Journal Bearing Analysis Suite Released for Planetary Gear System Evaluation

Planetary gear system.

Long description of figure 1. Planetary gear systems are widely used in helicopter transmissions, aircraft turbine engine reduction gears, automotive automatic transmissions, and many industrial applications. Because of the multiple load paths of planetary gearing, the horsepower transmitted is divided between several planet meshes and the gear size can be reduced significantly, compared with parallel shaft designs. In addition, planetary stages can be linked together to achieve high ratios. Hence, the use of planetary gearing is an efficient method of achieving high reduction ratios in minimum space. Planetary gear systems are compact, resulting in significant envelope and weight savings; they have reduced noise and vibrations and improved efficiency because of smaller, stiffer components, and they have concentric input and output shaft axes and only transmit the torque.

Planetary gear systems are an efficient means of achieving high reduction ratios with minimum space and weight. They are used in helicopter, aerospace, automobile, and many industrial applications. High-speed planetary gear systems will have significant dynamic loading and high heat generation. Hence, they need jet lubrication and associated cooling systems. For units operating in critical applications that necessitate high reliability and long life, that have very large torque loading, and that have downtime costs that are significantly greater than the initial cost, hydrodynamic journal bearings are a must.

Computational and analytical tools are needed for sufficiently accurate modeling to facilitate optimal design of these systems. Sufficient physics is needed in the model to facilitate parametric studies of design conditions that enable optimal designs.

The first transient journal bearing code to implement the Jacobsson-Floberg-Olsson boundary conditions, using a mass-conserving algorithm devised by Professor Emeritus Harold Elrod of Columbia University, was written by David E. Brewe of the U.S. Army at the NASA Lewis Research Center[1] in 1983. Since then, new features and improved

modifications have been built into the code by several contributors supported through Army and NASA funding via cooperative agreements with the University of Toledo (Professor Ted Keith, Jr., and Dr. Desikakary Vijayaraghavan) and National Research Council Programs (Dr. Vijayaraghavan). All this was conducted with the close consultation of Professor Elrod and the project management of David Brewe.

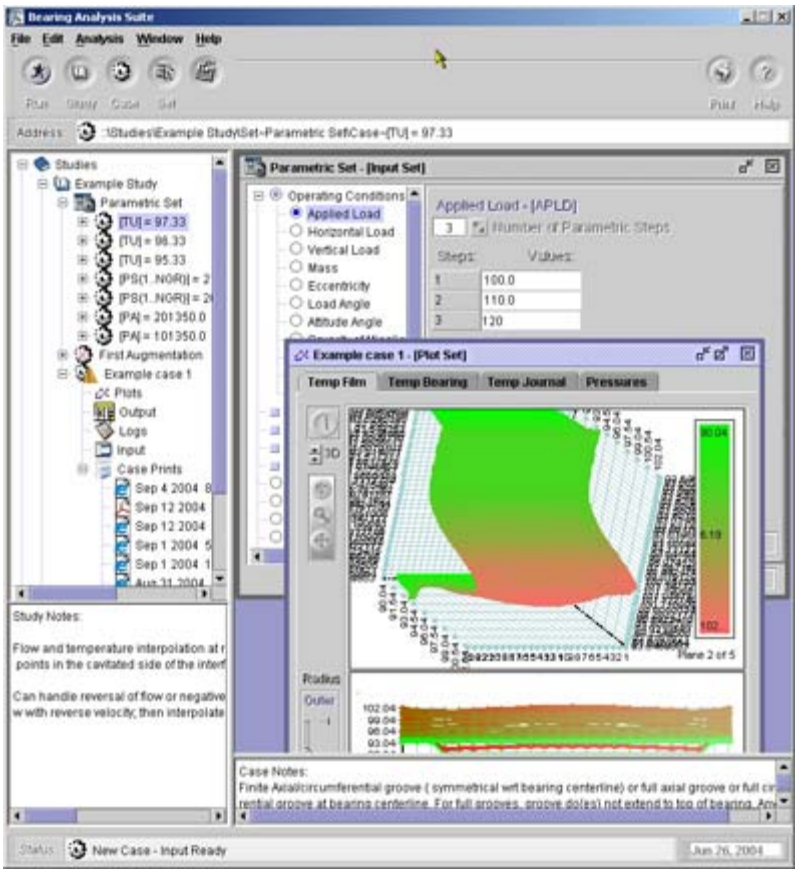
This version uses collocation across the film thickness at Lobatto points and Legendre polynomials to perform a thermohydrodynamic analysis of fluid-film journal bearings. The procedure is based on the development and program of Professor Elrod, and the code was developed by Dr. Vijayaraghavan at NASA Lewis with U.S. Army Research Laboratory, Vehicle Technology Directorate funding.

The latest features now include viscosity variation through the film due to shear heating and pressure viscosity effects. The program also can handle (1) aligned and misaligned bearings, (2) heat conduction through the bearing (stationary surface) and net heat flux through the journal (rotating surface) while considering free convection to the bearing outside and end surfaces, (3) a wide variety of groove designs for several grooves, (4) groove mixing temperature of hot oil carryover with supply, (5) transient or steady-state analysis, (6) rotating or dynamic loading, and (7) the rotation of either surface (i.e., journal or bearing).

In addition, a modern graphical user interface was added to facilitate simple, intuitive case studies for nonexperienced users. The package is presented as the Bearing Analysis Suite.

Special features of the user interface include the

- Study Manager--Enables the easy generation of parametric sets of cases
- Notes Manager--Provides an intuitive note-taking interface
- Plot Viewer--Shows two- and three-dimensional output plots
- Log Viewer--Gives convergence histograms and three-dimensional convergence plots
- Web Printer--Publishes output to portable document format (PDF) or hypertext markup language (HTML)



User interface of Bearing Analysis Suite Version 1.0.

Long description of figure 2. The Bearing Analysis Suite is a set of tools that facilitates parametric studies of boundary conditions, including tools for note management implemented in a graphical (study) tree. Two and three-dimensional plotting, input editors, and more are available through a fully integrated graphical user interface.

Find out more about this research:
Glenn's Tribology & Surface Science Branch at http://www.grc.nasa.gov/WWW/SurfSci/
Bearing Analysis Suite at http://www.grc.nasa.gov/WWW/SurfSci/JournalBearings/

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[1]Renamed the NASA Glenn Research Center at Lewis Field in 1999.