



## Active Mirror Predictive and Requirements Verification Software (AMP-ReVS)

This software is designed to predict large active mirror performance at various stages in the fabrication lifecycle of the mirror. It was developed for 1-meter class powered mirrors for astronomical purposes, but is extensible to other geometries. The package accepts finite element model (FEM) inputs and laboratory measured data for large optical-quality mirrors with active figure control. It computes phenomenological contributions to the surface figure error using several built-in optimization techniques. These phenomena include stresses induced in the mirror by the manufacturing process and the support structure, the test procedure, high spatial frequency errors introduced by the polishing process, and other process-dependent deleterious effects due to light-weighting of the mirror. Then, depending on the maturity of the mirror, it either predicts the best surface figure error that the mirror will attain, or it verifies that the requirements for the error sources have been met once the best surface figure error has been measured.

The unique feature of this software is that it ties together physical phenomenology with wavefront sensing and control techniques and various optimization methods including convex optimization, Kalman filtering, and quadratic programming to both generate predictive models and to do requirements verification. This software combines three distinct disciplines: wavefront control, predictive models based on FEM, and requirements verification using measured data in a robust, reusable code that is applicable to any large optics for ground and space telescopes.

The software also includes state-of-the-art wavefront control algorithms that allow closed-loop performance to be computed. It allows for quantitative trade studies to be performed for optical systems engineering, including computing the best surface figure error under various testing and operating conditions. After the mirror manufacturing process and testing have been completed, the software package can be used to verify that the underlying requirements have been met.

*This work was done by Scott A. Basinger of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov).*

*This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at [danielb@caltech.edu](mailto:danielb@caltech.edu). Refer to NPO-47667.*

## Navigation/Prop Software Suite

Navigation (Nav)/Prop software is used to support shuttle mission analysis, production, and some operations tasks. The Nav/Prop suite containing configuration items (CIs) resides on IPS/Linux workstations. It features lifecycle documents, and data files used for shuttle navigation and propellant analysis for all flight segments. This suite also includes trajectory server, archive server, and RAT software residing on MCC/Linux workstations.

Navigation/Prop represents tool versions established during or after IPS Equipment Rehost-3 or after the MCC Rehost.

*This work was done by Tomas Bruchmiller, Sanh Tran, Mathew Lee, Scott Buckner, Catherine Bupane, Charles Bennett, Sergio Cantu, Ping Kwong, and Carolyn Propst of the United Space Alliance for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24957-1*

## Personal Computer Transport Analysis Program

The Personal Computer Transport Analysis Program (PCTAP) is C++ software used for analysis of thermal fluid systems. The program predicts thermal fluid system and component transients. The output consists of temperatures, flow rates, pressures, delta pressures, tank quantities, and gas quantities in the air, along with air scrubbing component performance.

PCTAP's solution process assumes that the tubes in the system are well insulated so that only the heat transfer between fluid and tube wall and between adjacent tubes is modeled. The system described in the model file is broken down into its individual components; i.e., tubes, cold plates, heat exchangers, etc. A solution vector is built from the components and a flow is then simu-

lated with fluid being transferred from one component to the next. The solution vector of components in the model file is built at the initiation of the run. This solution vector is simply a list of components in the order of their inlet dependency on other components. The component parameters are updated in the order in which they appear in the list at every time step. Once the solution vectors have been determined, PCTAP cycles through the components in the solution vector, executing their outlet function for each time-step increment.

*This work was done by Frank DiStefano III, Craig Wobick, Kirt Chapman, and Peter McCloud of The Boeing Company for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.*

*Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457(f)), to The Boeing Company. Inquiries concerning licenses for its commercial development should be addressed to:*

*Terrance.Mason@Boeing.com or  
Phone No.: (562) 797-9034*

*Refer to Boeing ID No. 10-0614 & MSC-24971-1, volume and number of this NASA Tech Briefs issue, and the page number.*

## Pressure Ratio to Thermal Environments

A pressure ratio to thermal environments (PRatTIE.pl) program is a Perl language code that estimates heating at requested body point locations by scaling the heating at a reference location times a pressure ratio factor. The pressure ratio factor is the ratio of the local pressure at the reference point and the requested point from CFD (computational fluid dynamics) solutions.

This innovation provides pressure ratio-based thermal environments in an automated and traceable method. Previously, the pressure ratio methodology was implemented via a Microsoft Excel spreadsheet and macro scripts. PRatTIE is able to calculate heating environments for 150 body points in less than two minutes.

PRatTIE is coded in Perl programming language, is command-line-driven, and has been successfully executed on both the HP and Linux platforms. It supports multiple concurrent runs. PRatTIE

contains error trapping and input file format verification, which allows clear visibility into the input data structure and intermediate calculations

*This work was done by Pedro Lopez and Winston Wang of The Boeing Co. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24963-1*

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### Probabilistic Fatigue Damage Program (FATIG)

FATIG computes fatigue damage/fatigue life using the stress rms (root mean square) value, the total number of cycles, and S-N curve parameters. The damage is computed by the following methods: (a) traditional method using Miner's rule with stress cycles determined from a Rayleigh distribution up to  $3\sigma$ ; and (b) classical fatigue damage formula involving the Gamma function, which is derived from the integral version of Miner's rule. The integration is carried out over all stress amplitudes.

