ADCSS2022 – Model based Avionics Panel

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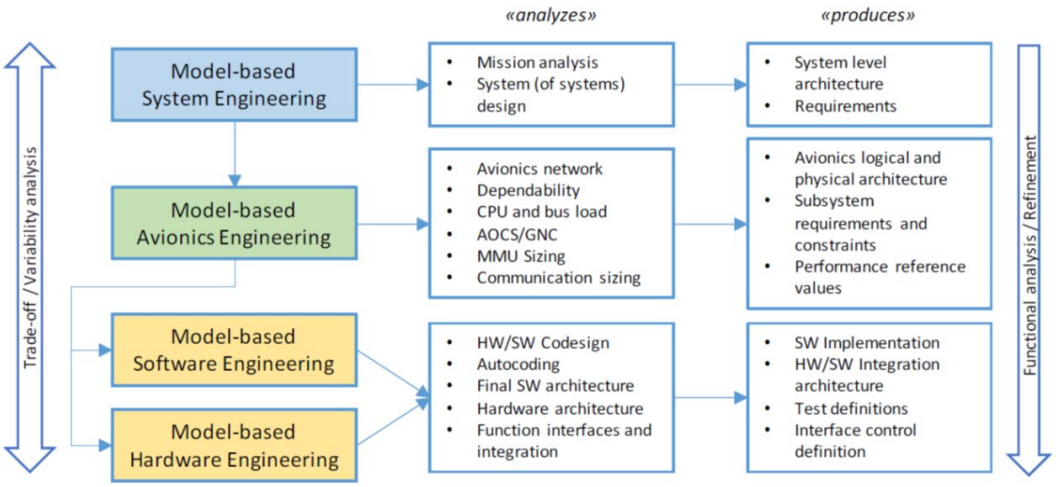
The panel gathered representatives from the SAVOIR Advisory Group. The objective was to consider the context of adoption of “Model Based Avionics” as a link between “Model Based System Engineering” and both “Model Based Software Engineering”, hardware and microelectronics.



The panel was asked a number of questions. The time did not allow to address them all, but many subjects were tackled.

Q1- Model Based Avionics establishes the digital continuity between system and Hw/Sw/Control What is, in your own professional context, the specific benefits that we can expect from MBA?

(*hints: automation, consistency verification, data flow verification, performance, resource usage, automatic generation of document/ICDs/configuration files, clear description of the avionics bus usage, clear software architecture, clear deployment view, requirement traceability, avionics validation, reuse, schedule, etc.*)

- Much better understanding of interface and exchanges along the system life cycle. Improve V&V
- Reuse of generic baseline design of e.g. OBC software transceiver expressed as generic models used within the process for simulation, automatic code generation.
- Interesting for the avionics architects as support to facilitate the design discussion, on e.g. the hardware design traces, helped by the graphical view. The functional layer is the most interesting because it decouples from any physical solution and allow to allocate components to flight qualified or COTS. It keeps the link between the avionics architecture and the overall system architecture.
- Model based approaches are taking a larger role independently in each discipline for their own needs, and the benefits are recognized. The difficulty is now to combine all these discipline in a larger model based approach. Engineers are not always prepared to understand and use system level models. ESA requirement to move towards model based is helpful, as it has been done on early phase programs. It has improved the communication and the co-engineering in view of getting quickly a set of budgets.

- Make the link between system need and avionics architecture. Then it enables to coordinates and manage implementation with several partners based on a common understanding.
- Immediate benefits of Digital Continuity between Avionics Models and SW models is the increase of the productivity and the reduction of Non-Quality : Automatic generation of SW models and code saves a lot of manpower, and human error is prevented while correct by construction approach ensures that the implementation is aligned with the specification.
- Documents are partially (export from the model for specification, design description or user manual purpose) or fully replaced (data model) by models, which simplifies the configuration and version management process. Traceability between Avionics models and SW artefacts is automatically created and maintained up to date by tooled transitions.
- Model based allows to master the complexity of systems (functional, organisational, architectural)

Q2- What are the main obstacles which exist in your company to establish MBA?

(*hints: interoperability of tools, unclear process, lack of discipline synchronisation in schedule [means hw is early, sw is late, aocs life cycle]*,)

- In a project aiming at replacing the document centric approach by a model, a training program was put in place in a workshop to learn the Virtual Satellite approach. System engineers initially doubted that it would be better than their excel sheet, but after one and half to two years after PDR, they saw the benefit for e.g. generating test cases. But it took some time and training.
- There is a Learning Curve for the acceptation of the tool. The engineers who have background in this space engineering field, does not necessarily see the advantage of having that. There are Early Adopters (<10%) in the same way than any innovation curve but it is hard to go to a common adoption.
- ESA implements also internal training on MBSE and specific ESA SysML solution, for the ESA projects team to be able to follow industry when ESA has introduced a specific MBSE workpackage in early phases ITT.
- The experience of massive training in industry shows that the technology should be used just after the training, otherwise, the training is quickly forgotten…
- A modelling coach is also introduced in the team. It is a paradigm shift equivalent to moving from classical software coding to object oriented coding…
- Modelling is sometimes seen by people as a nice to have, or as an optional activity that costs a lot and slows down the team work. When modelling activities are part of a “side car” process, benefits are not there and it is rapidly abandoned.
- The natural solution is likely to be a kind of pedagogy, learning (general) and coaching (contextual) sessions. Not having a local and skilled team in charge of tool developments and day to day user support is also a frequent obstacle.
- It seems to be mandatory of an organization and set up which enable a shared Virtual Machine in which the model is shared and modifiable by anyone.
- MBSE tools are not suitable for efficient brainstorming and trade offing → prefer white board & snap shots. (for high level architectural trade-off)

