SIEMENS

Aerospace and defense

NASA

Femap helps NASA satellite handle the stresses of space

Products

Femap, NX

Business challenges

Reduce the amount of physical testing

Minimize costly post-testing design changes

Reduce weight of individual components

Keys to success

Digital modeling of satellite components with NX

Pre- and postprocessing of analysis information in Femap

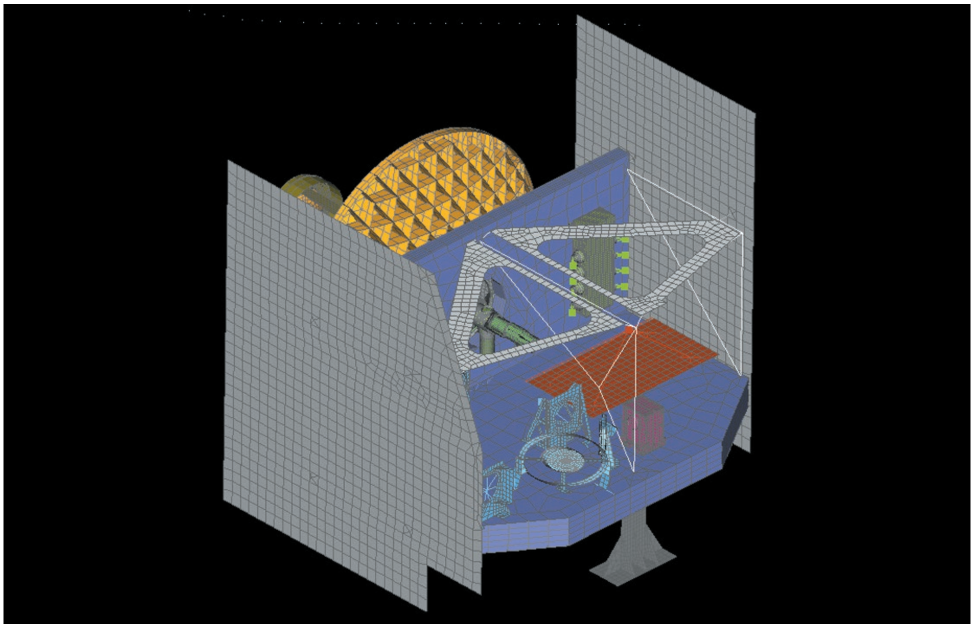
Results

Analyses that formerly took weeks are now done in a few days

Analysis revealed artificial grounding condition that was fixed during the design stage

Graphic capabilities of Femap helped make complex scientific information more understandable

