SIEMENS

Space systems

NASA Goddard Space Flight Center

Using Femap helps NASA develop next-generation space telescope

Product

Femap

Business challenges

Design a next-generation space telescope

Coordinate systems supplied by multiple sources

Operate at temperatures near absolute zero

Keys to success

International cooperation and collaboration

Using a single pre- and postprocessor

Incorporating lessons learned from past missions

Results

Standardizing on Femap shortens learning curve

Visualization pinpoints potential flaws in components

Finding and fixing potential problems long before the telescope is launched

Simulating the performance of James Webb Space Telescope components

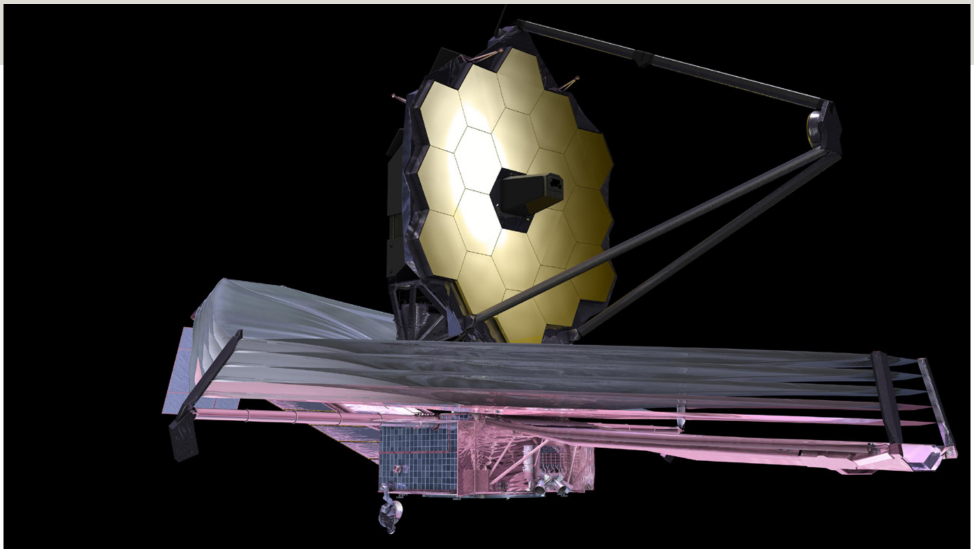
Building a time machine

The use of Femap™ software from Siemens PLM Software is helping NASA develop a time machine. Scheduled for launch in 2018, the James Webb Space Telescope Observatory (JWST) will operate 1.5 million kilometers above the Earth. Its mission is ambitious: examining every phase of cosmic history "from the first luminous glows after the Big Bang to the formation of galaxies, stars and planets to the evolution of our own solar system," according to the JWST website. The telescope will look back light-years into the past.

Considered to be the next generation – not the replacement – of the Hubble Space Telescope, the JWST is an infrared telescope that enables the viewing of more distant, highly redshifted objects. The Hubble is used to study the universe in optical and ultraviolet wavelengths. The JWST will also be larger than Hubble, which is about the size of a large tractor-trailer truck. At 22 by 12 meters, the JWST will be almost as large as a Boeing 737.

Fully deployed, the JWST will feature a reflecting mirror with seven times more collecting area than the Hubble. The telescope will be launched into space atop an Ariane 5 rocket from the European Space Agency's (ESA) launch pad in French Guiana.

Primary mirror segments are prepped to begin final cryogenic testing at NASA's Marshall Space Flight Center.



Artist's conception of James Webb Space Telescope

"Femap is a very usable tool that is at once very affordable and also provides high value. It enables us to carry out our mission of analyzing the structural and thermal performance of parts and systems."

Mark McGinnis
Thermal Distortion Working Group Leader
NASA Goddard Space Flight Center

The JWST will have a hot side and a cold side, with the hot side consisting of the observatory spacecraft, which manages pointing and communication, and a shield that blocks heat and radiation from the sun, Earth and moon. The cold side of the JWST, operating at temperatures near absolute zero, is where the science will happen.

Four major instruments will be in operation, including the near-infrared camera or NIRCam, provided by the University of Arizona. Other major instruments include the near-infrared spectrograph (NIRSpec), provided by the ESA, with additional instrumentation provided by the NASA Goddard Space Flight Center (GSFC); the mid-infrared instrument or MIRI, provided jointly by the ESA and NASA's Jet Propulsion Laboratory (JPL) and the fine guidance sensor/near infrared imager and slitless spectrograph, provided by the Canadian Space Agency.

All in all, there are more than 1,000 people in 17 different countries working on JWST, including academic and industrial partners ATK, Ball Aerospace, ITT, Lockheed Martin, Northrop Grumman (the prime contractor) and the Space Telescope Science Institute.

Multiple analysis applications feed into Femap

Designing, testing, building and assembling JWST is a team effort, taking place on three continents. The instruments now under development are being tested using a variety of computer-aided engineering (CAE) solvers for modal, thermal, thermal distortion and structural analysis. Gluing all this analysis and simulation work together is Femap, the JWST team's standard application for pre- and postprocessing.

