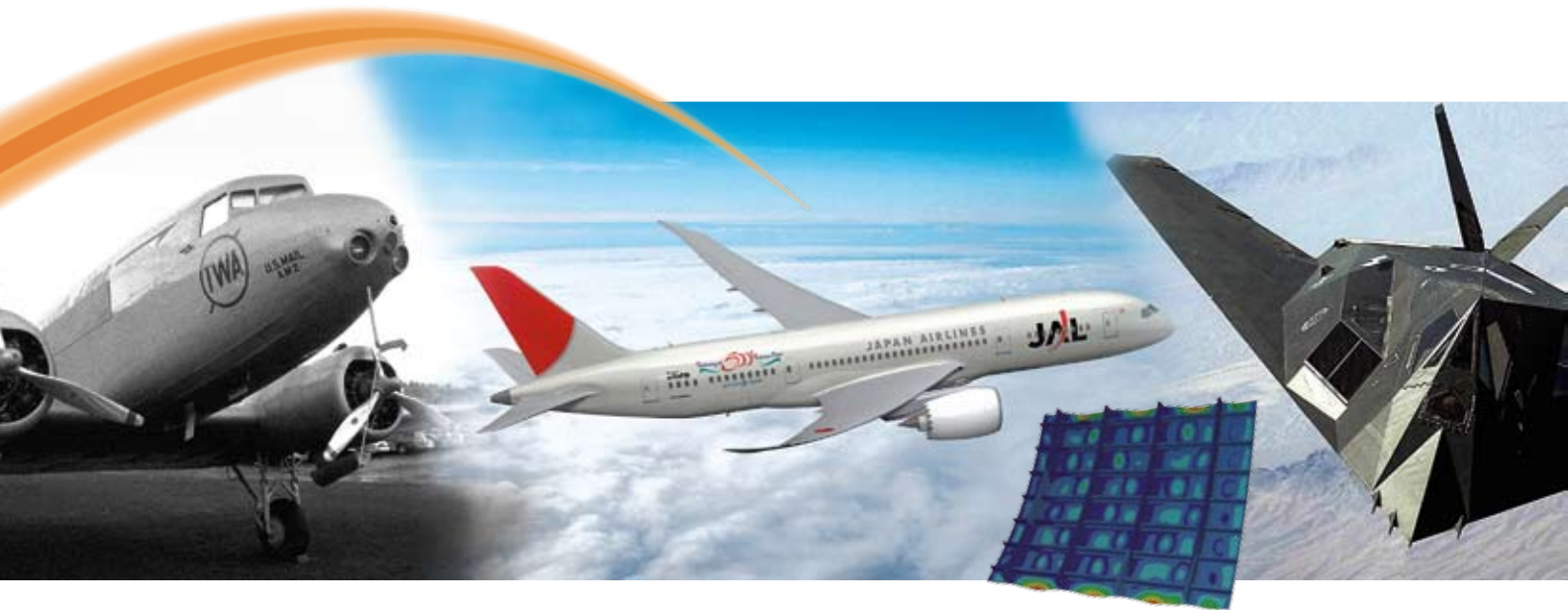


Aerospace Innovation Requires Simulation Technology and Methods Evolution

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Innovative materials, new manufacturing processes, adoption of the latest technologies, and unique methodologies have always been the driving factors for the next generation of aerospace products. The aerospace industry tends to take large steps in product innovation which are enabled through the application of new technology and engineering methods.

Looking at the transformation of aircraft over the past 100 years, the steps forward in technology are clearly visible. In the earliest years of flight, the construction of aircraft was primarily wood and fabrics. By 1919, the first all-metal aircraft took to the skies. The Junkers J-13 (later known as the F-13) was not only the first all-metal aircraft, but that technology leap also enabled it to be the first practical cantilever (internally braced), low-wing monoplane.

Just five years later, Junkers was supplying 40 percent of the world's transport aircraft¹. In 1933 another innovative aircraft made its first flight, the Douglas DC-1. The DC- series of aircraft (DC-1, -2, and -3) was hugely successful. One of the keys to the design of the aircraft was the methodology of letting science drive the design and shape. Its shape was a result of extensive wind tunnel testing which led to turbulence-reducing wing-fuselage fillets and payload-enhancing wing flaps¹. More recently, two of the more innovative aircraft designs have been Lockheed Martin's Stealth F-117 and the Boeing 787. As with all steps in product innovation, there are key technologies that enabled these designs. The

very distinctive faceted shape of the F-117 was a direct result of engineering software and computational power available in the late 1970s. Lockheed Martin developed a computer program called Echo that drove the shape of the aircraft to achieve its stealthy shape. And today, the Boeing 787 is scheduled to be the first commercial aircraft to have the majority of the structure built out of composites.

The history of the aerospace industry clearly illustrates how significant breakthroughs—whether in aircraft, satellites, spacesuits for astronauts, or other successful new products—are driven by innovations in materials, technology, and methodologies. SIMULIA's realistic simulation solutions are enabling companies to improve existing processes and develop new methodologies. Our R&D teams are committed to developing new analysis capabilities, improving high-performance computing, enabling true multiphysics simulation, and providing the tools needed to perform multi-domain optimizations. These capabilities are being developed to support industry-specific workflows and are the building blocks for the next step in aerospace innovation.

