



How to include Soft Modelling into an expanded MBSE approach

Keys: MBSE, SSM, Model

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Purpose

Purpose of this Session

Personal:

- I need your feedback on my Thesis Work.
- Your feedback will be reported in my Thesis (Anonymously)

Community:

- Share my findings and discuss the outcomes
- Get in touch if you are interested in this work



Work and Education

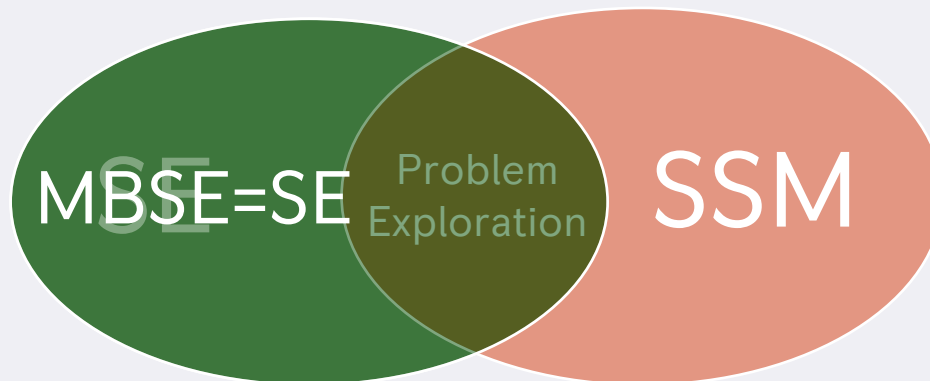
My Background

- Aerospace Engineering MSc – Politecnico di Torino (2006)
- Airbus – Software Engineer for Aerodynamics Methods and Tool in Flight Physics (2006)
- Airbus – Software Engineer for Loads and Weight Methods and Tool in Flight Physics (2010)
- Software Engineering MSc – Politecnico di Torino (*Started 2011 but never finished*)
- Roll-Royce – Controls Software Engineer EMU Trent 7000 (2014)
- Systems Engineering MSc – Cranfield University (*Jan 2017 -Jan 2021*)
- Roll-Royce – Controls Systems Engineer (2017)
- Roll-Royce – Project Systems Engineer – Future Concepts (2020)

It is assumed that ‘what’ is needed is already established whilst ‘how’ is up to the engineer tasked to the problem (Checkland and Scholes, 1999)

The Facts:

- ❑ Systems Engineering
- ❑ Soft Systems Methodology
- ❑ Model Based Systems Engineering

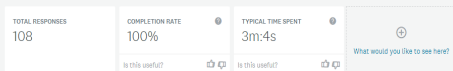


Succeeding with MBSE requires MBSE full adoption by the systems engineering community to an extent where SE = MBSE (Eisenmann, 2018).

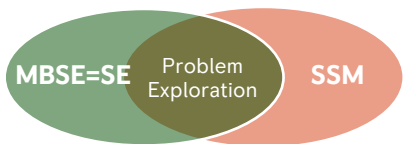
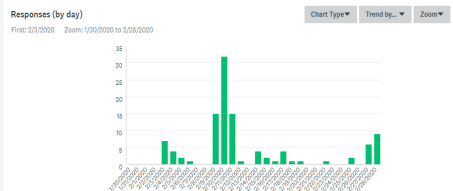
SSM have been proven successful and appropriate in understanding and structuring the problem before SE is used (Checkland and Scholes, 1999)

Survey

Insights



Trends



MBSE = SE is that true ?