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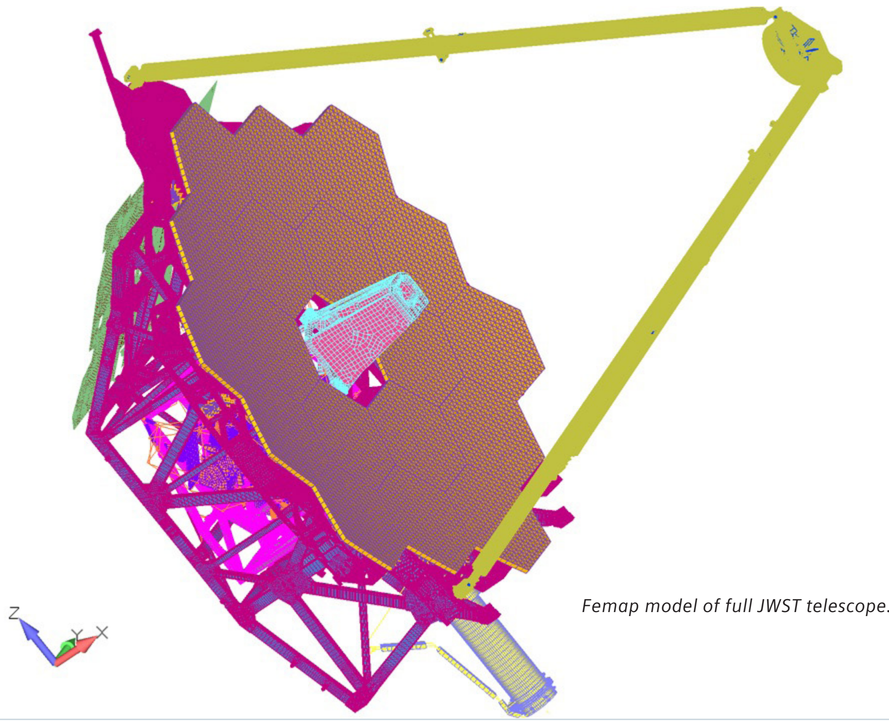


Femap model of full JWST telescope.

"We use Femap as the pre- and postprocessor. The mechanical design team provides us with CAD files and we use Femap to generate meshes for our mathematical model and, after the finite element analysis, to extract results and view the condition and state of the structure under the various load conditions."

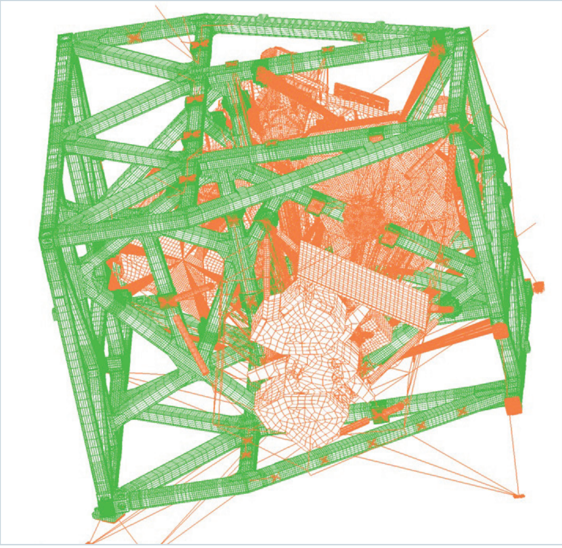
Emmanuel Cofie
Thermal Distortion Analysis Group Leader
NASA Goddard Space Flight Center

"We use Femap as the pre- and postprocessor," says Emmanuel Cofie, who leads thermal distortion analysis on the ISIM (integrated structural instrument model). "The mechanical design team provides us with CAD files and we use Femap to generate meshes for our mathematical model and, after finite element analysis, to extract results and view the condition and state of the structure under the various load conditions. It is the primary tool we use for visualization of the structure in its operational/launch states before actual environmental testing."

Because there will be only one opportunity for the JWST to succeed, every part and assembly of every system needs to be thoroughly tested on Earth to ensure that all instruments will function flawlessly under expected conditions. Simulating the JWST's performance on Earth is the only way to determine that the observatory will function once it is in place. It's a one-of-a-kind, custom job.

Using CAE solvers in conjunction with Femap, NASA engineers conduct simulations to ensure each part does not interfere with another and that parts and assemblies have sufficient strength and can withstand extreme heat or cold and vibrations experienced during launch and normal operating conditions. "Femap is a very usable tool that is at once very affordable and also provides high value," says Mark McGinnis, thermal distortion working group leader at Goddard. "It enables us to carry out our mission of analyzing the structural and thermal performance of parts and systems. Femap is easy to learn and use, and works well with any solver." He estimates that the software is used frequently by at least 75 NASA engineers at Goddard.

"For example, we will import a back plane sub-assembly model from a contractor and populate it with 18 mirrors to visualize how they come together," says McGinnis, "We need to be sure the interface grids are



Femap model of ISIM (integrated structural instrument model) with instruments

Solutions/Services

Femap
www.siemens.com/plm/femap

Customer's primary business

The NASA Goddard Space Flight Center is home to the United States' largest organization of combined scientists, engineers and technologists that build spacecraft, instruments and new technology to study the Earth, the sun, our solar system and the universe. Named for American rocketry pioneer Dr. Robert H. Goddard, the center was established in 1959 as NASA's first space flight complex. Goddard and its several facilities are critical in carrying out NASA's missions of space exploration and scientific discovery.
www.nasa.gov/goddard

Customer location

Greenbelt, Maryland
United States

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Thermal Distortion Analysis
NASA Goddard Space Flight Center

coincident as they are supposed to be, and then use it to build the more than 8 million required grids, which makes a very large model from a computing standpoint. We assemble the model using Femap."

Most of the engineers working on the JWST have used Femap as far back as the mid-1990s. Cofie recalls using Femap during the development of Hubble. "We used it for a lot in those days and we continue to use it," he says. "Femap helps us understand loading conditions so we can take a structure, run the analysis and see what gets hot and what gets cold. It helps us visualize whether or not a model is feasible."

McGinnis agrees that the visibility Femap provides in postprocessing is a key advantage. "An engineer can easily understand the mathematical results of an analysis conducted with a solver," he says. "But visualizing analysis results using Femap is an important benefit, showing you exactly what is going on."

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