

MBSE in an SME Context

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Project Outline

- YGT project within the telecommunications and Integrated Applications (TIA) directorate
- Answering the question – Would TIA would recommend **SMEs** to adopt **MBSE**?
- The purpose of this investigation is to explore the **potential benefits of MBSE** to support **new space** in the rapid development of new missions with **reduced lead times** and at **lower associated costs**

INCOSE defines MBSE - “Model-based systems engineering (MBSE) is the formalized application of modelling 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.”

Definition of MBSE (Applied Space Systems Engineering)

“Model-based systems engineering is the art and science of applying software-based tools to capture systems engineering evidence in a **systematic, disciplined way, to connect system relationships, control system configuration and communicate a common system site picture** in the form of an integrated model to all stakeholders throughout the lifecycle.”

Definition of an SME (EU)

An SME employ fewer than 250 people and have an annual turnover not exceeding €50 million and/or an annual balance sheet total not exceeding €43 million.

In order to assess the effectiveness of MBSE in the satellite design process the following has been performed:

Methodology

1) Literature Reviews

Reading relevant journals on the adoption, opinions and maturity of MBSE

2) Modelling in Vitech Genesys

An upcoming ESA mission has been modelled within Vitech's GENESYS.

3) Interviewing SMEs

Multiple SMEs have been interviewed regarding their current systems engineering process and challenges they face with regards to systems engineering.

- A lot of literature about the adoption of MBSE
- “MBSE enables effective decision making” - Mike Russell, Using MBSE to Enhance System Design Decision Making, *Procedia Computer Science*, Volume 8, 2012, Pages 188-193, ISSN 1877-0509
- A common theme stated is that MBSE is fairly immature for the time being
- There is currently not enough recorded / documented proof that measures the MBSE benefits claimed
- Outlines that negative attitudes towards MBSE stem from high expectations
- MBSE not well defined

“There might be cases where MBSE adoption would generate higher costs compared to its benefits. In fact, MBSE adoption requires a holistic and systematic approach, and it differs among industry sectors and organization environments.” - Chami, M. (2018). *Towards Solving MBSE Adoption Challenges: The D3 MBSE Adoption Toolbox. INCOSE International Symposium*, 1463-1477.

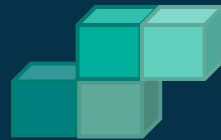
“We conclude that bad experiences and frustration about MBSE adoption originate from false or too high expectations” - Vogelsang, Andreas & Amorim, Tiago & Pudlitz, Florian & Gersing, Peter & Philipps, Jan. (2017). *Should I Stay or Should I Go? On Forces that Drive and Prevent MBSE Adoption in the Embedded Systems Industry.*

“This literature review indicates that there is no empirical evidence present in the publicly available literature today that supports the hypothesis that MBSE is beneficial for the development of engineered systems” – Henderson, K.. (2020). *Value and benefits of model-based systems engineering(MBSE): Evidence from the literature.* Virginia: Wiley.



Selection

- Vitech Genesys was selected as it was recommended by a colleague who has experience with Genesys, Cameo and Capella
- Genesys was said to be the most **intuitive**



Experience

- **Easiest tool** to use as a **beginner** to MBSE
- Best user interface
- Helped improve my systems engineering
- **However**, learning how best to utilize the tool was still a challenge and took a lot of effort and time



Trade-off Criteria

- The criteria used was based on an internal investigation about MBSE and industry
- Using a selection criteria, I found Genesys to be one of the best MBSE tools on the market



Learning Process

- Getting stuck into a tool was the best approach
- Did not know much about MBSE so a trade-off to start with is hard exercise to do well
- Helped me define / understand MBSE

- 10 SMEs interviewed
- Used conversational interviewing approach
- Each interview was analysed by coding each transcript
- Interview touch on the following topics:
 - What is Systems engineering to them
 - What is importance of Systems engineering
 - Common challenges faced and how to mitigate these challenges
 - What tools are used to aid system engineering activities
 - Attitudes towards MBSE

	SMEs									
Discipline	1	2	3	4	5	6	7	8	9	10
Platform Provider	1	1	1	1	1	0	0	1	0	1
Software Provider	0	0	0	0	0	1	0	0	0	0
Consultant	0	0	1	0	0	1	1	0	1	0
Data Provider	0	1	0	0	0	0	0	0	0	0