Analysis results made physical testing of some components unnecessary

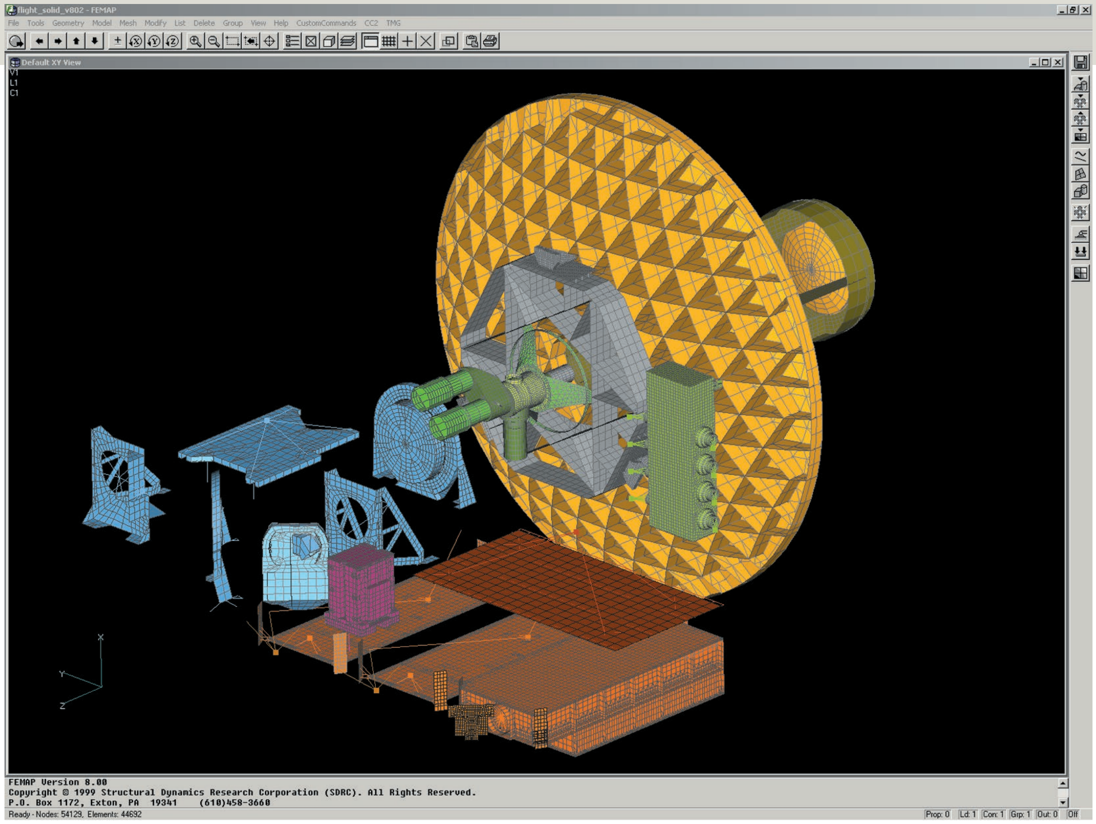


Specially designed satellite

NASA's Geoscience Laser Altimeter System (GLAS) is a specially designed satellite that uses a laser altimeter to measure the thickness of the polar ice caps – an indicator of global warming. Because its laser transmits light through several instruments within the system, positional error between the various components must be extremely low. To ensure that it meets these requirements, NASA is using physical testing, computer simulation, finite element analysis (FEA) and the Femap™ software from Siemens PLM Software to predict the response of the satellite to the stresses of space flight.

Situation

GLAS is the primary scientific instrument aboard the ICESat spacecraft. GLAS consists of thousands of individual parts and weighs about 600 pounds. As with all satellites, this one must withstand the extreme stress of the launch (about 8-g launch acceleration; up to 30-g dynamic responses to random vibration). However, thermal stresses during operation are the more serious problem for GLAS. The satellite will constantly be heating and cooling



as it passes through its 96.5-minute orbit, causing expansion and contraction in many of the structural components. NASA knew it had to use a combination of testing capabilities to predict the response of the satellite to the stresses of space flight.

Objectives

Perform finite element analysis on each individual component of GLAS, as well as on the entire system to:

- Reduce the amount of physical testing
- Minimize costly post-testing design changes
- Reduce weight of individual components

Process vision

- Perform static and dynamic analysis to predict the structural integrity of the satellite under launch conditions.
- Perform thermal analysis on components such as the instrument bench to 1) determine the response to the constant thermal cycling and 2) predict whether the instruments can be held to such a close positional tolerance.