Emerging Trends: Simulating Events, Not Just Load Cases

Traditionally, aerospace structures are analyzed to meet a specified load case. This load case might be a static load, a dynamic load, or a thermal load. But in reality, vehicles are subject to “events”—not just “load cases.” For example, a load case for a landing gear may be a specified vertical force and lateral force. Compare that to the real landing event, where the landing gear is deployed, locks into place, has aerodynamic forces on it, possibly strikes a bird or debris before landing, and then impacts the runway on the landing. Assumptions have been made to define the load case that represents the event. Companies today are reducing the number of assumptions they are making to more accurately simulate the event and understand their product’s behavior. To realistically simulate the event, the computer model must incorporate mechanisms, control systems, fluid modeling, explicit dynamic impact modeling, nonlinear stress analysis, contact behaviors, and damage models (maybe even composite damage models). In addition, the industry wants to optimize these complex models.

Abaqus FEA provides the technology to perform full-event simulations, which is enabling companies to evolve their methodologies to take advantage of these realistic simulation capabilities.

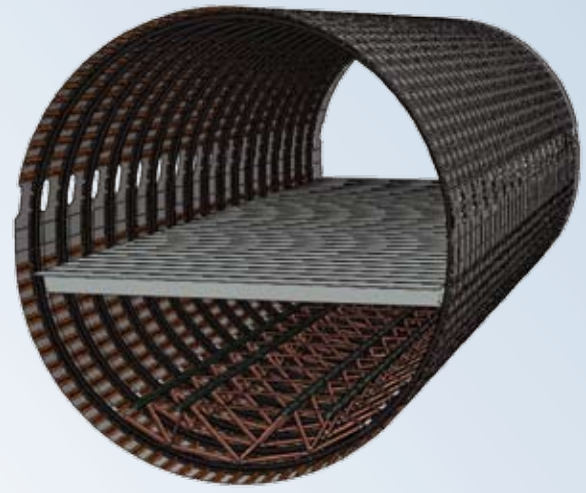
Large-Scale Nonlinear Analysis

Traditionally, nonlinear analysis has been used at the component level to understand joint details, failure modes, and composite fracture issues. Now, nonlinear FEA is being used more frequently for the large-scale simulation of whole aircraft structures, such as wing assemblies, fuselage sections, and tail-planes². Until recently, these types of analyses would have been undertaken only as a last resort—toward the end of the design phase, or even later—in order to solve a challenging problem related to manufacture or certification. Today, however, manufacturers are developing analysis methods and processes, which allow advanced nonlinear analysis to be applied during the design phase well in advance of the build and test phases.

High-performance computing (HPC) is a key requirement for large-scale nonlinear simulation. Large-scale aerospace models may have 10-20 million degrees-of-freedom (DOF), over 5,000 individual parts, and 10,000 fastener definitions, as well as contact and cohesive surface definitions.



Abaqus/CAE free body diagram for an aircraft landing gear strut.



Example of a large-scale fuselage model.

Solving these large-scale problems requires tens to hundreds of processors working in parallel. The SIMULIA development team is creating new algorithms to take advantage of today’s computational resources.

Managing It All

The development and implementation of new methodologies has created the need to capture and share these methods as standard procedures. The large models and multiple simulation runs are also creating the need to manage and secure the newly created data. SIMULIA has developed a new solution for Simulation Lifecycle Management (SLM). The new product suite provides online collaboration capabilities to allow distributed teams to easily share simulation methods and results to improve confidence in the decision-making process. It also provides the ability to manage simulation data at the individual, workgroup, and/or enterprise level. The data management is inclusive of processes, model files, configuration data, requirements, and results.

Customers Are the Key

A significant portion of our new product capabilities are developed through customer-requested enhancements and direct working relationships with our customers and partners. One such partnership, with Boeing Commercial Aircraft Group, enabled us to deliver the Virtual Crack Closure Technique (VCCT) within Abaqus/Standard. SIMULIA also participates in the FAA Center of Excellence workshops and the CMH-17 (Composite Materials Handbook) working group. By working with industry and customers, we are able to understand the aerospace industry processes and simulation requirements and align our development efforts towards solving real engineering problems.

We invite you to join us in this dialogue on simulation trends in aerospace and in our efforts to provide better simulation tools for an industry eager to move forward.



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Kyle Indermuehle is the Industry Solutions Manager at SIMULIA focused on the aerospace industry, and specifically composites. Prior to his role at SIMULIA, Kyle worked on a variety of aerospace programs including the Pratt & Whitney RL10B-2 rocket engine, analysis and testing of Unmanned Aerial Vehicles, and satellites. Kyle received his B.S. in aerospace engineering from Purdue University and his M.S. in structural engineering from UCSD.

1. http://www.airspacemag.com/history-of-flight/Airplanes_that_Transformed_Aviation.html

2. Tim Brown, Airbus, *Working to Meet the Challenges of Next Generation Composite Wing Structural Design*. RAeS Conference: Challenges for the Next Generation - Concept to Disposal, October 14-16, 2008

For More Information

www.simulia.com/solutions/aerospace