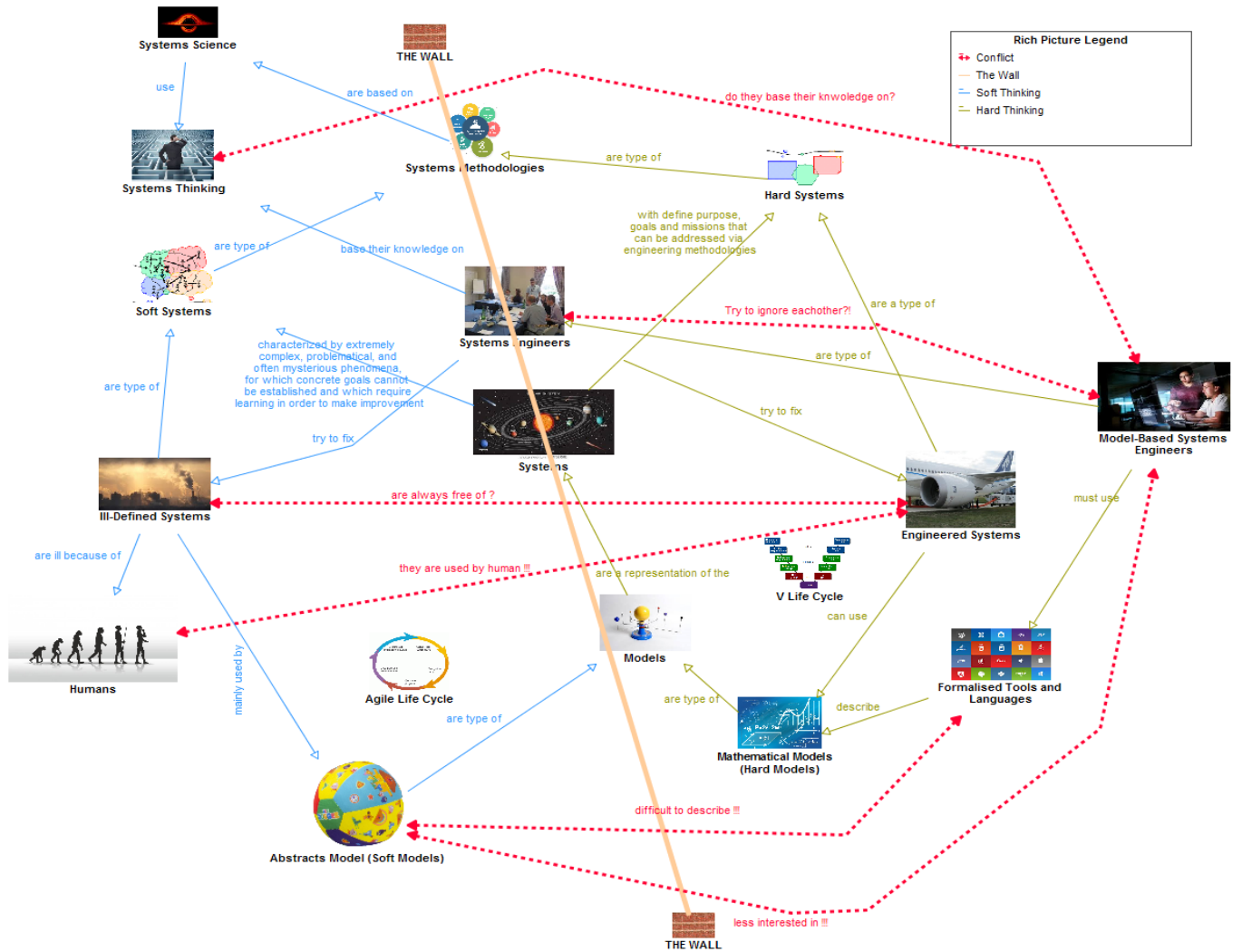
- Amongst the population of SE users 98% of them use models (Q6)
- According to Q7 also 98% assert that they use MBSE as enabler for their SE activities.

SE(or MBSE) and SSM ?

- Q2 and Q3 seems to convey that a significant set of the sample (50% of the SE population in question) do use SSM to explore complex problem (Q1), and that 50% of that have used or use some of Checkland's tools such as Rich Picture, Root Definition and Conceptual Model.
- Q8 shows that a significant amount of user are claiming they use or have used MBSE for Systems Thinking activities (almost 70%).

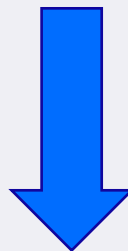
* *Population: Systems Engineers in Aerospace Companies + INCOSE MBSE working group.*

Rich Picture of the 'perceived' Problem



Research Questions

Is it possible to include SSM into a MBSE approach and what issues emerge when an attempt to mix soft and hard systems methodology is provided?

