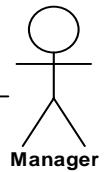
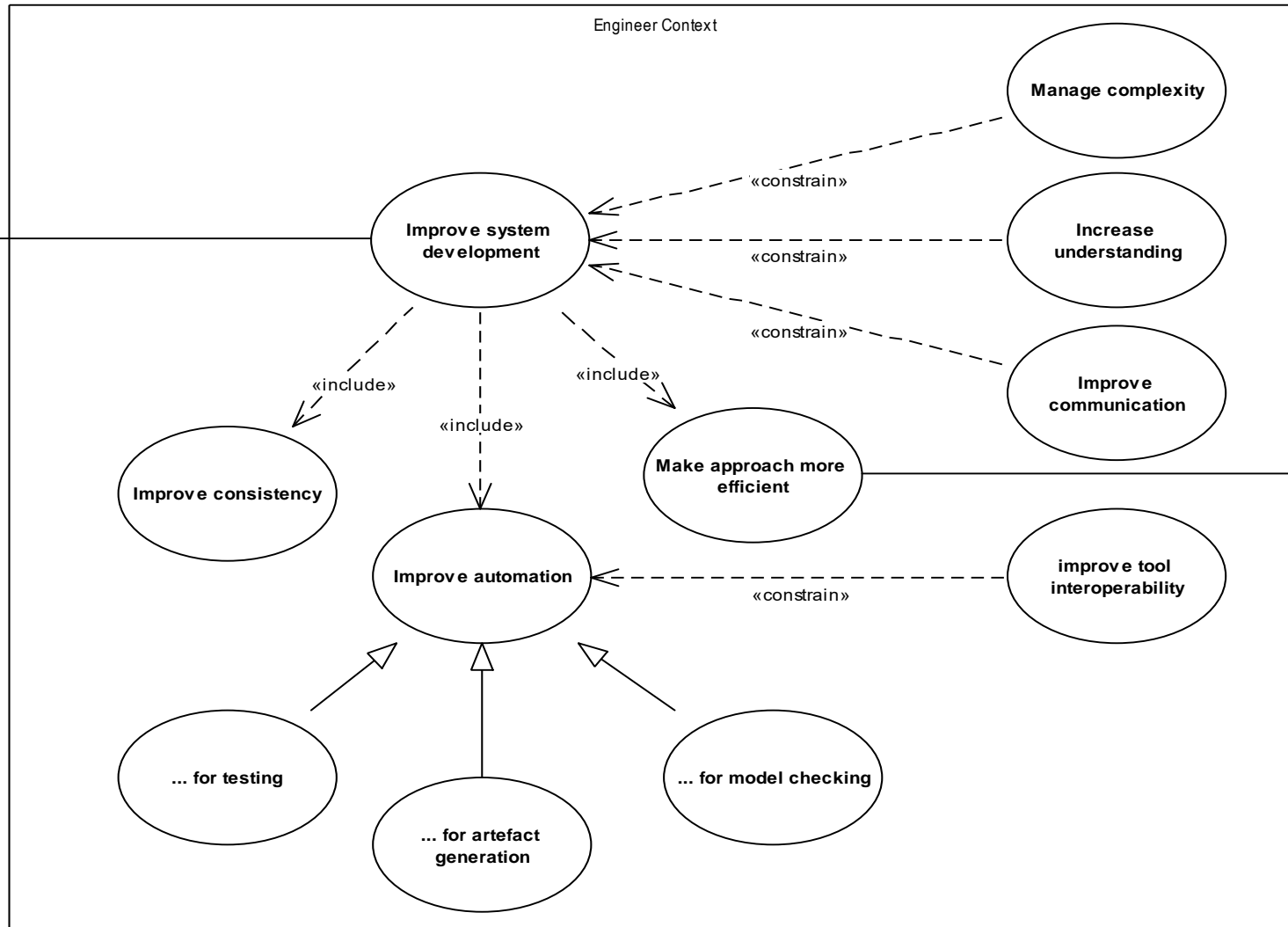
Realising MBSE Benefits