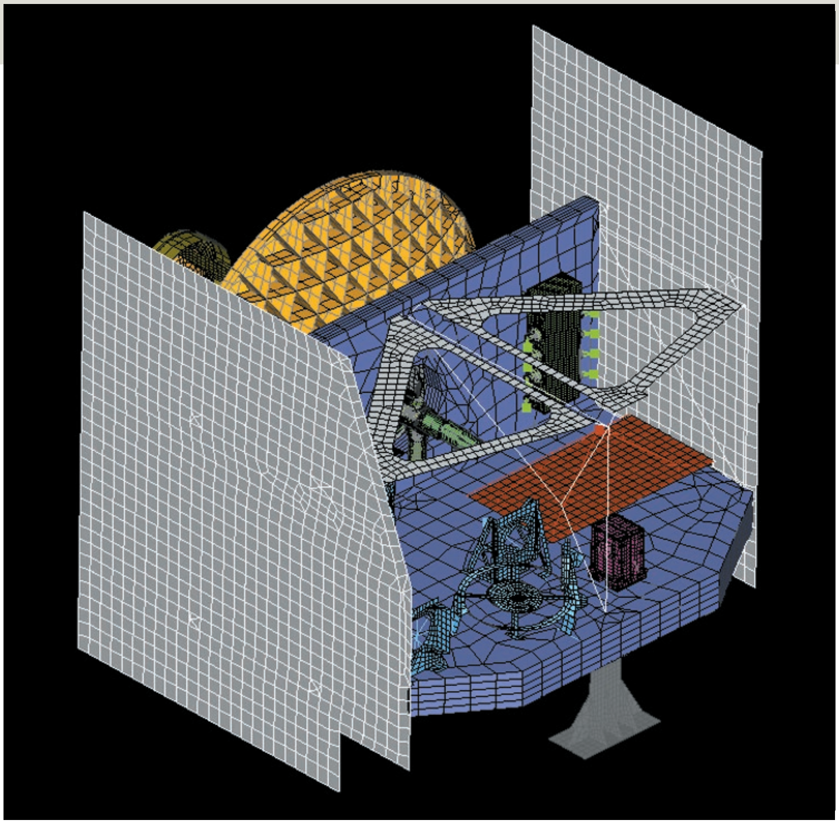
Actions

- Designers are creating digital models of GLAS (components, subsystems and the entire assembly) with Siemens PLM Software's NX™ I-deas™ software. The models are exported in IGES format and sent to the GLAS analysis team.
- Analysts import the IGES files into the Femap modeling solution. Several members of this branch of NASA Goddard have used the Femap pre- and postprocessor since the software's introduction in the early 1990s. Femap was chosen at the time for its low cost and ease of use. Additionally, the GLAS primary analysis contractor, Orbital Sciences Corporation, uses Femap.
- Analysts use the layering capability of Femap to build an analysis model from the CAD data. The imported IGES file forms one layer, while the points and lines that analysts use as the basis for their model are placed on a different layer. By turning off the layer containing the IGES model, analysts can display only the information they need.

"In addition to overall ease of use, many features within Femap are helpful to our work."

Ryan Simmons
Lead Mechanical Analyst
for GLAS

- After constructing either a 2D model using plates and beam elements (for dynamics analysis) or a 3D model using solid elements (for thermal analysis), analysts create the analysis mesh. They use a combination of hand meshing for areas where they expect complicated loads, and Femap automatic meshing for less complicated areas.
- The analysts working on GLAS developed a novel method for modeling the honeycomb panel that serves as the main instrument bench. By taking advantage of the ability of Femap to vary material properties by direction, they can account for the fact that mechanical properties of a honeycomb core vary dramatically depending on their orientation.
- The Femap analysis model is exported to Nastran® software, the primary solver for this project. While NASA analysts use UAI/Nastran, formerly sold by Universal Analytics Inc. and now owned by MSC Software, some contractors use MSC's version of Nastran. The ability of Femap that allows you to write accurate files for either version of the solver advances consistency of results from all analysts.
- Once the Nastran run is finished, the results are transferred back into Femap for visualization.



Results

- When Nastran results differ from what analysts expect, they use the thorough model interrogation functionality of Femap to search for an explanation. Selecting an element, for example, brings up a detailed list of its features, such as constraints, with other elements it borders, and so on. Using this tool, analysts were easily able to find an artificial grounding condition – where parts of the model are constrained from moving when they should move freely – that caused erroneous results in a normal mode dynamics analysis.
- The analysts use the graphic capabilities of Femap to communicate their work to others. They use a combination of the color-coded, finite element results models, animated mode shapes and exploded 3D assembly views to clearly convey information that may otherwise be difficult for many of those involved in the GLAS project to understand.

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Solutions/Services

Femap
www.siemens.com/plm/femap

NX
www.siemens.com/nx

Customer's primary business

NASA's mission is to pioneer the future in space exploration, scientific discovery and aeronautics research.
www.nasa.gov

Customer location

Florida
United States

- The ease of creating the analysis model, combined with powerful postprocessing tools, has reduced turnaround time for many analyses. According to Ryan Simmons, lead mechanical analyst for GLAS, "In addition to overall ease of use, many features within Femap are helpful to our work. The ability to model in layers, to vary material properties by dimension and to highlight elements and instantly see their features, for example, have helped us shrink turnaround time. Analyses that formerly took weeks are now done in a few days."
- Although the entire satellite will be thoroughly tested, the use of analysis has made it possible to eliminate physical testing for some individual components. Physically testing a new component requires a factor of safety of 1.25 times the expected flight loads. However, through analysis, that same part may only need testing to flight-load levels if the analysis shows the design can survive loads with a 2.0 factor of safety. Femap often plays a part in that analysis.

Plans

Throughout the development of GLAS, engineers have been performing physical tests of various components and subsystems. The analysts have been incorporating this information into their analysis models all along. This is called model correlation. When the entire satellite assembly is built and tested prior to launch, they will use that test data to further refine their models.

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Ryan Simmons
Lead Mechanical Analyst for GLAS

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