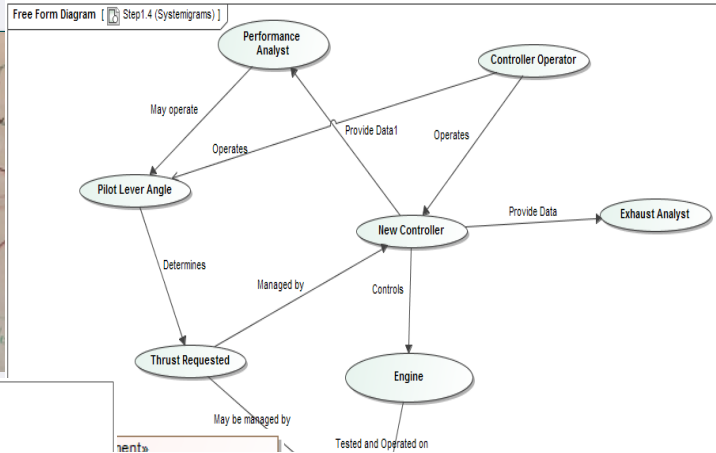


Systems Thinking: Coping With 21st Century Problems (*Boardman and Sauser, 2008*)

Transitioning Systems Thinking to Model-Based Systems Engineering: Systemigrams to SysML Models (*Cloutier et al., 2015*)

Soft Systems and Use-case Modelling: Mutually Supportive or Mutually Exclusive? (*Bustard et al, 1999*)

SSM Seven Stages (Checkland and Scholes, 1999)

