true modular robot operator interface. This workflow is extremely time-consuming, and is not suited for use in an operations context. Current operator interfaces, both at JPL and in the broader exploration robotics community, are largely focused on non-reconfigurable hardware. Reconfigurable modular hardware such as Tri-ATHLETE promises to extend greatly the capability of future exploration missions for a relatively small additional cost. Whereas existing missions based on monolithic hardware can only perform a limited set of pre-defined operations, modular hardware can potentially be reconnected and recombined to serve a range of functions. The full realization of these promises is contingent not just on the development of the hardware itself, but also upon the availability of corresponding software systems with algorithms that enable operators to rapidly specify, visualize, simulate, and control particular assemblies of modules. In the case of articulated, re-connectable hardware like Tri-ATHLETE, operators also can determine feasible motions of the assembly, and disconnect/reconnect actions that change assembly topology.

This work was done by Jeffrey S. Norris of Caltech, Marsette A. Vona of Northeastern University, and Daniela Rus of MIT for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47777.

Algorithms for Determining Physical Responses of Structures Under Load

Structure can be monitored in real time while in actual service.

Dryden Flight Research Center, Edwards, California

Ultra-efficient real-time structural monitoring algorithms have been developed to provide extensive information about the physical response of structures under load. These algorithms are driven by actual strain data to measure accurately local strains at multiple locations on the surface of a structure. Through a single point load calibration test, these structural strains are then used to calculate key physical properties of the structure at each measurement location. Such properties include the structure’s flexural rigidity (the product of the structure’s modulus of elasticity, and its moment of inertia) and the section modulus (the moment of inertia divided by the structure’s half-depth). The resulting structural properties at each location can be used to determine the structure’s bending moment, shear, and
Oscillating moment propagator and an osculating to
mean element converter that allows long-term orbital stability analysis for the
first time in compiled code.

The optimized trajectory search tool
COSMIC allows users to place constraints
and controls on their searches without
any restrictions. Constraints may be user-
defined and depend on trajectory infor-
mation either forward or backwards in
time. In addition, a long-term orbit stabil-
ity analysis tool (morbit) existed previ-
ously as a set of scripts on top of Monte.

Monte is becoming the primary tool
for navigation operations, a core com-
ponent at JPL. The mission design capabil-
ities in Monte are becoming mature
enough for use in project proposals as
well as post-phase A mission design.

Monte has three distinct advantages
over existing software. First, it is being
developed in a modern paradigm: ob-
ject-oriented C++ and Python. Second,
the software has been developed as a
toolkit, which allows users to customize
their own applications and allows the
development team to implement require-
ments quickly, efficiently, and with mini-
mal bugs. Finally, the software is
managed in accordance with the CMMI
(Capability Maturity Model Integra-
tion), where it has been appraised at ma-
turity level 3.

This work was done by Richard F. Sunseri,
Hsi-Cheng Wu, Scott E. Evans, James R.
Evans, Theodore R. Drain, and Michelle M.
Guevara of Caltech for NASA’s Jet Propulsion
Laboratory.

This software is available for commercial li-
censing. Please contact Daniel Broderick of
the California Institute of Technology at
danielb@caltech.edu. Refer to NPO-48184.