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Digitalization and aerospace: The next era of engineering simulations

One of the next eras of economic value from engineering simulation such as CFD and FEA will come from combining it with Industrial Internet of Things (IIoT) and digital twin (DT) methodologies. The simulation-based digital twin will help companies analyze smart machines in real-world operating conditions and make informed decisions that will improve their performance far above what is possible today. Physics-based and system simulations with big data analytics and industrial devices augmented with embedded intelligence can reduce risk, avoid unplanned downtime, and speed up new product development. The resulting efficiency and productivity gains will have a dramatic effect on an organization's bottom line, as well as on the global economy. Engineering simulation has long been used to improve the design of nearly every type of physical product or process by evaluating multiple alternative designs before physical prototypes are built. Simulation has also been used for decades to model different operating scenarios to develop control strategies. These data and workflows can be incorporated into control algorithms to improve operations. The emerging IIoT has created the potential for a transformational voyage in which a product or process simulation model is tied, through the Internet, to sensors capturing data and to actuators controlling its operation. The digital twin of the physical product or process can be used to analyze, perform diagnostics and troubleshooting in real time, anticipate and communicate breakdowns, determine the optimal point to perform maintenance, tune the product to optimize its performance, and capture information that can be used to improve the next-generation design. The economic value is real and significant. There are fundamental core components that comprise a successful DT strategy, such as a full-fidelity simulation model that captures all multi-physics interactions; an IIoT platform such as GE's Predix, Amazon's AWS, or Microsoft's Azure; a systems-level control over the simulation model (1-D logic layout), sensor data inputs into the IIoT platform; and a tool or method for creating a reduced-order model (ROM) of the simulation model. A CPU-intensive full-fidelity simulation model typically cannot be a component of digital twins because most simulation models require hours, days, or months of single-core CPU-equivalent solve time, thus the need for the ROM. The result is that a properly tuned digital twin can be used to substantially increase the performance and reliability of the product or process while reducing its operating cost. The digital twin methodology allows for less unplanned downtime, improved product development feedback, increased reliability, lower maintenance costs, and better predictive and prescriptive maintenance. This discussion will cover both conceptual and practical ideas about these core components in order to illuminate the overall economic opportunity, basic technical components, and workflows. Some of the likely obstacles to a successful implementation will be reviewed, such as how original equipment manufacturers (OEM) are not necessarily the same company using the equipment in downstream production. The importance of standards for data compatibility will be addressed. High-level protocols for the ROM will be suggested and combined with an overview of what a simple verification and validation (V&V) program could look like for an OEM to maximize the value and relevance of their simulation workflow and models.

Biography

Rick James leads SimuTech Group's team of 85 professionals who focus on simulation-driven product consulting, training and mentoring in structural, thermal, fluids, electrical, RF, electromechanical, signal integrity, drop test, and probabilistic design. He is an expert in FEA and CFD and has excelled as a Consultant, Expert Witness, Trainer, and Leader. He has a BS and an MS in Mechanical Engineering and a DrEng in Engineering Management, all from Southern Methodist University in Dallas, Texas. He holds electrical and mechanical patents in semiconductor packaging and sits on the Board for Knowledge at Southern Methodist University's Department of Mechanical Engineering.

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