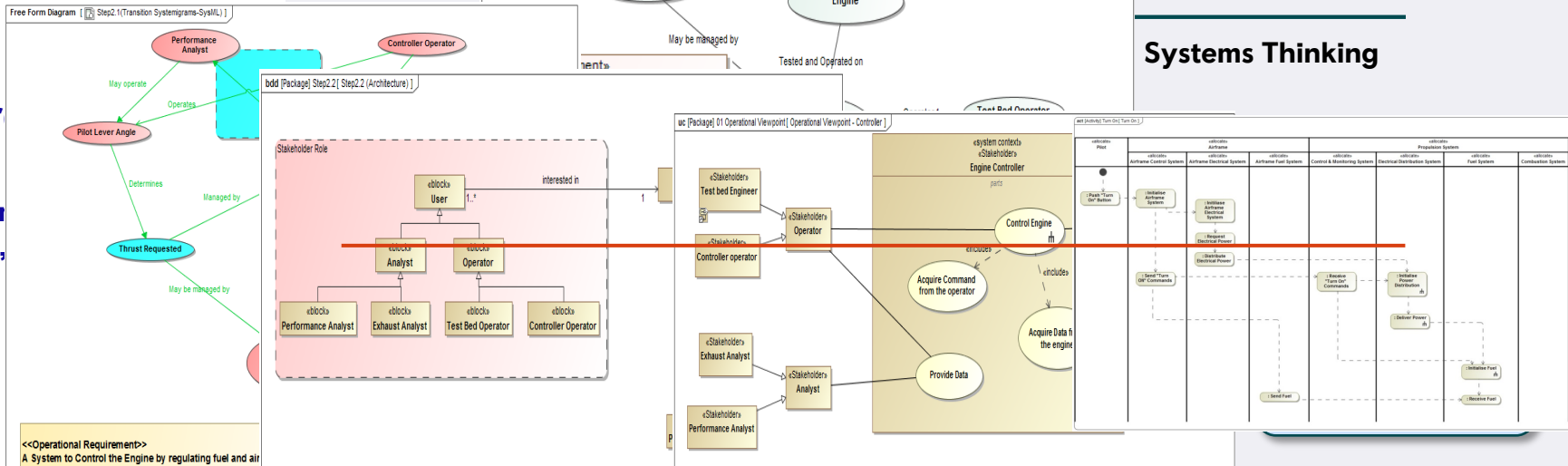


6. Feasible, Desirable Changes

Real World

Systems Thinking

Boar
SSM
(Board
Sauser,



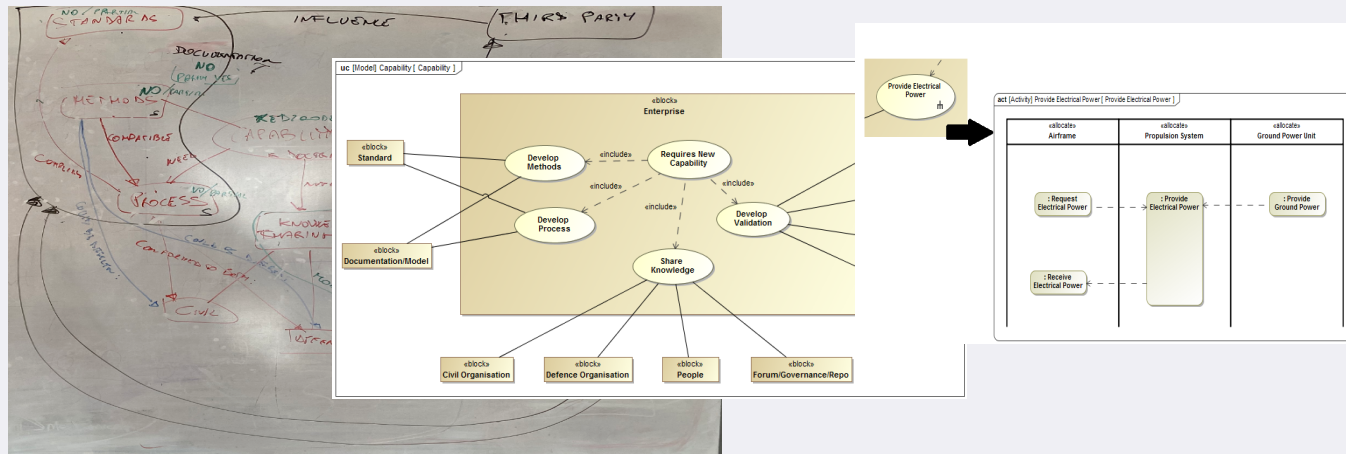
Systems Engineering (or MBSE)?

Soft Systems and Use-case Modelling

- Use-case modelling is used as validation of SSM models
- The idea is that Use Cases would provide a *cross-check* for SSM models by describing scenarios of possible behaviour that would be recognisable in those models.
- Each Use-case should be 'executable' in an associated SSM model, which means that:
 - Each interaction between a Use-case actor and the system concerned can be directly related to a particular activity in an SSM model; and
 - Each Use-case can be explained in terms of the activities in the SSM model and their interaction.

SSM and Use Case Models

Soft Systems and Use-case Modelling: Mutually Supportive or Mutually Exclusive? Bustard et al (1999)





Scenario Combinations

Methodology:

Scenario Identification and Down Selection

	SSM-Systemigrams-MBSE <i>BSSM</i>	SSM-MBSE (Use Cases) <i>Bustard</i>	MBSE
Scenario 1: High Level System (New Propulsion system within Airframe)	X		X
Scenario 2: Low Level System (New Controls System within Propulsion System)	X	X	
Scenario 3: Capability (Doctrine within Organisation)	X	X	

Scenario 1 Approach

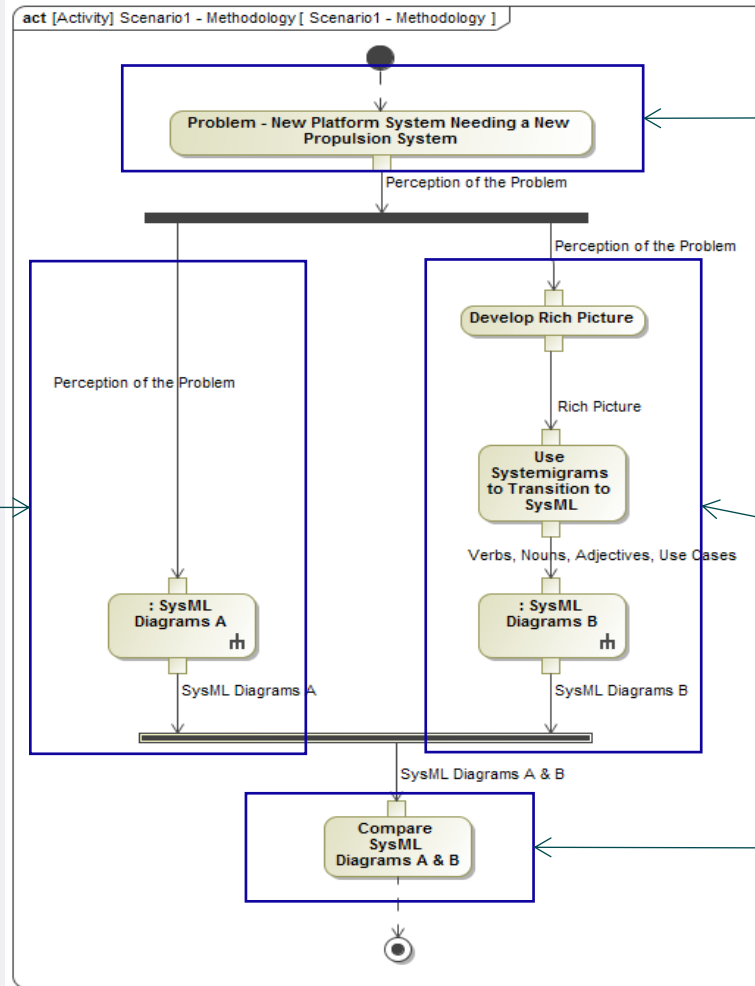
Methodology:

