

> Had any of the SME's you spoke to attempted to implement MBSE already and actively decide against them?

From SMEs spoken to, only one SME mentioned that they had implemented MBSE and decided to go back to a document-based approach. The reason for their decision was due to lack of knowledge / experience of MBSE within the SME to be able to implement MBSE successfully. Other SMEs interviewed are either starting to investigate MBSE solutions or have only used document-based approaches.

> For the case of supplier SME who would handle and complete a larger model provided by a Large System Integrator, I suppose the limitation could come from the fact that current MBSE tools do not go deep enough into technical modelling to cover SME activities. What do you think?

Yes, I think that is a fair statement. Although I have had not much experience with modelling a system in detail within an MBSE tool - I can see that you must be strict with how much information you model as if you model in too much detail, it is hard to manage all the inputted information. So at the level a supplier SME will be working at – MBSE may not be practical to support the detail they will be working on.

> Would you recommend a Tier-based MBSE adoption approach (tier 1 just some components, Tier 5 fully integrated), or moving to MBSE needs to be to the full system (even this is where the biggest gains are met)?

Yes, I think this would be a good approach. From my investigation, an incremental approach to the adoption/implementation of MBSE could be beneficial for an SME. To adopt MBSE “in one go” would require a lot of time and effort that an SME may not have and also requires the SME to be able to afford the risk that the time and effort may not have the intended outcome - which in my opinion, I do not think is realistic.

> In your opinion, would it make sense to have "levels of adoption" somehow standardised, so an SME could for example fall in a lower level of adoption and a LSI in a top level?

Yes I think an incremental approach would be beneficial (please see answer to question above for more detail).

> Thanks for the presentation. Would you please provide a reference to the textbook Applied Space Systems Engineering that you quoted?

Sure! The book is called “Applied Space Systems Engineering (Space Technology Series)” by Wiley Larson (Edited By: Larson, Kirkpatrick, Sellers, Thomas, Verma. Date: 2014, Second Edition / CEI)

> The recommendations not to use MBSE for SMEs is understood if SMEs have to create a standalone model for their own product but what about the case of a supplier SME who would handle and complete a larger model provided by a Large System Integrator?

For the case of a supplier SME, if there is money / time for them to learn how to use MBSE then yes MBSE would be recommended. However, the learning curve is still high and the SME will still need to be able to have the resources to overcome the learning curve.

> Do you think could ESA could play a role helping SMEs to implement MBSE in their missions? i.e. could trainings/materials/other resources be helpful?

100%! The adoption process of MBSE is a long process. Not only is learning how to use the tool and implement within the company a long process but a lot of time can be taken researching and

selecting a tool that best fits your needs. If there are more resources about MBSE (clearly defining it), describing the tools and what they offer, providing training and use cases, then this could help to solve the problem regarding the large learning curve.

> it seems that MBSE is here focused only on information exchange and traceability. What about advantages connected to early V&V and detection of req/design issues, test case generation, higher assurance, etc? Were these considered by the interviewed SMEs?

Yes, the results from the interviews highlighted the SME's systems engineering process throughout the whole lifecycle of a system. Challenges raised by SMEs touched on multiple topics such as commercial pressures SMEs face, challenges of having a small workforce, information exchange, defining requirements and the design process. However, challenges faced later on the life cycle, for example during testing and verification were not common themes mentioned by the SMEs.

> in the presentation you speak a lot of tool but what about method which is a prerequisite to practice with MBSE

The methodology used to use Vitech Genesys was STRATA. STRATA is a methodology created by Vitech to compliment Genesys (although you do not need to implement this methodology to be able to use the tool). The goal of this methodology is to design your system layer by layer. This approach make the user focus first on the high-level understanding of the system before diving into detail. This methodology helps to structure the SE process and ensure that the smallest of design decisions are not made early on so that the system design is not limited.

> To which extent are the engineers of the SMEs already familiar with MBSE prior to join the SME? In the coming years we may see more and more young engineers knowledgeable about MBSE and less about paper-based processes. Was this considered in your assessment?

Majority of SMEs were aware of MBSE – however only a minority had previous experience with MBSE.

My investigation comes to a conclusion on the current market. As the amount of young engineers knowledgeable on MBSE increases – this will help to make MBSE to be more accessible to SMEs.

> Did you consider use of more light-weight / web-based / open source MBSE tools?

Yes, I have had experience with Capella. However, I would say the conclusions presented would still be valid when referring to open source / web-based tools. This is because the learning curve is still relatively large and requires a lot of effort of the SME's behalf to be able to fully integrate within their systems engineering.

> What would you consider the size cut-off to be for a "small" SME, i.e. where you do not recommend MBSE?

Although I cannot give an exact number for the cut-off point of a small SME, I would say if you are unable to know the personal lives of all your colleagues – you are not classed as a small SME in the scenarios suggested.