Introducing KARREN: Data intelligence for collaborative engineering

An electromechanical actuator use case

By Nathan Marguet
Digital Product Simulation (DPS)

The complexity of today's highly engineered products requires efficient collaboration between specialized disciplines. One of the big changes in 2020 was the stunning increase in home working, requiring more stringent work allocation and improved communication. KARREN, a new software tool created by DPS, provides a unique instrument for the collaborative design of complex systems. The aircraft Electromechanical Actuator (EMA) use case described below illustrates the design of such a system using KARREN.

KARREN is a web- or cloud-based agnostic framework to support agile engineering and the trade-off processes. It offers flexible and powerful capabilities to define, share and trace key information, such as the engineering parameters of a project, between users and disciplines. It uses a collaborative, multi-disciplinary engineering process to achieve convergence and integration of products at the workgroup or enterprise level.

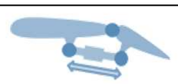
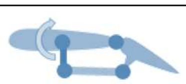
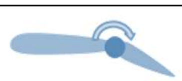
"3-bar" system with a screw-type cylinder	
"4-bar" system with a crank and rod	
"Direct-drive" system	

Fig. 1 - The concurrent architectures for the EMA

A pilot uses EMA, a simple yet complex system, to flip the wing ailerons to generate an aircraft's rotation of roll. This case study explains the pre-design work done on this system and compares three different system architectures.

Project knowledge and connection diagram

The engineering teams responsible for development of the EMA begin by gathering the key project data (product knowledge) to be integrated by KARREN, thus creating a new model.