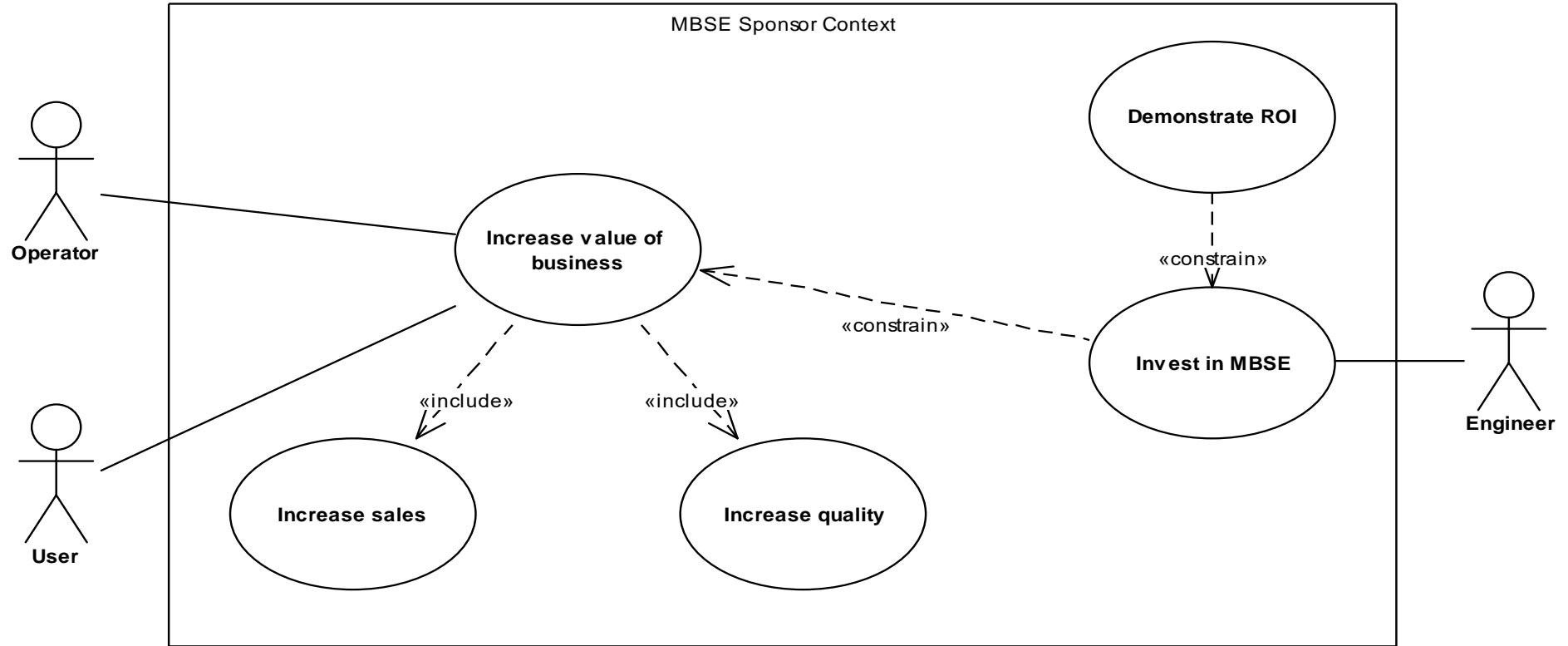
Typical MBSE Stakeholder Roles



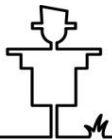
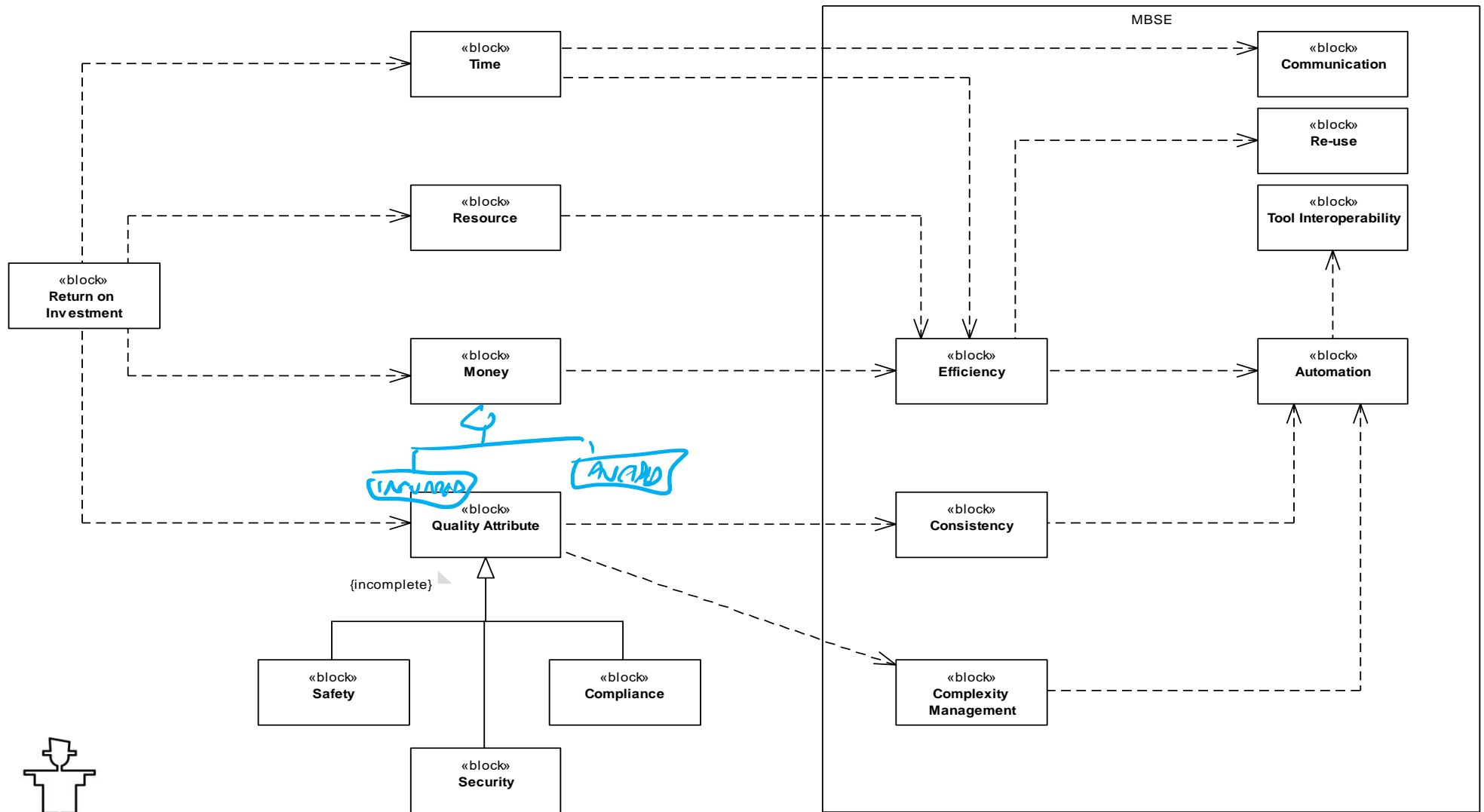
Engineer Context



MBSE Sponsor Context



Identified Benefits of MBSE



3. MBSE Evolution

- *How* does the organisation need to evolve in terms of its People, Processes and Tools to be able to do what they want to do in the future?
- In other words:
 - Where are you now?
 - Where do you want to be?
- See presentation number 1!
 - <https://www.youtube.com/watch?v=bcvWf4pGTz4>



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)



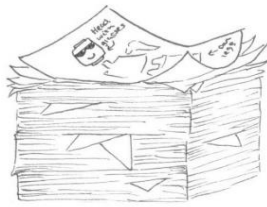
Evolution of MBSE

*As the complexity of our Systems evolves over time....
....so must our approach to Systems Engineering....
....MBSE is the natural evolution of Systems Engineering*



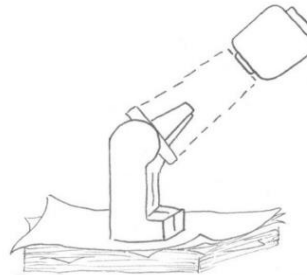
Stage 1:

Document-
based



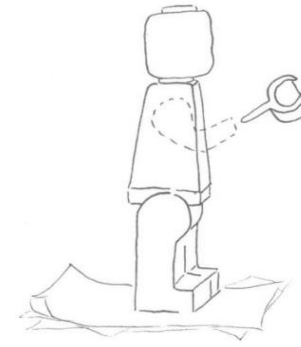
Stage 2:

Document-
centric



Stage 3:

Model-
enhanced



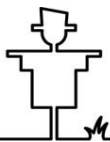
Stage 4:

Model-
centric



Stage 5:

Model-
based

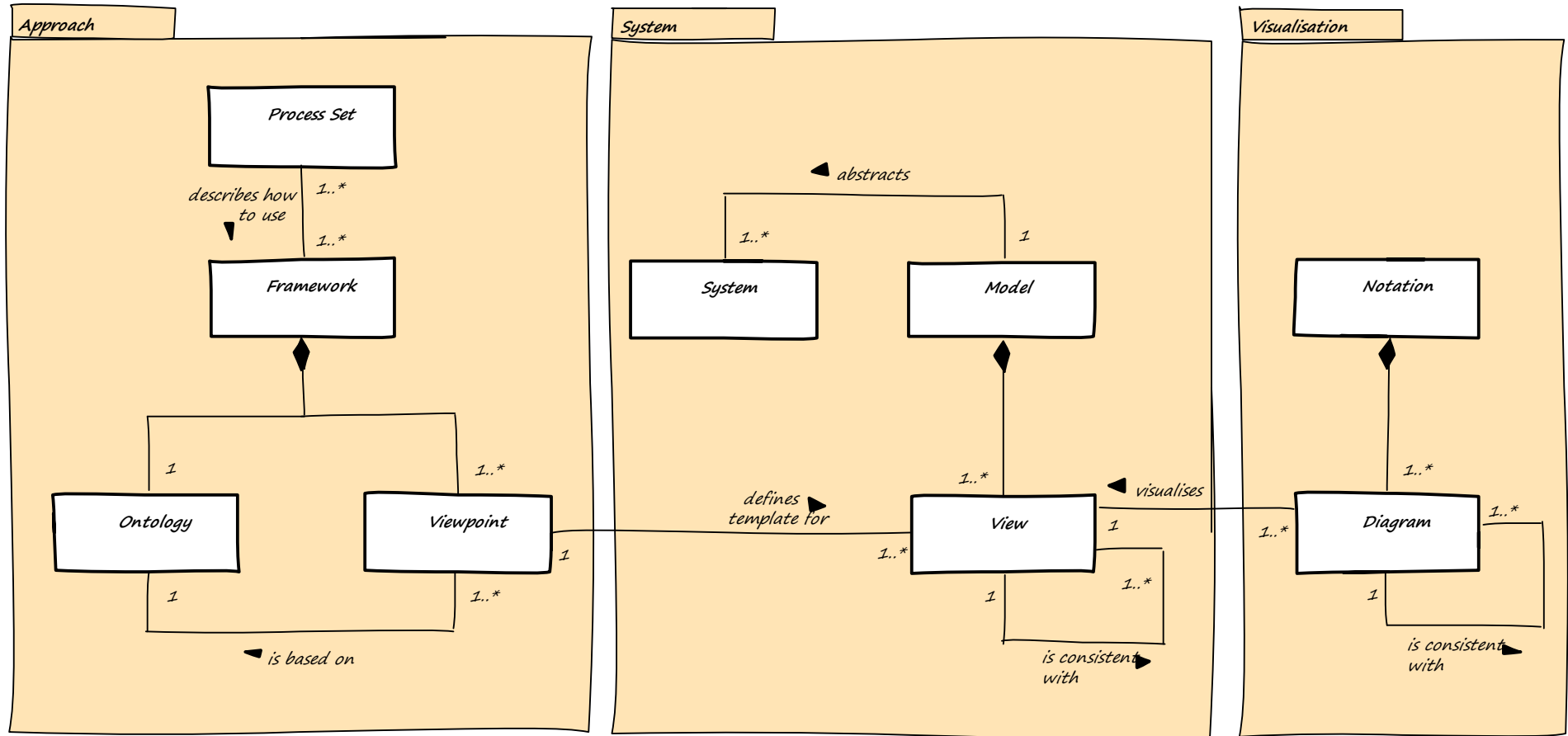


4. MBSE Capability

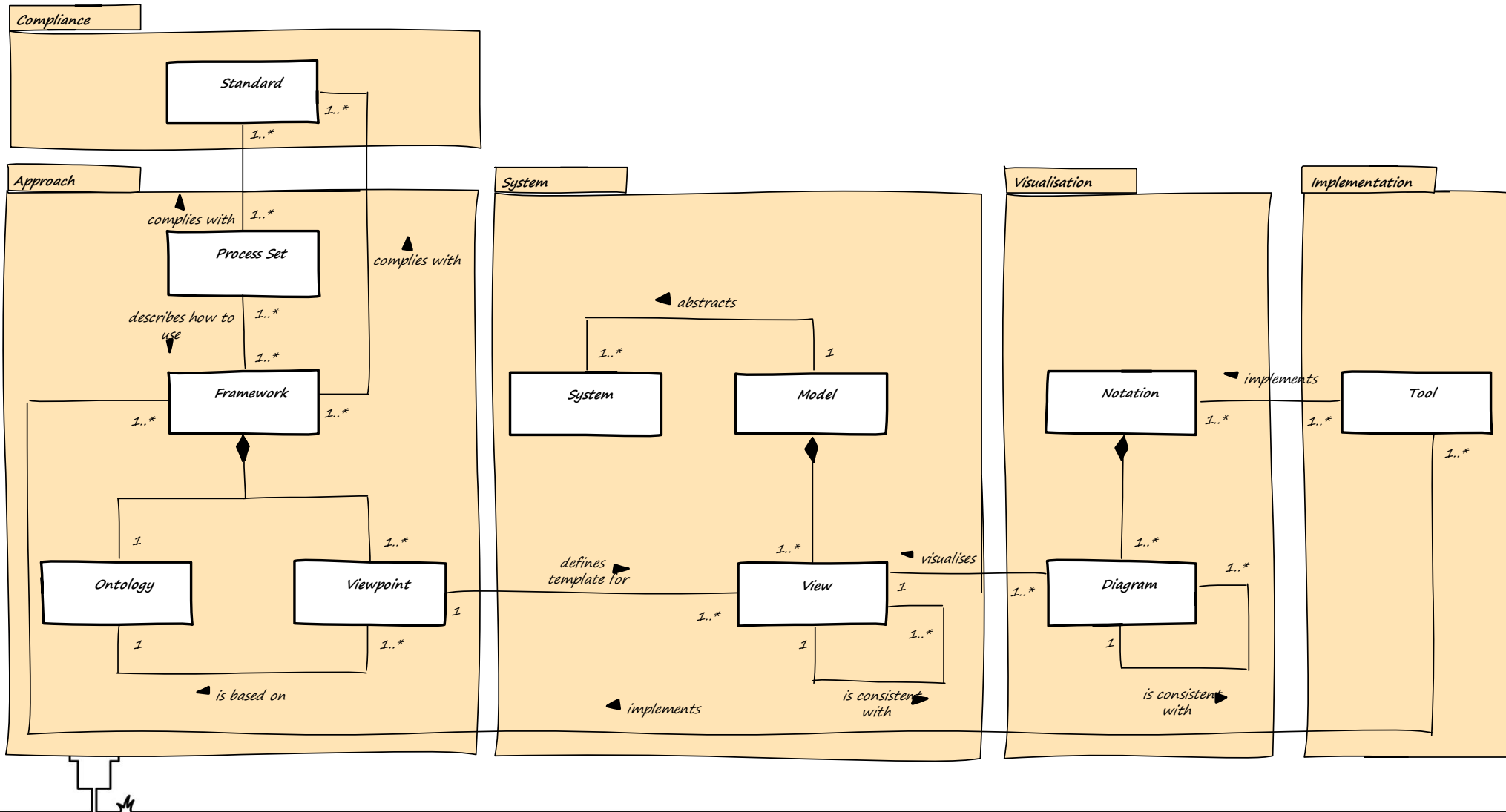
- *What*, with regards to MBSE, can the organisation already do and what do they want to be able to do in the future?
- In other words:
 - Where are you now?
 - Where do you want to be?
- See Presentation number 2!
 - <https://www.youtube.com/watch?v=rctS5cpqjsc>



