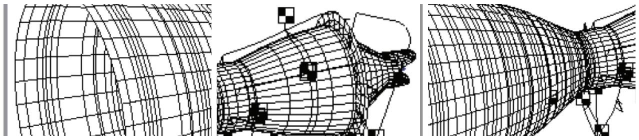
Advanced CAE tools and expertise support aerospace innovation

DYNAMIC CONCEPTS INC.



Business initiatives

New product development

Process efficiency

Business challenges

Assist customers with solutions to technically complex problems

Provide fast, accurate analysis and simulation

Support innovation in space exploration

Keys to success

Deep engineering expertise in structural dynamics, FEA

Leading-edge CAE tools

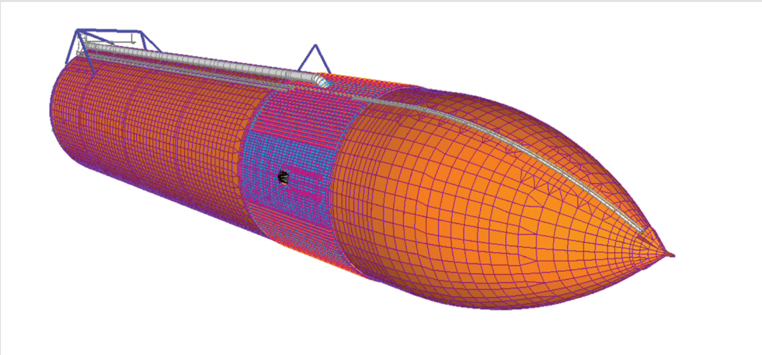
Detailed reporting and documentation of analysis results

Results

Faster, more accurate analysis

In-depth insight into behavior of complex structures

Improved finite element models, documentation to support advanced studies



Supporting aerospace and defense through CAE

Founded in 1995, Dynamic Concepts Inc. (DCI) has forged a reputation for simulation expertise in the aerospace and defense communities. With a solid track record based on a can-do attitude and deep technical knowledge, DCI is often called upon to quickly chart out a course for problem-solving in its clients' projects. The company has developed from four founders and a handful of contracts in 1995 to more than forty engineers and a growing portfolio of clients and projects today.

DCI's structural engineering group provides contract support for programs at the National Aeronautics and Space Administration (NASA), for the U.S. Army's Aviation Engineering Directorate, and for other companies involved in missile defense projects. For NASA's Marshall Space Flight Center, DCI is the go-to company for structural dynamics work, investigating the dynamic characteristics of systems to develop vibration loads used in stress analyses. For the U.S. Army, most of DCI's work focuses on fatigue analysis of helicopter systems. In missile defense projects, DCI primarily develops finite element models and performs stress analyses. The typical project involves building a finite element model, running the analysis and producing detailed reports, presentations, images and animations to communicate its findings.

Dynamic Concepts has a strong background in the technical disciplines of its customers' high-tech problems. The engineering personnel at DCI are knowledgeable experts in structural dynamics and finite element stress analysis. They leverage their expertise with leading-edge digital simulation technology, including Siemens' Femap® FEA modeling software and comprehensive NX™ Nastran® CAE software.

Femap provides an intuitive and productive model preparation and results visualization solution, available to DCI engineers through several floating licenses.

DCI's analysis engine of choice is NX Nastran, both the Basic and Advanced packages, as well as DMAP and Superelement capabilities for specialized analysis needs. Running on a server accessible by the entire staff, NX Nastran is the everyday workhorse tool.

SIEMENS

NX Nastran offered significant cost savings compared to versions of Nastran from another vendor previously used by DCI. An additional benefit is that it is the same analysis software used by DCI's largest client, NASA.

Fine-tuning the space shuttle rollout

In a recent project, NASA tasked DCI with assessing the structural dynamics of the rollout process, whereby the Space Shuttle orbiter, external tank and solid rocket booster assembly is moved via a crawler transporter from the vertical assembly building to the launch pad. At speeds of less than one mile per hour, the rollout was assumed to be a benign process that had no impact on the vehicle assembly's fatigue life. But with renewed attention to return to flight issues such as the foam insulation on the external tank, NASA sought to more thoroughly examine vibrations that had been observed and recorded on camera during the rollout.

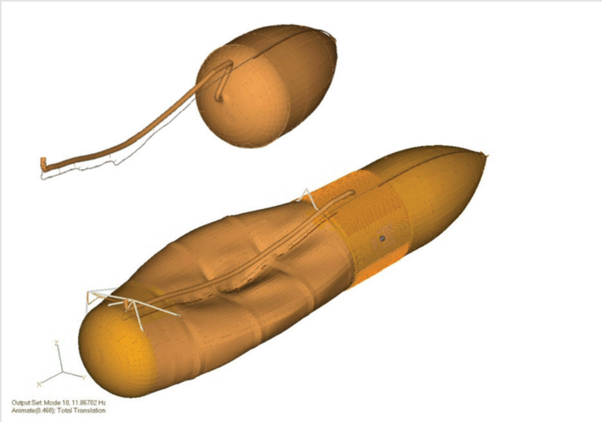
DCI used Femap to create an integrated model of all the shuttle components and used NX Nastran to analyze the simulated vibration environment. The results visualization tools of Femap helped DCI engineers create an animation of the rollout-induced vibration that clearly demonstrated the vibration of the vehicle. When placed side-by-side with a film of the shuttle tail fin during rollout, the Femap animation closely synchronized with the 2.5 Hz vibration recorded in the filmed version, validating the results of DCI's analysis. The analysis helped NASA resolve issues with support structures, and also helped determine target rollout speeds that minimized the potentially damaging vibration.