- MBSE do not provide efficient way to make easy reading, good looking , ergonomical figures → you need to train
- Model based is not only producing a model, but introducing it into an industrial process, including versioning, configuration management, etc. The way of working in large organisation must be adapted into a consolidated solid process. Configuration management is often mentioned as a difficult point.
- The purpose of the model must also be defined, it is very different between early phased 0/A/B1 and next phases C/D. The timeflow of adaptation of the model must be defined. System engineering are not always able to enter into discipline details, while disciplines engineers are not always aware of system needs. Indeed, the transition from B1 to B2 has been identified as a point needing attention. It is important to align the data models of all the disciplines in order to have a digital continuity between system and disciplines.
- The various roles in the project must also be well identified, system role, avionics architect, software architect, etc. The avionics architect is often in charge of the system model because he has already the system thinking.
- Connecting the discipline tools between them at system level is a challenge.
- Transferring a model based approach from Agency to Industry is also necessary but requires a timely adoption without impact on current projects, as well as the technical interoperability of the tools.
- In some cases, a model based method is tailored for specific needs, breaking the compatibility with other users of the same methods. So the governance of method is very important.
- The data hub is a solution for interoperability, but translating models could be more difficult than expected. Instead, exchanging the data which are in models could be more feasible, and could allow comparing models, not at the level of the appearance or structure, but at the level of the content. For example, once the ontology has defined what a function and a function tree are, they can be exchanged as such, extracted from a source model and reinjected in a target model which uses different method.

Discussion with the audience

- When model based is used together with automation (e.g. automatic code generation), engineers sometime modify the generated code directly without modifying the model… This should be forbidden by the process.
- Beside, this approach that we defined in Space is also in development in aeronautic, aircrafts, automotive, following the trend of digital transformation. Also it must be introduced in universities.
- The system scenario are very useful to analyse a system.
- In order to reply to proposals, it is important to be able to link quickly to the product lines, and early modelling is key… The product line model is plugged into the system model, and the variabilities of the product line can be defined in the system model. The benefit of having a digital thread between system, avionics, software etc. is confirmed, although it could take some time before it is established…
- It is confirmed that we cannot have a single tool for all space, due to the massive gravity effect of Thales for Capella and Airbus for Cameo… If some suppliers cannot invest in one of the tool, TAS perform the training and the support for their Suppliers, in order to perform co-engineering. Beside the pure tool difference, the tooling environment is also quite different in organisations or units…

- The tool difference affects not only the platform supply chain, but also the relationship between platform and payload. Here there is a role for the Electronic data Sheet for the interface platform/payload. This was exactly the reason for starting MBSE in Euclid…
- Exchange of models is finally very seldom in industry. Collaboration on the same model is more frequent. Even the export in html is not always used. Instead, document generation is the way to communicate the content of models, and this ensure that all the documents are consistent.
- LSIs recognize a major interest of MBSE already in their organisation. Going to Suppliers is a plus.

Q3- What would you change in your company or in your customer/supplier relationship to enable MBA ?

(*hints: organisation/merge hw and sw teams, process/define a MBA process, roles/define an avionics architect role, training*)

- Engineers would spend less time to write and review documents and would spend more time in the models. Sometimes documents are so long (could reach several hundreds of pages) than there are inconsistencies between the first pages and last pages.
- Engineers from several departments would work on the same basis.
- Engineering Process and Tools responsible are already in the TAS organizations for the coordination of models, training and support in case of compatibility problems
- Definition of a MBA process in collaboration with system and HW/SW teams is the key of success. This process should come with a Modelling Plan (list of compatible tools, versions, and clear Modelling Guidelines).
- Having a suitable infrastructure to exchange models instead of documents, and adapt reviews processes to include model review.
- Notes/Remarks
- Today even if models provide meaningful information, “paper like” documentation is the reference for contracts, reviews, specifications,… So documentation export capability is major requirement

Q4: We have seen presentations mainly related to the descending part of the V life cycle (requirements, design, implementation).
How could we extend this part of MBA to (i) the rest of the life cycle and (ii) other disciplines?

(*hints: use avionics and power models for simulation, executable systemC for tradeoff, Simulink for AOCS, OBC simulator , microchip emulator, and then flatsats, twins of equipments, contribution to spacecraft twin, avionics validation; electrical design, PCB*)

- First, we are using tool for design and not necessarily for validation so this is normal that only the descending part is presented.
- Models have started to be used for the ascending branch of the V cycle, what we call Model Based Validation Models should also be used for consolidation of the Design (feasibility

assessment, design exploration, design validation) either thanks to simulation (Ex: FDIR Simulator) or by model checking techniques (validation rules, …).

- It can also be useful for multi-disciplinary collaboration. For instance, using Capella viewpoints for FDIR, RAMS, Data Handling or AOCS purpose allows to keep all those activities aligned and coherent.