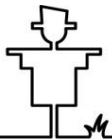
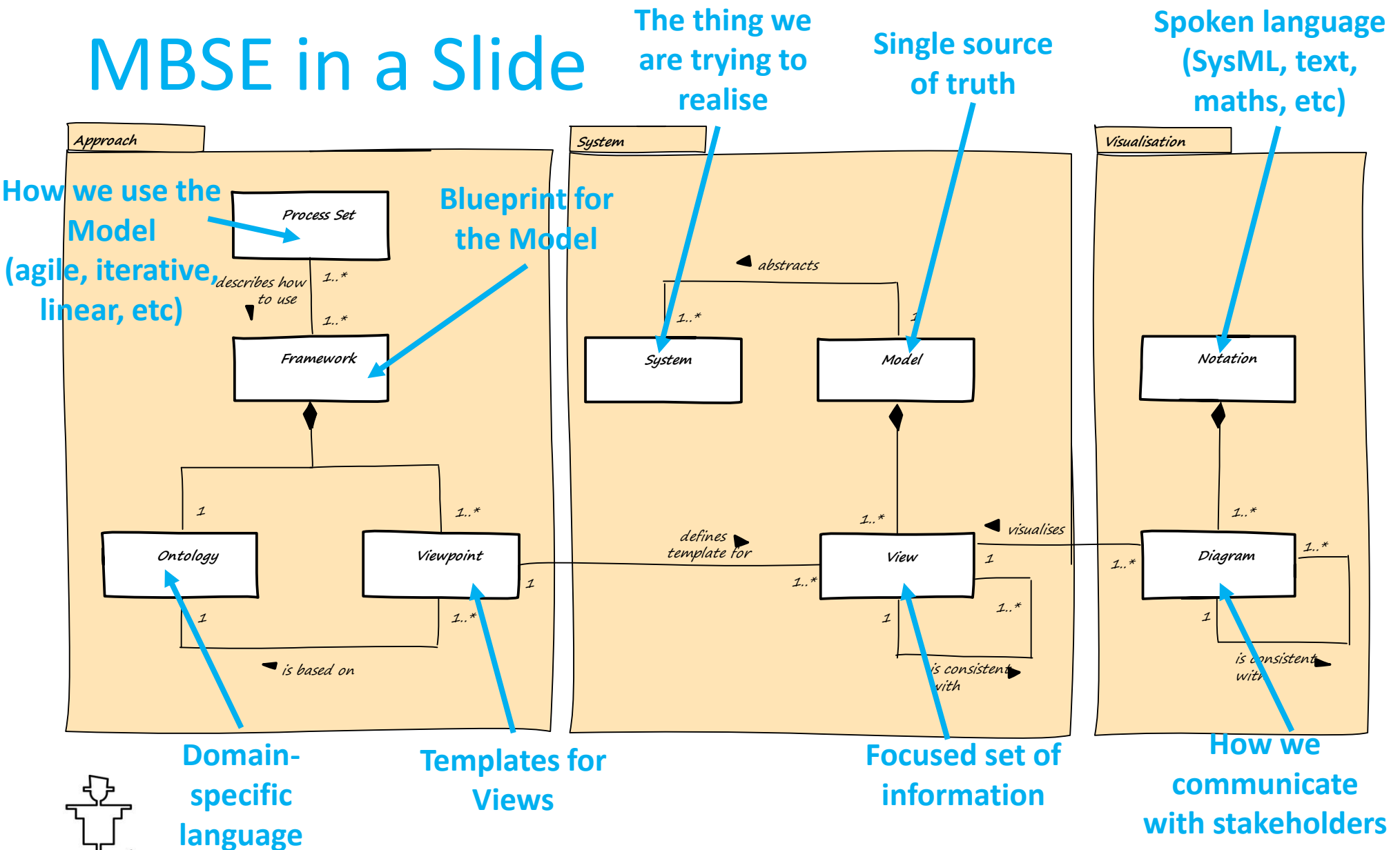
MBSE in a Slide



MBSE in a Slide (and a bit)



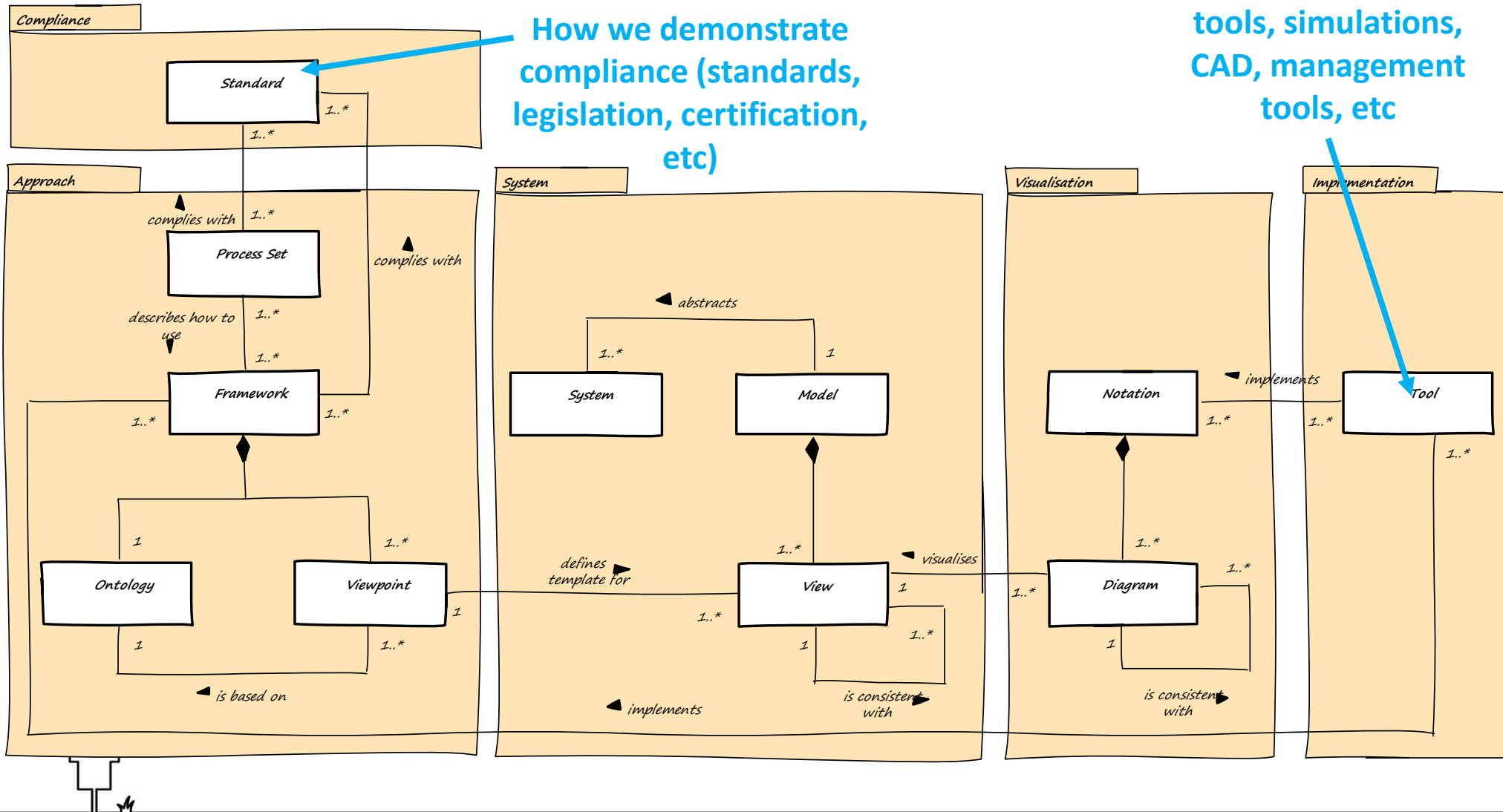
MBSE in a Slide



MBSE in a Slide (and a bit)