Anthony Williams, a DCI senior engineer/scientist, cites the shuttle rollout project to highlight the value of the Femap visualization tools in communicating analysis results. "If a picture is worth a thousand words, an animation is worth a million," says Williams. "In previous generations, the state of the art was scatter plots, bar charts and maybe modal animations with stick figures. With Femap, we can quickly produce animations of the analysis results – using the entire model, from inside or outside the structure and from any angle, depending on the interest. It takes all that engineering data and communicates it in a clear and intuitive way."

Developing a more detailed finite element model

In the wake of the Columbia shuttle disaster, NASA sought to more fully understand the structural behavior of the space shuttle with detailed engineering studies. To support this effort, NASA engaged DCI to develop a more detailed finite element model of the external tank. Much of the computer-aided engineering work on the space shuttle for the past two decades has used a reviewed and approved finite element model of the tank, which supported gross structural and interface studies well, but by itself was not sufficient to meet the current needs for detailed analysis of local components.

The two-year project began with creating much of the new finite element model directly from drawings, using Femap modeling and NX Nastran analysis tools. "The external tank is more complex than people may think," says Jeffrey Oliver, senior engineer/scientist, who modeled the Intertank and LH2 Tank Barrels. "There is



Deformed plots of the liquid oxygen system and the entire tank.

Solutions/Services

Femap

NX Nastran

Client's primary business

Dynamic Concepts, Inc. provides engineering and software services for government and commercial applications.
www.dynamic-concepts.com

Client location

Huntsville, Alabama
United States

"If a picture is worth a thousand words, an animation is worth a million. With Femap, we can quickly produce animations of the analysis results – using the entire model, from inside or outside the structure and from any angle, depending on the interest. Femap takes all that engineering data and communicates it in a clear and intuitive way."

Anthony Williams
Senior engineer/Scientist
DCI

a great deal of engineering to reduce weight and maintain structural integrity, and there are many asymmetrical features that are not included in the finite element model currently in use."

In its current state, the DCI-developed model has 140,000 degrees of freedom; more than 50,000 elements; 23,250 nodes; 99 materials and 744 properties. The foam thermal protection system is a separate set of elements. When complete, the new model will be structurally resolved to the current model, and it will work in a plug-and-play fashion with other component models to support a much broader range of engineering studies. NASA engineers will use the new model for sensitivity and what-if analysis. If they identify potential problems, they turn to the contractor responsible for the hardware for resolution.

Engineering the next generation of rocket engines

DCI is also supporting development of next-generation rocket engines that will power the return to the moon. The Ares I launch vehicle in NASA's Constellation program includes a new upper-stage engine, the J2-X, being developed by Pratt & Whitney-Rocketdyne. Dr. Eric Christensen, a senior engineer at DCI with more than 20 years' experience in rocket engine dynamics, is working with NASA to define the dynamic environment for simulations that will be used in the J2-X design. "An ongoing problem in engine design structural dynamics is how to model the response of the engine to random vibration," Christensen explains. "You have combustion, fluid flow, turbulence and other forces, loads and stresses that are difficult to characterize and calculate. Very conservative methods were used in earlier engines that resulted in higher calculated loads. These loads can greatly influence the weight of many engine components and thus affect the overall engine performance, so it's important to calculate them as accurately as possible."

Recent NASA engine programs have indicated the need for improved methodologies for calculating the dynamic loads. Because of computational limitations in earlier programs, NASA had relied on a component-by-component approach that did not take into account the dynamic coupling between components. For the first time in the 1990s, NASA used a complete engine system finite element dynamic model in which all the major engine components were modeled, but the methods used to calculate the random loads resulted in such high loads that the system model was abandoned for the traditional component approach.

To improve the methodology for calculating loads, Christensen worked with NASA using an engine of similar design, the Fastrac, developed in the 1990s. They devised a vibration testbed using an actual surplus engine suspended on bungee cords and attached to several shakers that provided the random force inputs. Accelerations and strains were measured at several critical locations on the engines.

Christensen then used a finite element model of the engine, adapted to the testbed configuration, to simulate the results with NX Nastran, using several calculation methods and comparing the results to the test data. While all the methodologies yielded conservative results, an enforced acceleration approach reproduced the acceleration environment exactly, and removing a load component due to static forces in the structure yielded more reasonable load levels. Christensen believes the methodology will improve the accuracy of analysis in the design of the J2-X.

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