This software solves the problem of probabilistic fatigue damage using the integral form of the Palmgren-Miner rule. The software computes fatigue life using an approach involving all stress amplitudes, up to  $N\sigma$ , as specified by the user.

It can be used in the design of structural components subjected to random dynamic loading, or by any stress analyst with minimal training for fatigue life estimates of structural components.

*This work was done by Constantine Michalopoulos of The Boeing Co. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24975-1*

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### ASCENT Program

The ASCENT program solves the three-dimensional motion and attendant structural loading on a flexible vehicle incorporating, optionally, an active analog thrust control system, aerodynamic effects, and staging of multiple bodies.

ASCENT solves the technical problems of loads, accelerations, and displacements of a flexible vehicle; staging of the upper stage from the lower stage; effects of thrust oscillations on the vehicle; a payload's relative motion; the effect of fluid sloshing on vehicle; and the effect of winds and gusts on the vehicle (on the ground or aloft) in a continuous analysis.

The ATTACH ASCENT Loads program reads output from the ASCENT flexible body loads program, and calcu-

lates the approximate load indicators for the time interval under consideration. It calculates the load indicator values from pre-launch to the end of the first stage.

*This work was done by Richard Brown, Gary Collier, Richard Heckenlaible, Edward Dougherty, James Dolenz, and Iain Ross of The Boeing Company for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24978-1/9-1*

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### JPL Genesis and Rapid Intensification Processes (GRIP) Portal

Satellite observations can play a very important role in airborne field campaigns, since they provide a comprehensive description of the environment that is essential for the experiment design, flight planning, and post-experiment scientific data analysis. In the past, it has been difficult to fully utilize data from multiple NASA satellites due to the large data volume, the complexity of accessing NASA's data in near-real-time (NRT), as well as the lack of software tools to interact with multi-sensor information.

The JPL GRIP Portal is a Web portal that serves a comprehensive set of NRT observation data sets from NASA and NOAA satellites describing the atmospheric and oceanic environments related to the genesis and intensification of the tropical storms in the North Atlantic Ocean. Together with the model forecast data from four major global atmospheric models, this portal provides a useful tool for the scientists and forecasters in planning and monitoring the NASA GRIP field campaign during the 2010 Atlantic Ocean hurricane season.

This portal uses the Google Earth plug-in to visualize various types of data sets, such as 2D maps, wind vectors, streamlines, 3D data sets presented at series of vertical cross-sections or point-wise vertical profiles, and hurricane best tracks and forecast tracks. Additionally, it allows users to overlap multiple data sets, change the opacity of each image layer, generate animations on the fly with selected data sets, and compare the observation data with the model forecast using two independent calendars. The portal also provides the capability to identify the geographic location of any point of interest.

In addition to supporting the airborne mission planning, the NRT data and portal will serve as a very rich source of information during the post-field campaign analysis stage of the airborne

experiment. By including a diverse set of satellite observations and model forecasts, it provides a good spatial and temporal context for the high-resolution, but limited in space and time, airborne observations.

*This work was done by Brian W. Knosp, P. Peggy Li, Quoc A. Vu, Francis J. Turk, Tsae-Pyng J. Shen, Svetla M. Hristova-Velova, Stephen J. Licata, and William L. Poulsen of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov).*

*This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at [danielb@caltech.edu](mailto:danielb@caltech.edu). Refer to NPO-47787.*

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### Data::Downloader

Downloading and organizing large amounts of files is challenging, and often done using ad hoc methods. This software is capable of downloading and organizing files as an OpenSearch client. It can subscribe to RSS (Really Simple Syndication) feeds and Atom feeds containing arbitrary metadata, and maintains a local content addressable data store. It uses existing standards for obtaining the files, and uses efficient techniques for storing the files. Novel features include symbolic links to maintain a sane directory structure, checksums for validating file integrity during transfer and storage, and flexible use of server-provided metadata.

*This work was done by Brian Duggan of Adnet Systems and Curt Tilmes of NASA for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-16203-1.*

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### Fault Tolerance Middleware for a Multi-Core System

Fault Tolerance Middleware (FTM) provides a framework to run on a dedicated core of a multi-core system and handles detection of single-event upsets (SEUs), and the responses to those SEUs, occurring in an application running on multiple cores of the processor. This software was written expressly for a multi-core system and can support different kinds of fault strategies, such as introspection, algorithm-based fault tolerance (ABFT), and triple modular redundancy (TMR). It focuses on providing fault tolerance for the application code, and represents the first step in a plan to eventually include fault tolerance in message passing and the FTM itself.