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

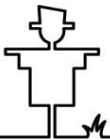
How we demonstrate
compliance (standards,
legislation, certification,
etc)



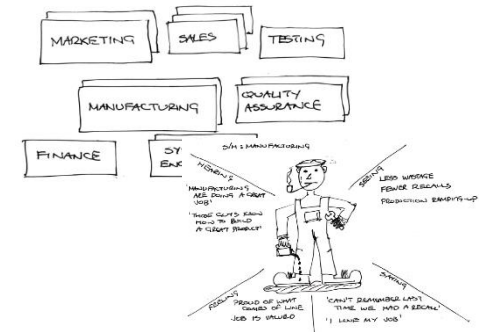
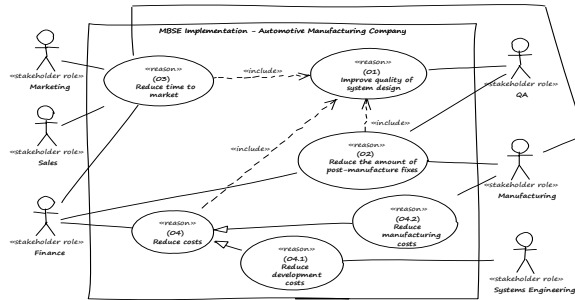
5. Some techniques

- This is all well and good, but....

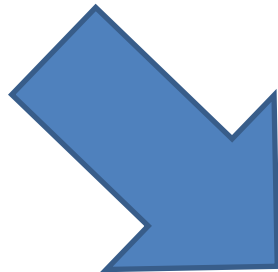
*How on earth do we do
this?*



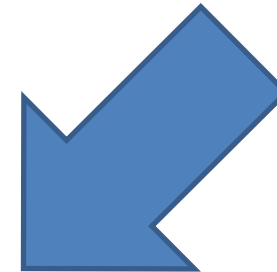
Reason - Why do you want MBSE?



Context modelling



TeamStorming



Reason



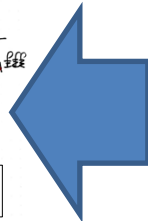
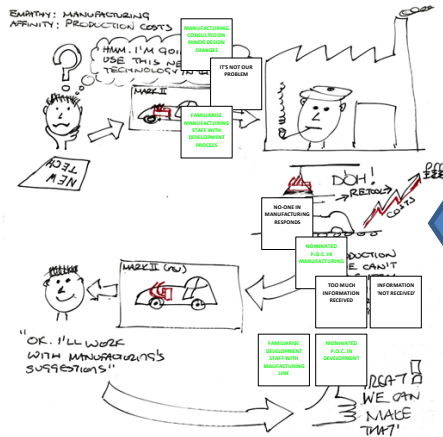
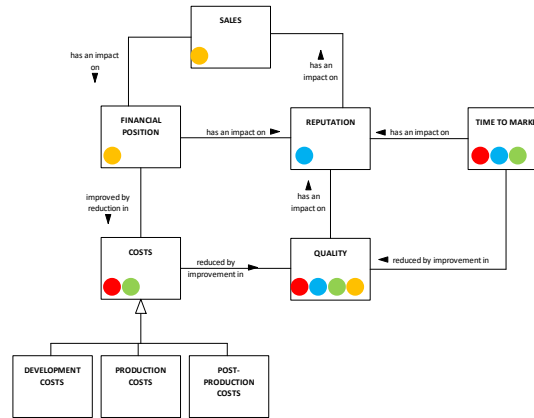
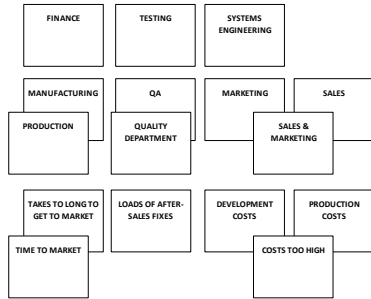
TeamStorming – How it Works

- Can be run at two levels:
 - Over a day or more – standard TeamStorming
 - Over a few hours – TeamStorming Lite
- TeamStorming consists of a number of Games
 - Group of 12 to 40 people
 - Answer a specific key question
- In this case:

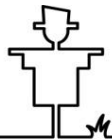
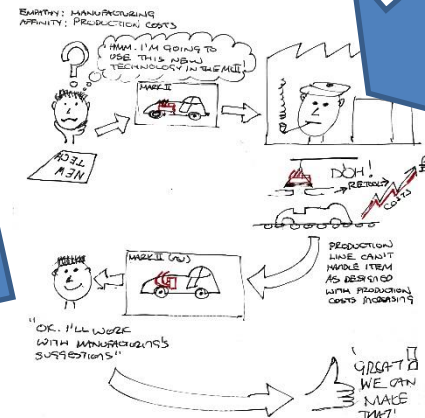
Why do we want to implement MBSE in our business?



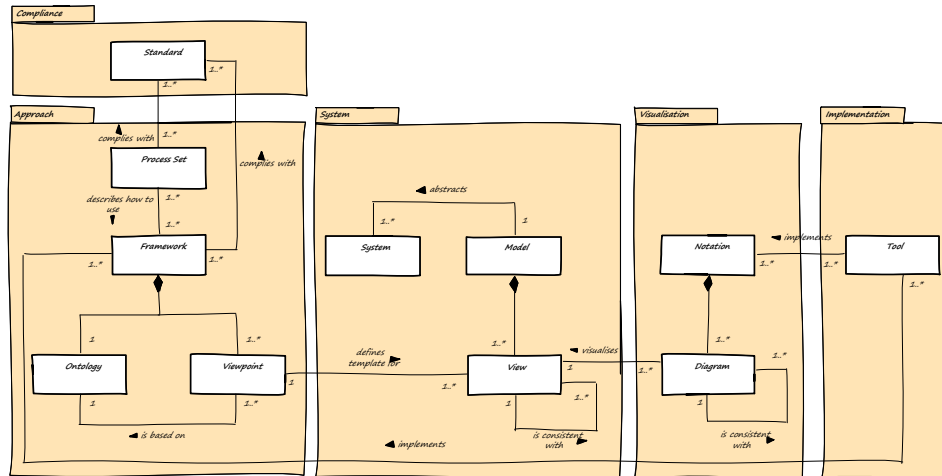
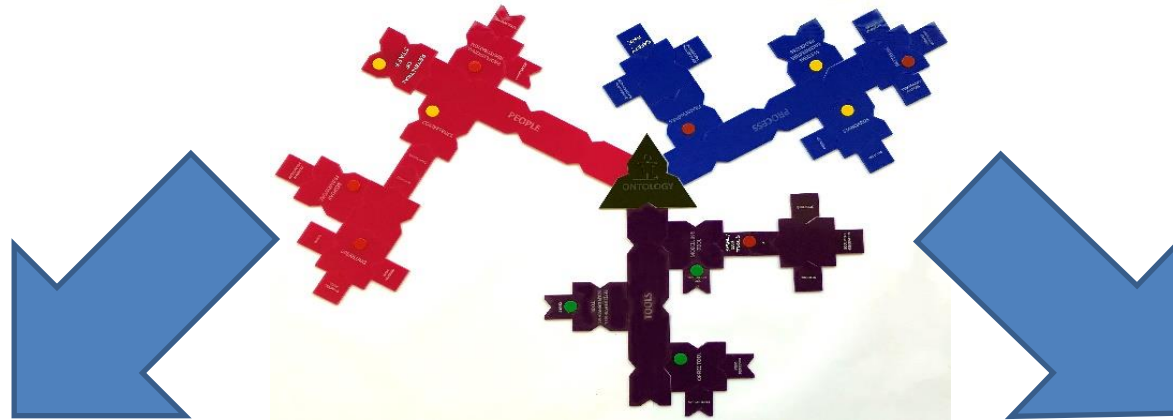
The Big Picture