Attitudes towards Systems Engineering



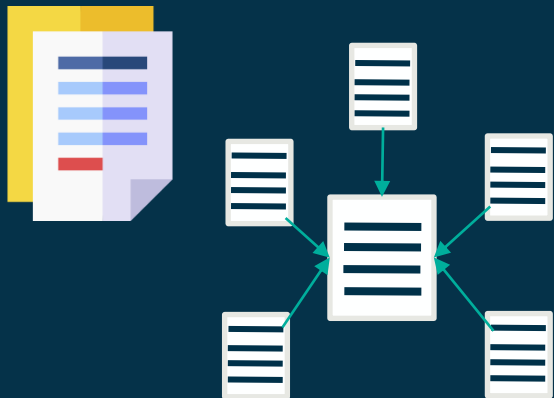
- View SE as the ability to solve a multi-discipline problem
- To be a good SE you must be experienced and knowledgeable
- Take a holistic approach
- Communication and collaboration is key to success

Common challenges SMEs face



- Transition from single missions to multi-missions
- Fast-paced environment
- Small workforce
- Hire early careers / little experience of SE

Tools used to aid systems engineering



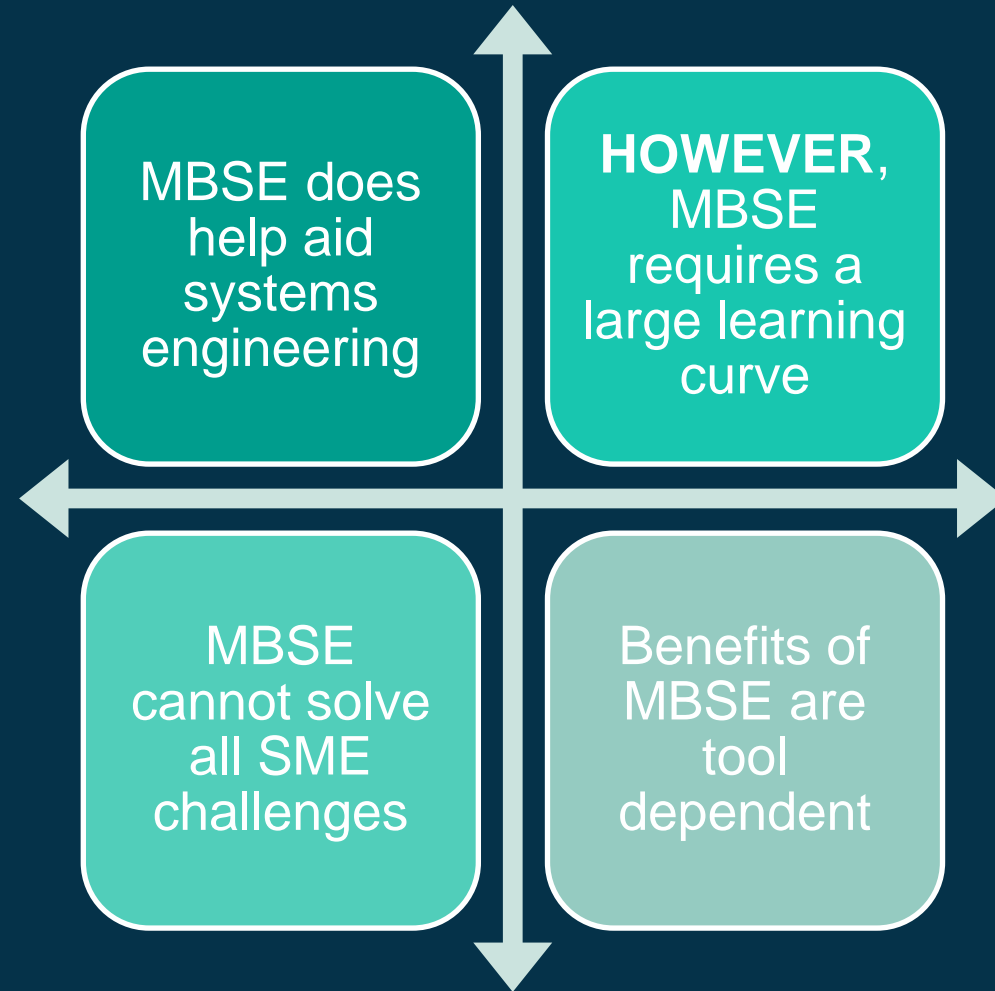
- Most still use document-based approach
- They try to incorporate some sort of source of truth
- A lot have produced their own in-house tools to perform SE

Attitudes towards MBSE

- Most SMEs are put off MBSE due to the time and effort it requires to adopt successfully
- SMEs who have experienced MBSE did propose some pros to MBSE
- Vendor locking is a worry
- Some SMEs believe that MBSE is too advanced for what they need to do

Can MBSE Solve SME Challenges?

