AIR POWER

ANSYS multiphysics software enables engineers to design new airships 40 percent faster than for the previous generation.

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Drones offer many potential advantages for intelligence, surveillance and reconnaissance (ISR) applications, such as threat identification and documentation, anti-terrorism, border security, harbor and port security, and loss prevention. However, there are many instances in which drones are not practical because they don't meet regulatory or safety requirements, because their limited payloads can't accommodate the required surveillance equipment, or because they can't stay in the air long enough to accomplish the mission. Lighter-than-air (LTA) airships, also known as blimps, are being used increasingly to replace or complement drones: This type of aircraft faces far fewer regulatory and safety issues, can carry much larger and more varied payloads, and can stay in the air for longer periods of time.

Worldwide Aeros Corp.'s 40E Sky Dragon is the newest LTA platform that supports ISR mission success and efficiency with multipayload mounting systems and the flexibility to cover more ground with less manpower requirements. Compared to the previous generation — the 40D Sky Dragon airship, which entered service in 2007 — the 40E offers a larger payload and a number of accommodation and operational improvements. Substantial design changes were involved in the 40E. For example, increasing the airship payload required increasing the helium volume and upgrading

DEVELOPING CUTTING-EDGE, LIGHTER-THAN-AIR VEHICLES AT AEROS
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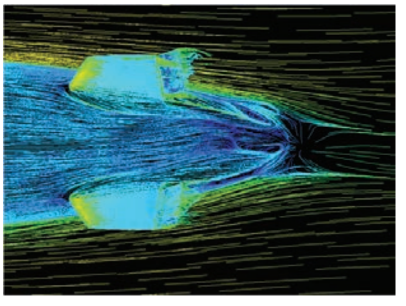
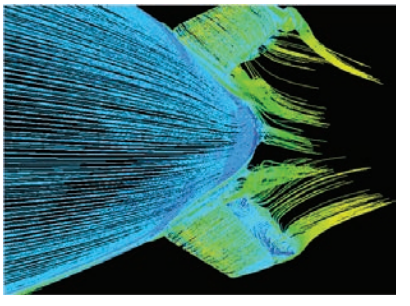


▲ CFD simulation of 40E airship shows turbulent behavior on control surfaces and the wake behind the airship.



▲ CFD simulation of 40E airship demonstrates the effects of ruddervator (combined rudder and elevator) angle of attack and deflected airstream.

ANSYS provides a full range of tools that cover nearly every aspect of the airship design process.

the propulsion system and landing gear. Aeros engineers used ANSYS multiphysics simulation tools from the beginning of the design process to deliver the 40E six to 12 months faster, or in about 40 percent less time, than would have been required using previous design methods.

PREVIOUS DESIGN METHODS

In designing the company's previous-generation 40D Sky Dragon airship, engineers used hand calculations to establish the basic parameters of design, such as evaluating aerodynamic profiles, determining where to put flaps, sizing the engines, etc. Engineers felt that the time involved in performing simulation with the tools available at that time made it inappropriate for use during the concept design stage. Once they had tentatively established basic design parameters, engineers used simulation tools, including computational fluid dynamics (CFD) and finite element analysis (FEA), to perform a more-detailed evaluation of the proposed concept designs.

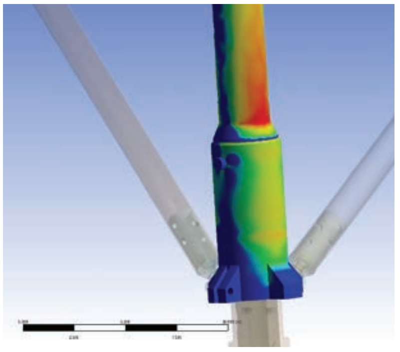
When Aeros began work on the 40E, the company decided to take advantage of advances that had been achieved in the intervening years in simulation software. Simulation tools have improved to the point that it is now possible to much more quickly model the behavior of proposed designs as well as rapidly iterate through a wide range of design alternatives, without the need for an engineer to manually model each proposed design.

Aeros selected ANSYS simulation software because, first of all, ANSYS is a proven technology, so the results are well accepted not only by Aeros engineers but also by existing customers. Second, ANSYS provides a full range of tools that cover nearly every aspect of the airship design process — including aerodynamics, static and dynamic structural analysis, signal and power integrity, and many others — within a single environment. This breadth saves time by making it possible to move data easily between different types of simulations and run automated simulation processes that incorporate multiple types of simulation.