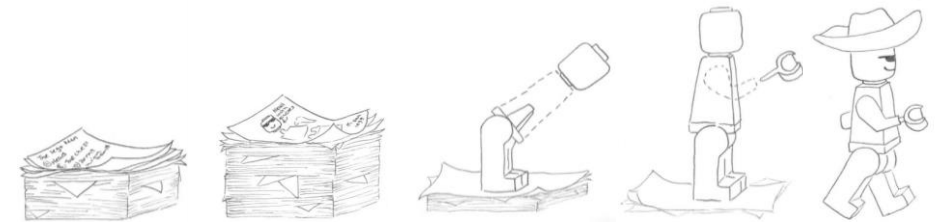
MANUFACTURING CONSULTED ON MAJOR DESIGN CHANGES	
NOMINATED P.O.C. IN MANUFACTURING	MONINATED P.O.C. IN DEVELOPMENT
FAMILIARISE DEVELOPMENT STAFF WITH MAUFACTURING LINE	FAMILIARISE MANUFACTURING STAFF WITH DEVELOPMENT PROCESS
NO-ONE IN MANUFACTURING RESPONDS	IT'S NOT OUR PROBLEM
INFORMATION 'NOT RECEIVED'	TOO MUCH INFORMATION RECEIVED



Capturing Capability & Evolution – RAVEnS



Capability



Stage 1:
Document-
based

Stage 2:
Document-
centric

Stage 3:
Model-
enhanced

Stage 4:
Model-
centric

Stage 5:
Model-
based

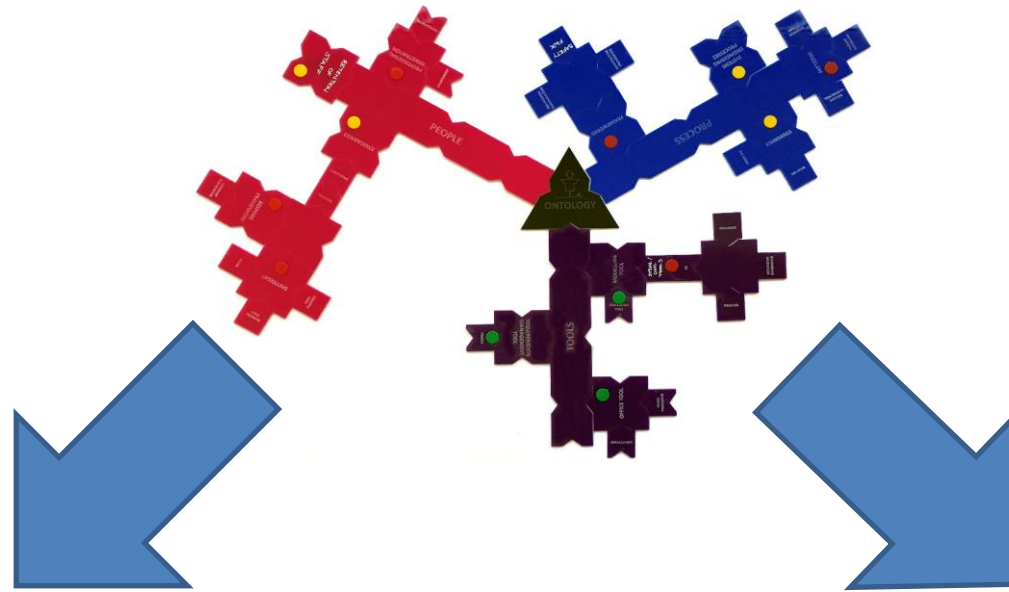
Evolution

Applying RAVEnS

- Review and Visualization of Enabling Strategy
- Used to determine current & future
 - Capability
 - Evolution
- Determine the scope
 - Group, project, organisation?
 - Identify key stakeholders
- Consider
 - People
 - Process
 - Tools

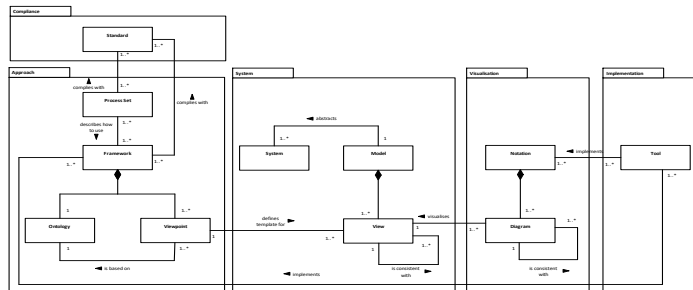


Overview – Current Capability



Red = no capability
Yellow = some capability
Green = capability

- Aware of standards
- Not actively conforming



- Informal, undocumented process
- No framework

- Document-centric approach only
- Nothing to ensure consistency

- Informal Visualisation
- Diagrams from simulation tool used

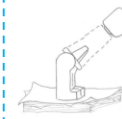
- Use of Cradle Requirements Management Tool
- Use of simulation tool
- No MBSE modelling tool used



Stage 1:
Document-
based



Stage 2:
Document-
centric



Stage 3:
Model-
enhanced

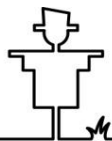


Stage 4:
Model-
centric



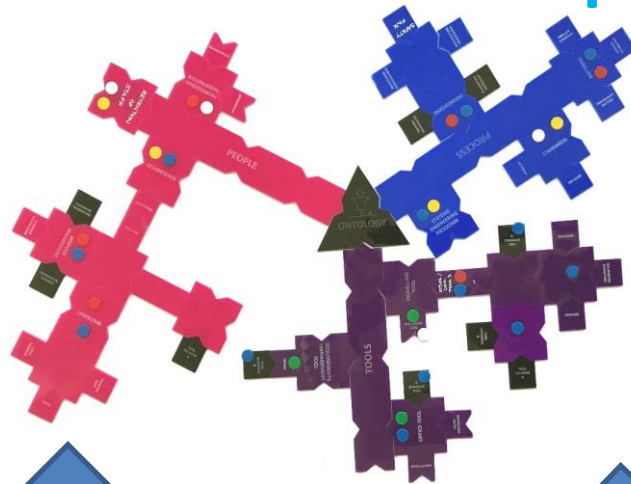
Stage 5:
Model-
based

- Staff with SE Competence
- MBSE Champion in place
- Informal, undocumented document-based process
- Using office tools, inc. drawing package
- Well-established use of Cradle Requirements Management Tool
- Well-established use of simulation tools