- The answer is dependent on the SME's and the tools selected...



Scenario 1 – Small company producing simple systems

- MBSE is **NOT** recommended
- MBSE is not something that will add much value to the company
- In a small team its easier to keep track of everyone's work
- Information management is not a big problem



Scenario 2 – A company transitioning from single to multi-missions, increasing workforce and increased employment of grads/ people early in their career and **CAN** afford the time and cost of adoption

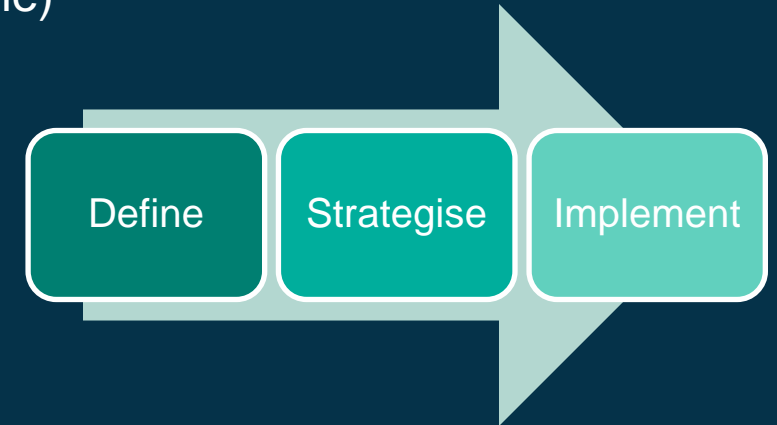
- MBSE **IS** recommended
- MBSE helps to enforce a standardised SE process
 - This helps to ensure that all outputs are **consistent**
 - Makes it easier to **teach newcomers** the company SE process
- MBSE helps aid the SE process to ensure the system is well defined
- MBSE helps to manage information – ensures traceability

Scenario 3 – A company transitioning from single to multi-missions, increasing workforce and increased employment of grads/ people early in their career and **CANNOT** afford the time and cost of adoption.

- MBSE is **NOT** recommended
- MBSE provides benefits to the SE process of an SME
- However if the SME cannot afford time and cost of adopting MBSE then adoption could be detrimental
- For MBSE to be accessible to SMEs. I recommend the following needs to happen:
 - Accessibility to MBSE resources – case studies, suggested tools, strengths & weaknesses of tools
 - MBSE to mature – more people becoming experts, best way to use the tool
 - Proof of ROI
 - Mitigate vendor locking worry

To successfully adopt MBSE I would recommend to do:

- Define what MBSE is trying to solve within your company (Define)
- Developing the MBSE approach (Strategise)
- Implementation



Recommendations on how to adopt MBSE:

- Have a MBSE team modelling alongside developing missions
- Focus on a small aspect you want to improve and master that aspect to start with
- Hire an MBSE expert that can manage and oversee MBSE activity

My conclusion from the investigation are...

- MBSE in general helps to improve the SE process by standardising and making each entity modelled traceable
- The large learning curve that comes with MBSE does not fit well with the dynamic of an SME
- MBSE is still fairly immature at the moment more needs to be done for it to be accessible to SMEs
- However learning how MBSE can be adopted with an SME and providing support to SME could be a business opportunity

Thank You for Listening



Back-up Slides

Vitech Genesys Trade-Off Part 1

How does Genesys rank against tool selection criteria?

Criteria	Performance
Usability	<ul style="list-style-type: none"> • Follow a methodology called STRATA with documents provided to support • Although Genesys does not require you to use STRATA • Good user interface • Auto-generated diagrams
Collaboration Capabilities	<ul style="list-style-type: none"> • Real time modelling, User control, multi-user collaboration via repository
Exploitation Capabilities	<ul style="list-style-type: none"> • Document Generator
Modelling Language	<ul style="list-style-type: none"> • SysML
Training & Support	<ul style="list-style-type: none"> • Training available at a cost • Vitech offers technical support
Cost of Licenses	<ul style="list-style-type: none"> • On the High-end
Suitable Interfaces to Existing Tools	Connectors with: Word, Excel, Powerpoint, MS project, Matlab, Simulink, ModelCentre, Open API and OSLC

Vitech Genesys Trade-Off Part 2

How does Genesys rank against tool selection criteria?

Criteria	Performance
Ease of Deployment	<ul style="list-style-type: none">• Admin rights needed• Windows installer
Cost of Maintenance	<ul style="list-style-type: none">• Quote on Request
Cost of Infrastructure	<ul style="list-style-type: none">• Quote on Request
Cost of Training	<ul style="list-style-type: none">• Quote on Request