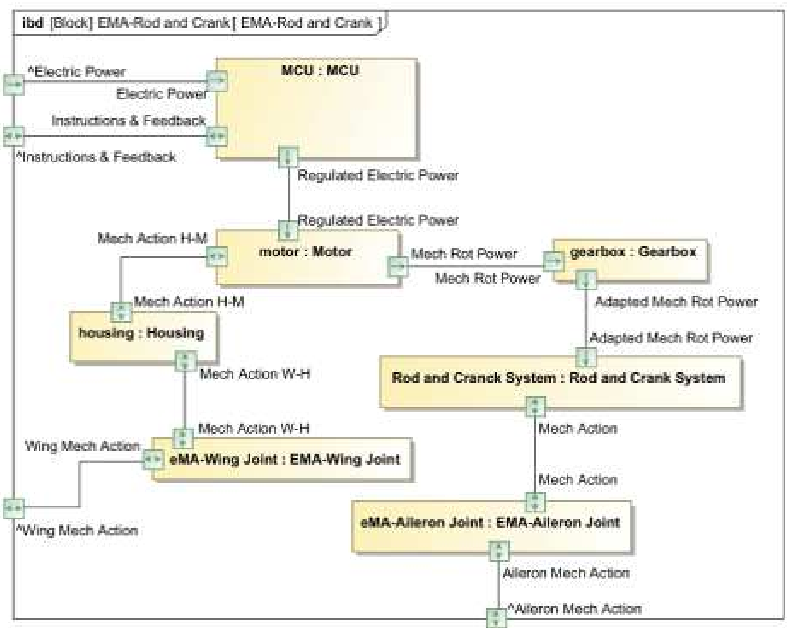


Fig. 2 - SysML diagram of the 4-bar architecture block

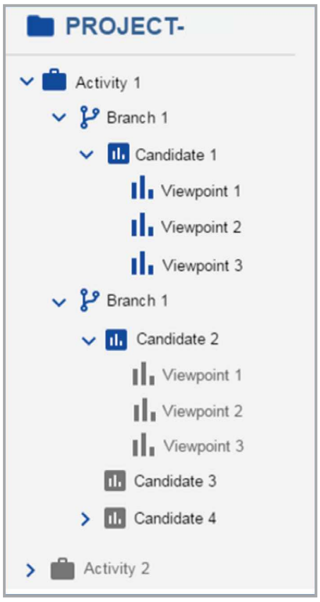


Fig. 3 - KARREN Project treeview

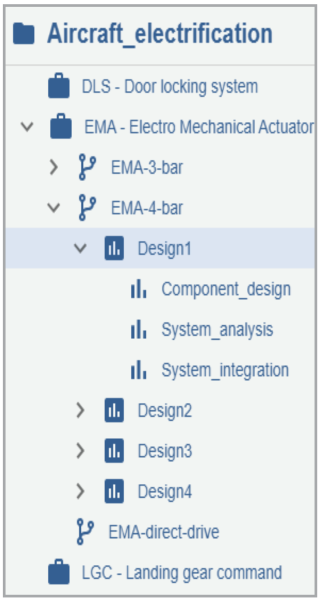


Fig. 4 - EMA treeview

The EMA project requirements are translated into easy-to-understand parameter-based constraints and objectives (e.g. System.Mass < 5kg [CSTR]; Minimize Mass [OBJ]). These parameters are inserted into an object called Activity.

Activity includes as many Branches as there are architectures to be studied (three in this case). In each Branch, the product structure (components and design parameters) is defined to describe the architecture and to correspond to the disciplines involved (CAD study, 0D-1D system analysis, etc.).

The teams then define a mapping between all of these elements and build a model of their Connections. This connection map will serve as the basis for the upcoming collaboration.

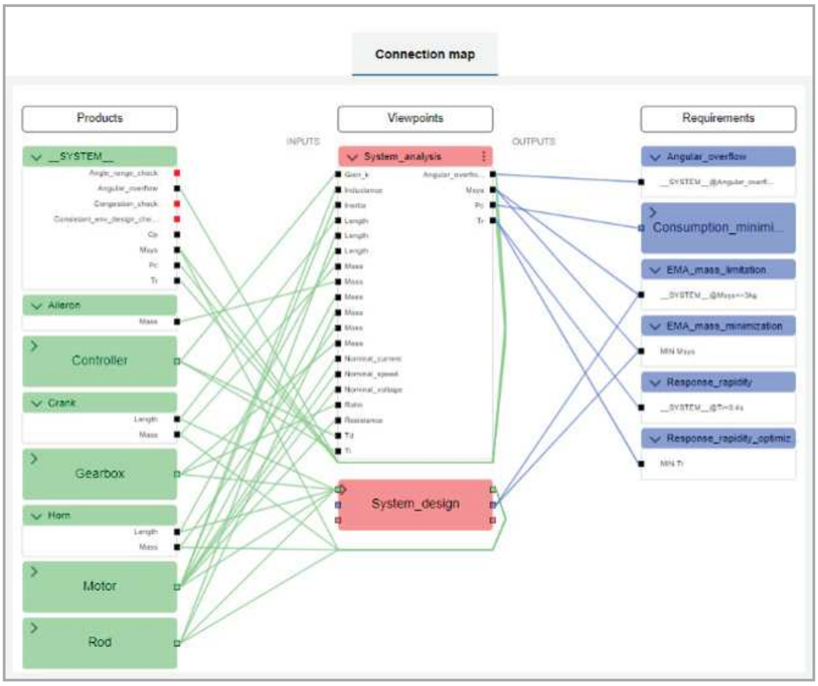


Fig. 5 - Connection map of the 4-bar Branch

From this point, KARREN automatically generates the Candidates: these are spaces dedicated to interdisciplinary collaboration. Each Candidate represents a viable solution proposition for the EMA system. A Branch may have many Candidates. The more there are, the better the design space is covered, increasing the likelihood of discovering a solution that significantly boosts performance.

Collaboration

The Connections between the parameters, disciplines and requirements are clearly defined. Data sharing is instant, and the models are all consistent. At this point, KARREN begins to work its "magic": the iterative work to achieve product convergence can occur in a truly collaborative way.