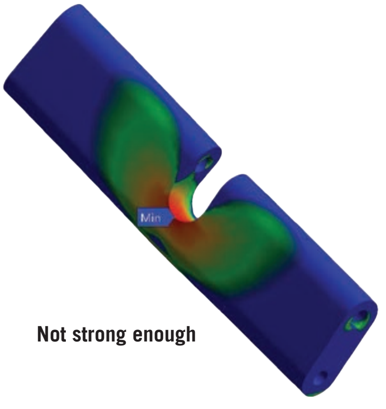
Aeros engineering management made the decision to use simulation from the beginning of the design process. They used ANSYS Fluent CFD to evaluate the aerodynamics of the new airship. Engineers performed a detailed aerodynamic simulation of the complete airship in about 24 man-hours over a period of 72–96 hours, including modeling and solution time. Pressures from the aerodynamic simulation were used as boundary conditions in ANSYS Mechanical to evaluate mechanical performance of many of the 40E's systems and components. At various stages of the design process, engineers used ANSYS DesignXplorer to rapidly iterate through the entire design space and select alternatives that provided the highest possible level of specified design objectives. Simulation provided far more accurate estimates of the performance of design alternatives than were obtained in the past with hand calculations. Using simulation early in the design process saved time and money by identifying and solving problems much sooner.

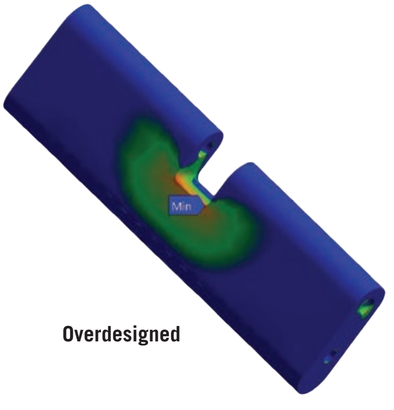
NEW LANDING GEAR DESIGN

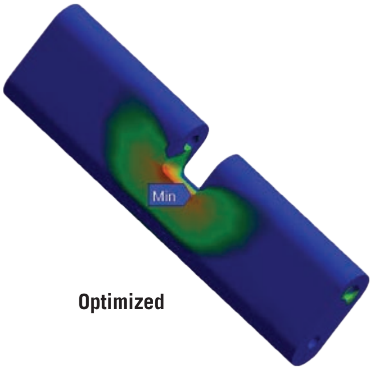
The new landing gear for the 40E Sky Dragon is a good example of how



▲ Structural analysis of 40E airship landing gear reveals the most critical stress areas under a range of landing conditions.







▲ Static simulations of shock bridge (landing gear component) design iterations

simulation was used. The landing gear now enhances performance, safety and operator empowerment by providing real-time static lift data for airship pilots during takeoff, while improved dampening force control ensures smoother landings. The airship's flight management system actively controls shock absorber dampening properties. The height of the landing gear was increased for greater clearance between propellers and ground, which increases safety for the landing crew. The landing gear was also upgraded to handle the heavier new airship.

RIGID BODY DYNAMICS

Engineers modeled the structural components, springs, shock absorbers and tires in the landing gear using the ANSYS Rigid Body Dynamics module. The maximum loading on the landing gear is defined by a drop test designed to reproduce the landing of a fully loaded airship. Engineers ran a series of rigid body dynamics simulations of the airship landing at various speeds and approach angles. The simulation was iterated to tune the springs and shock absorbers. A number of different performance characteristics were used to evaluate each design iteration, such as the minimum propeller/ground clearance distance, loads at various points, and number and height of tire bounces off the ground during landing.

STRUCTURAL ANALYSIS

Loads calculated by the Rigid Body Dynamics module were used as boundary conditions for structural analysis of individual components using ANSYS Mechanical. Other ANSYS Mechanical simulations were performed using the aerodynamic simulation results as boundary conditions. Engineers used DesignXplorer for many components to find the lightest possible design that would meet structural and functional requirements. Even though the 40E is significantly heavier than the 40D, the weight savings achieved through simulation made it possible to reduce the weight of a number of key components without increasing stress levels. For example, one part that was 0.5 inches thick in the 40D was reduced to a thickness of just over 0.25 inches, resulting in a 40 percent weight reduction.

In about six weeks, Aeros engineers performed hundreds of system-level and component-level simulations. The result was a landing gear design that met all design requirements yet was very close to the overall weight of the previous-generation landing gear. At this point, a prototype of the new landing gear design was built; its performance matched the simulation results within +/–10 percent or less. The prototype passed the drop test and all other required testing and was used without further significant modifications in the 40E.

ESTIMATED TIME SAVINGS OF MORE THAN SIX MONTHS

Aeros engineers estimate that, if the landing gear had been designed using the company's previous design methods, at least four months would have been required to reach the stage for which the design was ready to prototype. They also estimate that at least two, and more likely three, prototype iterations would have been required, with six months being required for each iteration. So the time savings on the landing gear design was between 8.5 and 20.5 months. Substantial cost savings were also achieved in both engineering and prototype-building expenses.

Aeros engineers believe that simulation made it possible to significantly reduce the weight of many components in the 40E compared with the design methods used on the 40D. These savings reduce manufacturing costs and will also save fuel for Aeros customers over the life of the airship. These manufacturing savings are probably many times larger than the savings that were achieved in the prototyping process.

Similar magnitude savings were achieved in the design of other 40E Sky Dragon systems. Aeros engineers estimate that the use of a more–simulation-intensive design process will make it possible to bring the 40E to market six to 12 months faster than if the previous design methods had been used. The first 40E is under construction and is expected to be completed in late 2015. It will enter service after Type Certification by the Federal Aviation Administration.

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