Scenario 1

High Level System
(New Propulsion
system within
Airframe)

MBSE
Modelling

Starting point:
The Problem



SSM-
Systemigrams-
MBSE modelling
BSSM

Comparison
Analysis

Scenario 2 Approach

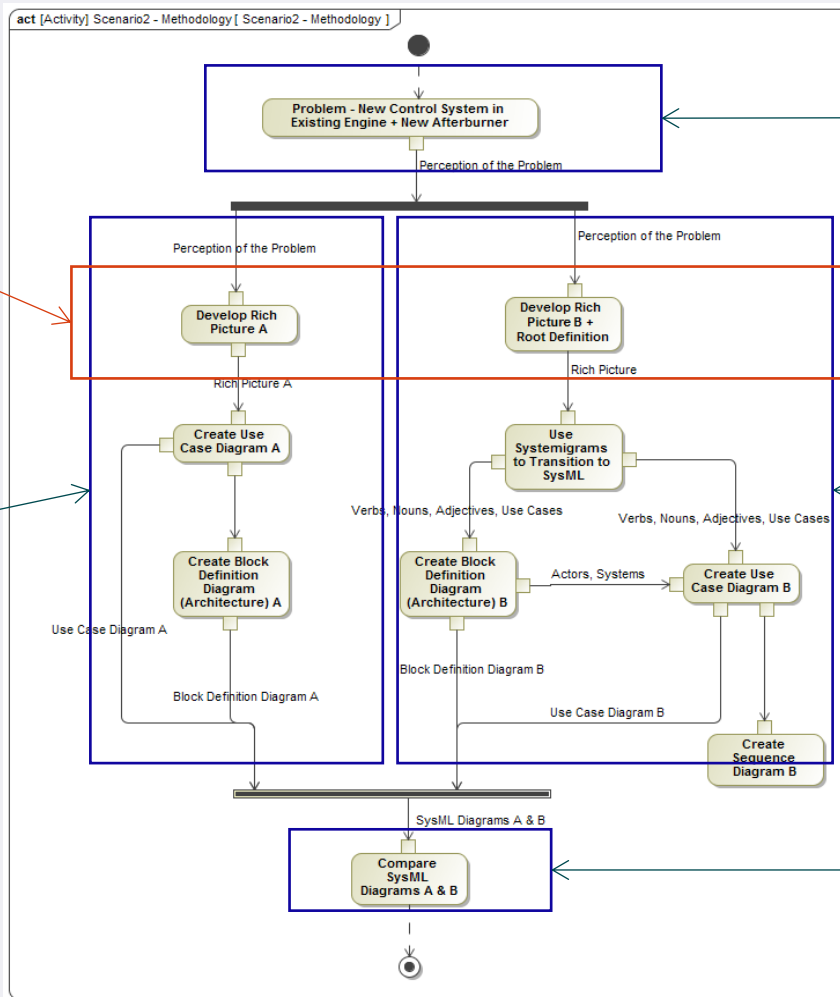
Methodology:

Scenario 2

Low Level System
(New Controls System
within Propulsion
System)

Rich Picture
slightly
different to
each other !