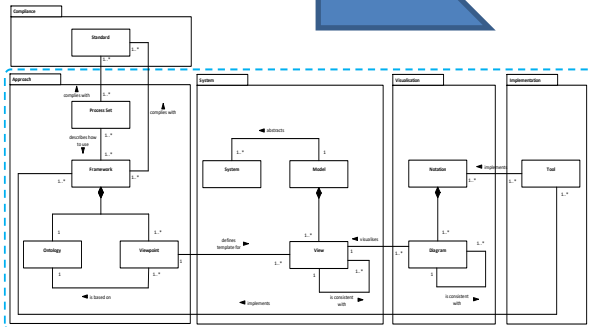


Overview – Desired Capability

White = not considered
Blue = considered



- Aware of standards
- Not actively conforming



- Full framework, including safety and variant modelling
- Defined and documented approach
- Ability to maintain framework
- Full model-centric approach
- Automated consistency checks
- SysML-based visualisation
- Use of EA SysML Tool
- Integration of EA with Cradle
- Document generation from EA

- SysML training
- MBSE mentoring
- Framework & process workshops
- Framework & process implementation
- Framework & process training
- Tool training
- Script development
- Cradle integration

- MBSE training
- Document generation mentoring
- Safety profile implementation
- Safety profile mentoring
- Framework creator mentoring
- Scripting mentoring



Stage 1:
Document-
based

- Staff with SE Competence
- MBSE Champion in place
- Informal, undocumented document-based process
- Using office tools, inc. drawing package
- Well-established use of Cradle Requirements Management Tool
- Well-established use of simulation tools



Stage 2:
Document-
centric



Stage 3:
Model-
enhanced

- Practical SysML competence
- Knowledge of key MBSE concepts
- Initial framework
- Initial process model
- EA tool familiarity
- Interface with Cradle
- Some automated checks



Stage 4:
Model-
centric

- Increasing knowledge of MBSE
- Maturing framework
- Full process model
- Use of standard patterns
- Simple document generation
- Initial safety profile
- Increasing automated checks



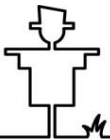
Stage 5:
Model-
based

- Able to create frameworks & profiles
- Full framework
- Full process model
- Inclusion of Variant Modelling in framework
- Full document generation
- Full automated checks

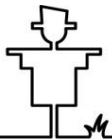
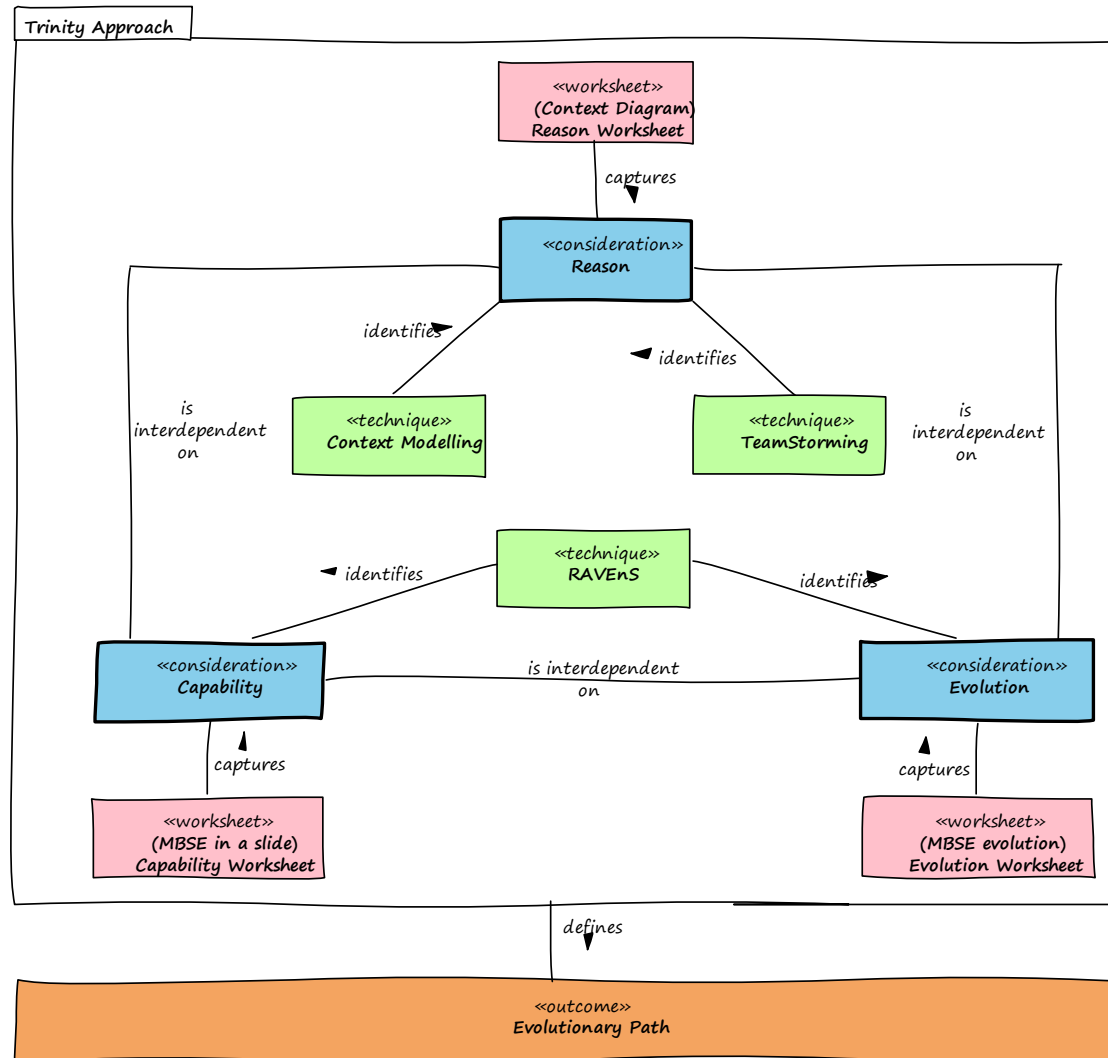


Defining the strategy - the Evolutionary Path

- Information captured on Reason, Capability and Evolution (via Worksheets) is brought together
 - Forms Evolutionary Path
- Capture in 'MBSE Implementation Strategy'



