

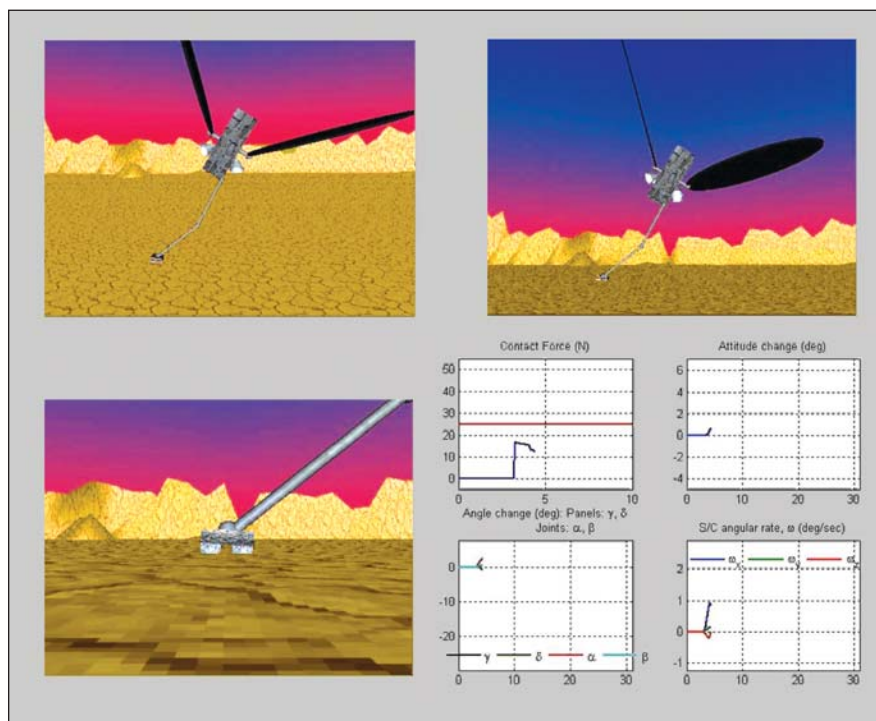
## Spacecraft Guidance, Navigation, and Control Visualization Tool

NASA's Jet Propulsion Laboratory, Pasadena, California

G-View is a 3D visualization tool for supporting spacecraft guidance, navigation, and control (GN&C) simulations relevant to small-body exploration and sampling (see figure). The tool is developed in MATLAB using Virtual Reality Toolbox and provides users with the ability to visualize the behavior of their simulations, regardless of which programming language (or machine) is used to generate simulation results. The only requirement is that multi-body simulation data is generated and placed in the proper format before applying G-View.

G-View allows the user to visualize the behavior of a multi-body system (i.e. a spacecraft, the translations and rotations of the spacecraft body components, thruster firings, and thrust magnitude) by simultaneously showing plots of various relevant states and parameters. In G-View, the user can easily manipulate the location, zoom, translation, and direction of the camera, thus providing a wide range of options for viewing the behavior of specific spacecraft components, such as the solar panels, mechanical arms, brush-wheel sampler, joints, etc.

G-View is easily modifiable and can be adjusted to specific design or simulation requirements. For example, one mode of usage is to create movie clips for a batch-collected set of data. This provides a visual aid supporting iterative design methods and an efficient tool for generating presentations. G-View can also be applied to a computer



Comet GN&C example of G-View.

simulation one frame at a time. This is especially beneficial when applied to simulation environments that require long running times. By extracting visualization data at specific time instants, the user can assess whether the simulation has the desired behavior or if something is wrong and is not worth continuing. In this manner, G-View can save significant time when simulating

complex scenarios, and improve troubleshooting efficiency.

*This work was done by Milan Mandic, Behcet Acikmese, and Lars Blackmore of Caltech 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](mailto:danielb@caltech.edu). Refer to NPO-47197.*

## Mission Operations Planning and Scheduling System (MOPSS)

Goddard Space Flight Center, Greenbelt, Maryland

MOPSS is a generic framework that can be configured on the fly to support a wide range of planning and scheduling applications. It is currently used to support seven missions at Goddard Space Flight Center (GSFC) in roles that include science planning, mission planning, and real-time control.

Prior to MOPSS, each spacecraft project built its own planning and scheduling capability to plan satellite activities and communications and to create the commands to be uplinked to the space-

craft. This approach required creating a data repository for storing planning and scheduling information, building user interfaces to display data, generating needed scheduling algorithms, and implementing customized external interfaces. Complex scheduling problems that involved reacting to multiple variable situations were analyzed manually. Operators then used the results to add commands to the schedule. Each architecture was unique to specific satellite requirements.

MOPSS is an expert system that automates mission operations and frees the flight operations team to concentrate on critical activities. It is easily reconfigured by the flight operations team as the mission evolves. The heart of the system is a custom object-oriented data layer mapped onto an Oracle relational database. The combination of these two technologies allows a user or system engineer to capture any type of scheduling or planning data in the system's generic data storage via a GUI.