**Impact of digital transformation on phases 0/A/B1 engineering activities**

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**Abstract**

Digital transformation is the today ultimate buzzword in companies. Behind all this buzz, there are deep and major on-going transformations both on the products and services we deliver to customers and on the way we work. Even if from our point of view digital transformation is more a matter of mind changing than pure technology, it is always followed immediately by a bunch of technology buzzwords like big data, artificial intelligence, digital continuity, data lake, … that evoke the set of technology coming from outside the space domain and which are building blocks of this transformation.

It is somehow difficult to understand clearly was are the concrete impacts of such a transformation on the way of working for teams involved in the early system phases of space projects (phases 0 / A / B1). This is mainly explained because, usually, all the examples of such transformation impacts are not applicable directly to the system activities of the early phases.

This paper exposes a set of concrete use cases and current implementation of major changes in the early space project phases.

This paper proposes to cover the following topics in particular :

* Impact of the digital transformation on the day to day work (digitalisation of the processes, new way of collaborate into the team, …).
* Use of artificial intelligence to improve the early design phase, for example the use of rule-based systems to quickly size the mission or the use of machine learning algorithms to deduce relations between parameters of a subsystem or an equipment (to perform estimations or consistency checks). This is linked to the capability to store large sets of structured information accessible to both humans and machines (for example an equipment database storing in a semi-formal way equipment properties).
* Use of artificial intelligence algorithms to optimise systems enable to shift from a “point based engineering” where only a couple of solutions are figured out by experts and then optimised locally to a broader evaluation of solution candidates. This makes it possible to find “non-intuitive” solutions by a larger exploration of the design space helped by the increase of computing power and easiness to deploy applications on server farms.
* Big data solutions to collaborate on end-to-end simulations and simulation results exploitations. End-to-end simulations are needed to perform system level design optimisation. They rely on many heterogeneous simulators (system of systems, mission, satellite, subsystems, …) that produce all together a huge volume of data. State of the art big data solutions coming from the Internet major players are particularly useful in this context to orchestrate, understand, display and compare simulations.
* Natural language processing applied to requirements in order to detect relations and inconsistencies into a project requirement set. Model based engineering is not mature enough (and will certainly never be) to capture all requirements in a formal (non-textual) way. Space projects rely both on formal modelled requirements (interfaces, state machines, CAD, …) but also a lot on textual requirements. Natural language processing technologies afford to process those requirements and extract structured information.
* Use of chatbots providing the teams with a seamless access to the engineering data. Natural language interfaces (both textual and oral) have been democratised by the personal assistants provided by big Internet players like Amazon and Google. From an engineering point of view, they simplify the access to the information by the team. This information being more and more stored into very specialised tools (from IDM-like tools to Capella and others) and thus less and less accessible to the whole team, chatbots permit this access in a very natural way.

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