COLLABORATIVE ENGINEERING & DIGITAL TWINS

Abstract

Conventional Aircraft Design for commercial airplanes as well as military fighters has heavily relied on physics based aerodynamics & structural analysis in an iterative manner since the end of World War II. Multiple successful designs including Boeing 747, and General Dynamics F-16 were designed using paper based calculations. In late 80s, with advancements in computational resources in terms of processing power, memory and sophisticated numerical analysis tools, the user requirements as well as certification requirements became more stringent. The aircraft design philosophy shifted from paper based calculations to numerical analysis tools with legacy codes for each discipline. Aerodynamic efficiencies improved with reduced weights utilising lower factors of safety improving the aircraft performance in terms of range, endurance, load carrying capacity and onboard processing power. But still the design process was confined to prototype and its testing & evaluation. Technology experts were responsible to translate this prototype into serial production models. Thousands of technologists used to work together to define the tooling required for manufacturing & assembly, process definition for each airframe part ultimately leading to manufacturing data packs for thousands of parts individually. This translation from prototype to serial production was many a times an even lengthier process than aircraft design itself resulting in design cycles spanning over multiple decades. In late 90s, industrial & system engineering experts working in conjunction with aerospace designers came up with a strategy of integrated product & process development. The focus was to reduce design cycle time with simultaneous manufacturing process definition of each part during its detailed design. A derivative of the same methodology was termed as concurrent engineering. It didn't meet the expected promise as the predictive ability of analysis tools used in design was far lesser than experimental results. In brief it was restricted by the predictive limitations of analysis tools. Additionally, in the absence of integrated design frameworks, each design house had to come up with their indigenous solution to integrate and automate the design process which further constrained the working and search for the best possible design. Meanwhile, computational analysis tools improved their predictive ability but needed intensive processing power. Very lately, leading design integration companies like Siemens and Dassault came up with computational frameworks. These frameworks have integrated aerodynamics, structural, propulsion and RCS analysis tools capable to produce a digital twin of the actual aircraft being designed with every manufacturing process, sequence, material, tolerances prescribed as in the actual product. This has practically reduced the gap between the digital model and physical model (termed digital twins) significantly reducing the experimentation effort as well as design cycle time. Another issue in modern aircraft design is that thousands of engineers are required to work together as complexity has increased manifold and no country has that kind of qualified human resource at one site. Thus, modern aircraft design generally works in international consortiums of multiple nations with design houses at each site working in conjunction. The advantage of collaborative engineering methodology with comprehensive design frame works is that multiple teams from around the world can not only simultaneously work on the same configuration maintaining configuration control, but also making possible the remote design teams working together from different locations in international consortiums. This talk will highlight specifics of collaborative engineering & Digital twin methodology, modern aircraft design frameworks, cost and time saving in design cycles and improved life cycle costs of the modern aircraft.