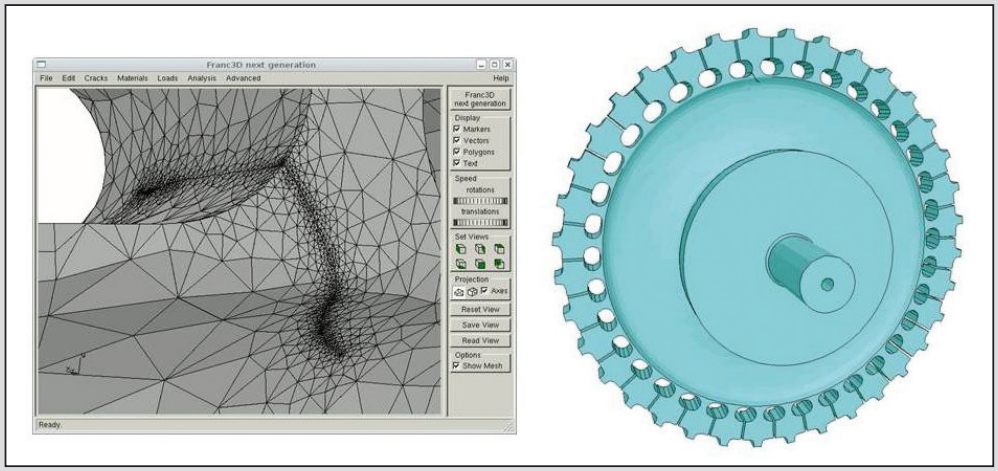
Next-Generation Software Improves Finite Element Modeling Tool Compatibility



Demonstration of FRANC3D/NG during spin-pit testing of a minidisk (pictured right) representative of turbine engine rotating hardware. FRANC3D/NG successfully meshed and analyzed a submodel of the cracked region (pictured left).

AFRL helped develop FRANC3D/NG, a Fracture Analysis Code 3-D/Next-Generation software product that uses finite element modeling (FEM) to simulate crack propagation in aircraft engine components. A Small Business Innovation Research (SBIR) contract with Fracture Analysis Consultants, Inc., facilitated this development effort, wherein the research team improved upon the original version of this software, FRANC3D. These enhancements provide a more efficient method for designing aircraft engine components, promoting more accurate forecasts of component life expectancies and, in turn, generating significant cost savings in the area of aircraft sustainment.

The integration of three-dimensional (3-D) modeling into engineering analysis adds precision and depth to results, a desirable outcome from which FRANC3D first emerged and from which FRANC3D/NG has further advanced. Using commercial FEM software, such as ABAQUS or ANSYS, an engineer starts a model with a computer-aided design drawing of the component, subsequently dividing the preliminary model into thousands of sections, or elements, to create a mesh. The engineer then uses FRANC3D/NG to incorporate this mesh and insert a crack, identifying its size, shape, and orientation. FRANC3D/NG automatically remeshes the model around the specified crack geometry and sends the updated modeling data back to the FEM-based software for analysis. After reading the results, FRANC3D/NG "grows" the crack based on the analyzed data, creates a corresponding mesh, and repeats this process accordingly.

AFRL initiated an SBIR contract with Fracture Analysis Consultants to improve upon early versions of the software, which were limited to the use of boundary element methods (BEM) for solving equations of motion. In addition to its various drawbacks, BEM code makes it difficult to leverage FEM models already in existence for given components. The lab desired a product both more user-friendly and more compatible with FEM tools used across the industry (e.g., ABAQUS, ANSYS). Joining Fracture Analysis Consultants personnel involved in the original, FRANC3D development effort, AFRL researchers began a dialogue with industry leaders—and the approximately 20 interested companies, universities, and other government agencies—to discuss the need for updating the software.

During Phase I of the contract, the researchers completed integration of FRANC3D/NG with commercial FEM codes. Phase II activity successfully verified and validated the software using FEM and data from spin-tested components. Thus far, the new software has tested favorably and is slated for further development and testing of several recommended improvements.