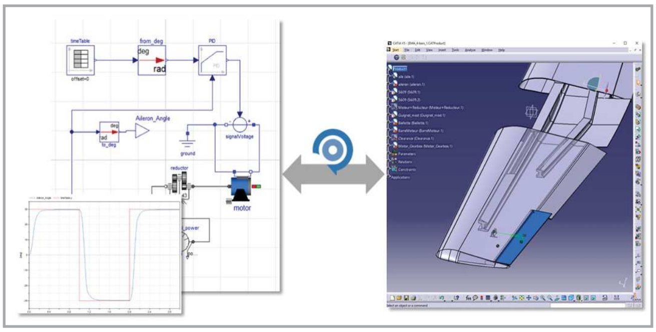


Fig. 6 - 0D/1D analysis engineers work in parallel with CAD integration specialists

The engineers continue to work in parallel as they always have. Fresh data updates the design, and Viewpoints integrate each engineer's work (products and requirements used, simulation model/tool, result value, etc.). Each alternative Candidate is simulated, and its overall impact can be evaluated without additional efforts. KARREN does not require any fundamental change in the teams' work habits; moreover, it strengthens them.

The project leader regularly assesses progress towards design convergence using the Consolidation panel built by KARREN. Any inconsistencies due to errors or bad design choices are apparent early on. They trigger immediate rework and iteration. Once all alternative solutions are completely consolidated, KARREN displays indicators to verify, validate, and compare their simulated performances. This is an agile process that saves EMA design teams additional time and costs.

With regard to the EMA with the 4-bar Architecture, the simulation detected weaknesses arising from one of its features, wing penetration: four out of six Candidates show penetration conflicts. In the Direct-drive Architecture, however, the power needed to drive the aileron requires costly equipment (motor/gearbox). Therefore, despite the difficulties of implementing a 4-bar EMA system design, one of its Candidates appears to be the most balanced with a low industrialization cost, reduced mass, and a rapid response to pilot commands. Further design studies can be conducted on the 4-bar design.

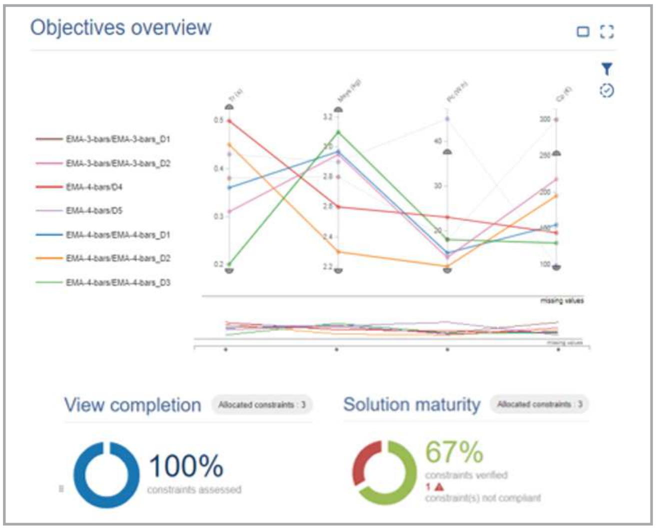


Fig. 7 - KARREN Dashboard: Solutions compared

Conclusion

Higher specialization in engineering disciplines is making collaboration between disciplines more and more difficult.
In this example of using KARREN to design an EMA, the overall complexity of the project is managed by mapping the products, requirements, and engineering studies, creating a solid foundation for intelligent and efficient collaboration.

Each alternative is analyzed and evaluated without additional effort using a traceable process. The product vision and business objectives are achieved by easily identifying the optimal trade-off (e.g. weight vs. cost). KARREN secures product maturity, convergence, and multidisciplinary integration at the workgroup or enterprise level.

For more information:
www.dps-karren.com

About DPS

INDUSTRY LEADER. Since 1997 DPS is a player in digital continuity recognized for its know-how integrating simulation within the process of the design of industrial products. We have solid expertise in CAD/CAE integration, process automation, system modeling & simulation and design optimization.

CONTINUOUS INNOVATION R&D is key to our strategy and contributes greatly to the drive to propose innovative solutions to our customers. For the past 10 years 'Le Lab' at DPS has been exploring new scientific and technological ideas in fields such as Industry 4.0, data mining, data analytics, A.I.

STRONG OFFER IN SERVICES DPS offers services including consulting, technical support, training, software customization and editing… With a strong background in mechanical engineering, our teams are experienced in domains such as stress, electrical, electronics, firmware/software, thermal & fluid dynamics, CEM modeling and optimization.