

Computers in engineering

CAD-embedded CAE simulation enables Design for Six Sigma

Whether it is lean manufacturing, Six Sigma, or some combination, quality improvement is now a primary focus of virtually every manufacturer in the aerospace industry. And now that the waste is squeezed out and quality is designed into manufacturing processes, visionary corporations are looking upstream toward the engineering of the product for further gains in quality. One of the keys to ensuring manufacturability and efficient integration of component systems is the implementation of high-fidelity CAE software during the early design stages.

One of the more popular methods for addressing quality improvement during the design process is known as Design for Six Sigma (DFSS). Like most quality

improvement acronyms, this process has different meanings for different organizations but, from a "big picture" perspective, DFSS simply means designing products that meet the customers' requirements while maximizing the efficiency and robustness of the manufacturing and/or integration process. With modern production being centered on CAD/PLM data, it is imperative that engineering simulations, which predict the product performance, be tied directly to the same CAD/PLM data to ensure consistent quality. This also allows a more direct use of DFSS statistical tools for measuring quality.

CD-adapco realized the benefits of upfront computational simulation and was the first to bring to market a true CAD embedded CFD solution. The STAR-CAD Series of products embed CFD technology directly in all the major CAD systems, which allows engineers to perform full CFD simulations (pre-processing, meshing, and analysis) from within the CAD system.

In the past, the product definition was simply tossed over the wall for detailed design and manufacturing. If production constraints were considered in the early design stages, they were typically considered as "rule-of-thumb." This led to major headaches and unexpected expenditures once production actually began. More recently, CAD/PLM systems have helped, but there is often still a wall between engineering analysts and designers, which prevents the direct inclusion of manufacturing constraints in the product design cycle. Essentially, analysts and designers must perform wasteful iterations to relate manufacturing constraints with performance goals.

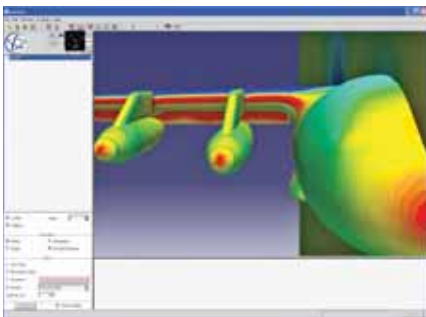
Now with CAD embedded simulation, manufacturing constraints can be considered directly when engineering analysts perform design studies. More often these studies are being executed as multidisciplinary design optimizations (MDO), which allow a Six Sigma ap-

proach to the product design. With direct access to parameterized CAD models, these MDO studies are much easier to set up, and manufacturing constraints are included in the formulation of the optimization problem. This results in the seamless inclusion of manufacturing requirements from the very inception of the product design.

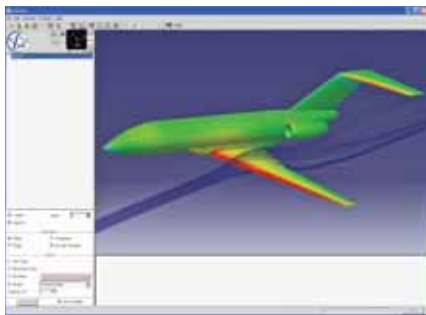
The benefits of DFSS via CAD embedded analyses extend beyond the initial manufacture of the product. Component reliability is a major contributor to the total life-cycle cost, and nowhere is this truer than in the aerospace industry. For example, a flap actuation system can benefit from this technology. Using a CAD embedded CFD product such as STAR-CAT5, the static aerodynamic loads on the actuation system are easily obtained early in the design process. But perhaps of more value in terms of life-cycle costs is the early consideration of dynamic loads throughout the range of flap motion by integrating embedded CFD, FEA, and multi-body dynamics simulations into a multidisciplinary design optimization. The entire actuation and flap track system can be optimized for life-cycle costs during early engineering stages.

From the CAE perspective, there are many benefits associated with the STAR-CAD Series of CAD embedded CFD tools—e.g., ease of use, superior accuracy, efficient numerical algorithms. None of these, however, affects the bottom line more directly than the enabling of DFSS. CD-adapco refers to the STAR-CAD Series of products as "gateway" solutions, meaning that they bridge the gap between CAD and CAE analysis. Looking at the bottom line, however, perhaps the more meaningful metaphor is the gateway between quality improvement and upstream engineering design.

David L. Vaughn, Director, Aerospace & Defense Industry Sectors, CD-adapco, wrote this article for *Aerospace Engineering*.



CD-adapco's STAR-CAD products provide CFD capability embedded within all major CAD systems.



CAD embedded CAE simulations enable the inclusion of manufacturing and maintenance requirements in upstream engineering design studies such as this one for a flap actuation system.