The Evolutionary Path



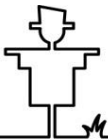
Evolutionary Path – Timescale

Starting Stage: Stage 2: Document-centric			
Target Stage	Timescale (from start)	Capabilities to Achieve in Stage	Activities Needed to Achieve Stage & Capabilities
Stage 3: Model-enhanced	3 months	<ul style="list-style-type: none"> ▪ Practical SysML competence ▪ Knowledge of key MBSE concepts ▪ Initial framework ▪ Initial process model ▪ EA tool familiarity ▪ Interface with Cradle ▪ Some automated checks 	<ul style="list-style-type: none"> ▪ SysML training ▪ MBSE mentoring ▪ Framework & process workshops ▪ Framework & process implementation ▪ Framework & process training ▪ Tool training ▪ Script development ▪ Cradle integration
Stage 4: Model-centric	6 – 9 months	<ul style="list-style-type: none"> ▪ Increasing knowledge of MBSE ▪ Maturing framework ▪ Maturing process model ▪ Use of standard patterns ▪ Simple document generation ▪ Initial safety profile ▪ Increasing automated checks 	<ul style="list-style-type: none"> ▪ As for Stage 2 to 3 plus: ▪ MBSE training ▪ Document generation mentoring ▪ Safety profile implementation ▪ Safety profile mentoring
Stage 5: Model-based	12 – 18 months	<ul style="list-style-type: none"> ▪ Able to create frameworks & profiles ▪ Full framework ▪ Full process model ▪ Inclusion of Variant Modelling in framework ▪ Full document generation ▪ Full automated checks 	<ul style="list-style-type: none"> ▪ As for Stage 2 to 3 plus: ▪ MBSE training ▪ Document generation mentoring ▪ Framework creator mentoring ▪ Scripting mentoring



Evolutionary Path – Meeting the Reasons

ID	Reason	Met by (Capabilities & Activities)
0	Implement MBSE	<i>Met by 1 to 6</i>
1	Develop MBSE competence of staff	<ul style="list-style-type: none"> Knowledge of key MBSE concepts Increasing knowledge of MBSE MBSE training MBSE mentoring
1.1	Develop staff's competence with SysML	<ul style="list-style-type: none"> Practical SysML competence SysML training
2	Carry out model-based requirements engineering	<ul style="list-style-type: none"> Initial framework Initial process model Interface with Cradle Framework & process workshops Framework & process implementation Framework & process training Cradle integration
2.1	Conform to industry best-practice	<ul style="list-style-type: none"> Initial to Full framework Initial to Full process model Use of standard patterns
3	Use Sparx EA tool	<ul style="list-style-type: none"> EA tool familiarity Able to create frameworks & profiles Tool training Framework & process implementation Document generation mentoring Scripting mentoring Framework creator mentoring
4	Reduce time to market	<ul style="list-style-type: none"> Inclusion of Variant Modelling in framework Initial safety profile Safety profile mentoring

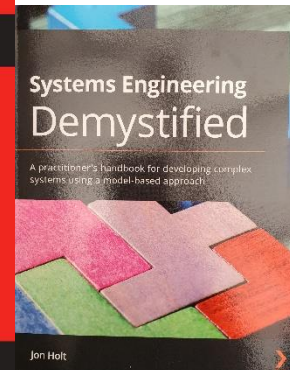
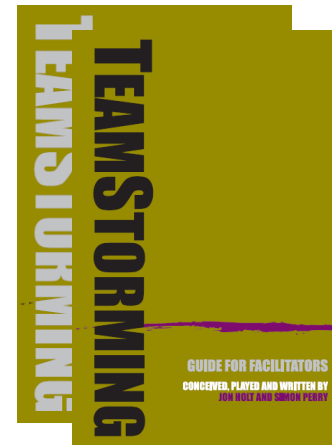
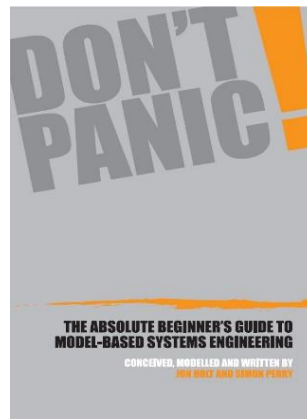
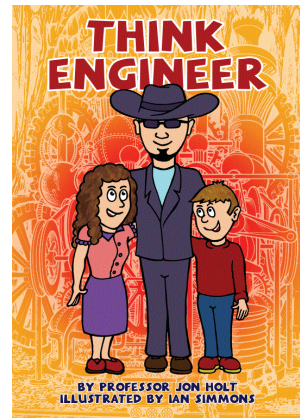
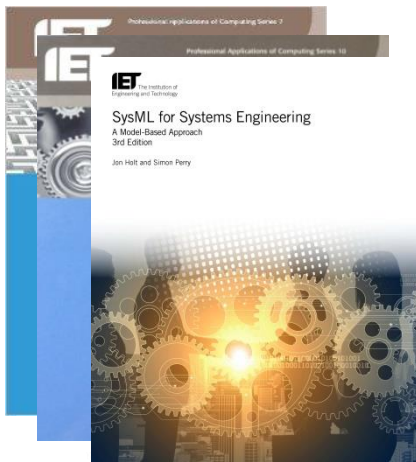
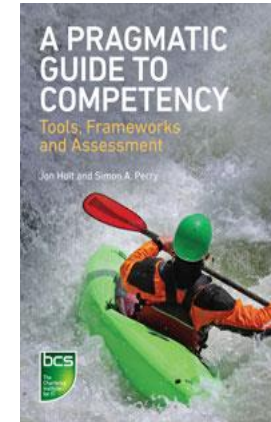
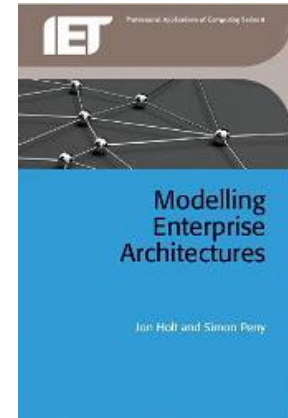
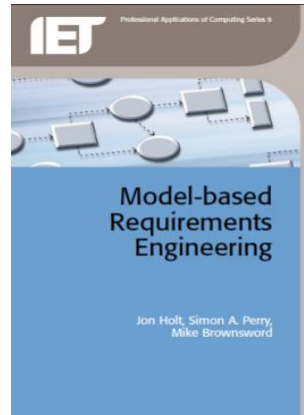
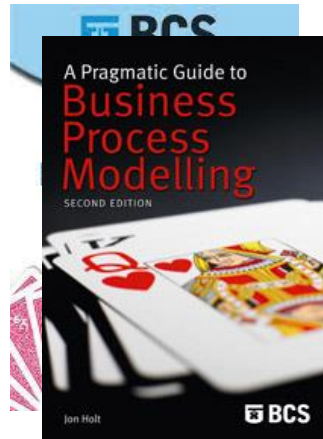
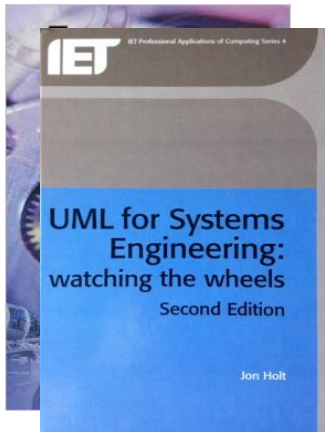


6. Summary

- Trinity has three Considerations
 - Reason
 - Capability
 - Evolution
- Explored using different techniques
- Results feed into Evolutionary Path
 - Part of the MBSE Implementation Strategy



Shameless self-promotion



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