SSM-
MBSE
modelling
Bustard



Starting point:
The Problem

SSM-
Systemigrams-
MBSE modelling
BBSM

Comparison
Analysis

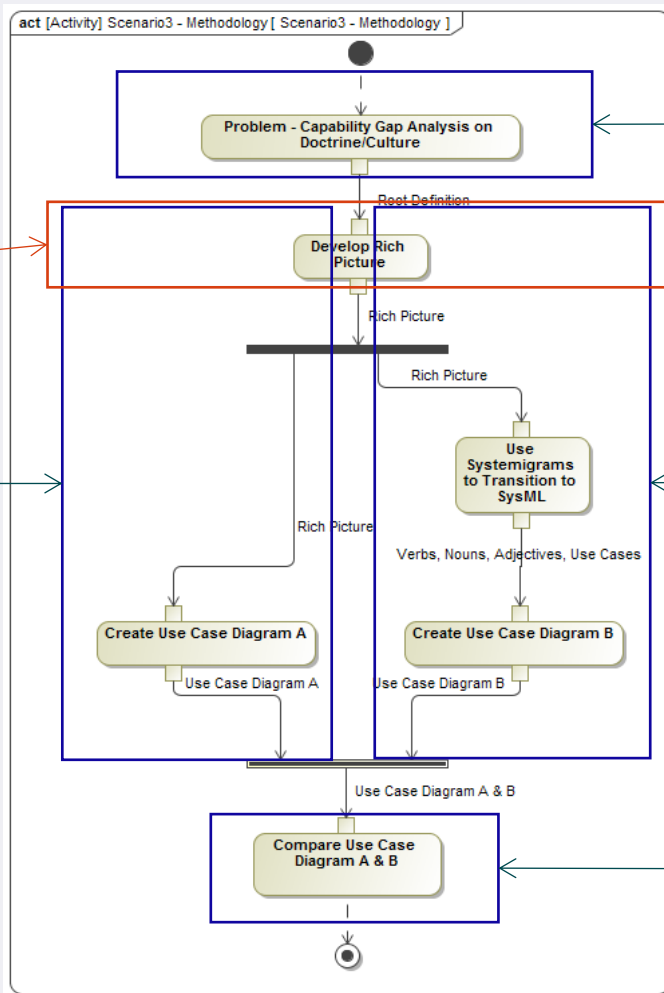
Scenario 3 Approach

Methodology:

Scenario 3

Capability (Doctrine within Organisation)

SSM-
MBSE
modelling
Bustard



Starting point:
The Problem

Same Rich
Picture

SSM-
Systemigrams-
MBSE modelling
BBSM

Comparison
Analysis



Analysis of the 3 Scenarios

Analysis

- For Scenario 1 the value added from Systemigrams is the better understanding of the wider problem: the use of BSSM improved the SE modelling activity. However:

- Would the result be the same if SysML using a wider system context was applied to start with?
- What if traditional SSM to set the initial context as an input to the SysML was used instead of BSSM and Systemigrams?
- If that was done, would BSSM and in particular the formalised translation through a Systemigram, still add value to this process?

- For Scenario 2, where SSM was applied in both modelling activities, Systemigrams was seen as a “Systematic” approach to transition between SSM and MBSE. However:

- What if the audience used for the second modelling activities to set the initial context as an input to the SysML was used instead of the one (only engineers) used for first model?
- If that was done, would BSSM and in particular the formalised translation through a Systemigram, still add value to this process?
- Will the approach scale up to the complexity of real world problems, and what would be the challenges of using an approach like this, which spans the business modelling, traditional SE and MBSE communities?

- For scenario 3 not particular value added was given by Systemigrams (use case diagrams almost the same) except for the additional models (stakeholders and architecture) developed as part of the approach.

	SSM-Systemigrams-MBSE	SSM-MBSE (Use Cases)	MBSE
Scenario 1: High Level System (New Propulsion system within Airframe)	X		X
Scenario 2: Low Level System (New Controls System within Propulsion System)	X	X	
Scenario 3: Capability (Doctrine within Organisation)	X	X	

Conclusions

	SSM-Systemigrams-MBSE	SSM-MBSE (Use Cases)	MBSE
Scenario 1: High Level System (New Propulsion system within Airframe)	X*	X*	X*
Scenario 2: Low Level System (New Controls System within Propulsion System)	X*	X*	X*
Scenario 3: Capability (Doctrine within Organisation)	X*	X*	X*

Author's Conclusion

- Process:
 - Systemigrams adds some values to the MBSE or Use Case modelling in all scenarios analysed.
 - The systemic approach of Systemigrams was seen as good way to transition from SSM to MBSE in the modelling environment
- Technical:
 - Systemigrams steps were developed using a SysML tool; however some initial drawing was needed on whiteboards.
 - Free Form of Cameo Systems Modeller was good enough to draw the Rich Pictures and the Systemigrams final artefacts.
 - Traceability between these artefacts and SysML object was maintained.
- Limitation:
 - Audience used for to developed the initial Scenario was not always the same
 - A comparison would have been done if all 3 modelling activities were done.
 - In scenario 2, 2 different Rich pictures were developed.
 - BSSM and Systemigrams approach was thoroughly applied in Scenario 1; partly in Scenario 2 and 3 due to time limitation and availability of stakeholder for this thesis.
- Future Work:
 - Apply the methodology rigorously: for each scenario do MBSE, SSM-MBSE(Use Case) and SSM-Systemigrams-MBSE modelling.
 - Consider doing this with 2 set of audience*: one predominantly engineers and the other one mixed
 - Apply BSSM and Systemigrams entirely.



So...What do you think?

