



Books & Reports

Flight Simulation of ARES in the Mars Environment

A report discusses using the Aerial Regional-scale Environmental Survey (ARES) light airplane as an observation platform on Mars in order to gather data. It would have to survive insertion into the atmosphere, fly long enough to meet science objectives, and provide a stable platform.

The feasibility of such a platform was tested using the Langley Standard Real-Time Simulation in C++. The unique features of LaSRS++ are: full, six-degrees-of-freedom flight simulation that can be used to evaluate the performance of the aircraft in the Martian environment; capability of flight analysis from start to finish; support of Monte Carlo analysis of aircraft performance; and accepting initial conditions from POST results for the entry and deployment of the entry body.

Starting with a general aviation model, the design was tweaked to maintain a stable aircraft under expected Martian conditions. Outer mold lines were adjusted based on experience with the Martian atmosphere. Flight control was modified from a vertical acceleration control law to an angle-of-attack control law. Navigation was modified from a vertical acceleration control system to an alpha control system. In general, a pattern of starting with simple models with well-understood behaviors was selected and modified during testing.

This work was done by P. Sean Kenney and Mark A. Croom of Langley Research Center. Further information is contained in a TSP (see page 1). LAR-17458

Low-Outgassing Photogrammetry Targets for Use in Outer Space

A short document discusses an investigation of materials for photogrammetry targets for highly sensitive optical scientific instruments to be operated in outer space and in an outer-space-environment-simulating thermal vacuum chamber on Earth. A key consideration in the selection of photogrammetry-target materials for vacuum environments is the need to prevent contamination that could degrade the optical responses of the instruments. Therefore, in addition

to the high levels and uniformity of reflectivity required of photogrammetry-target materials suitable for use in air, the materials sought must exhibit minimal outgassing.

Commercially available photogrammetry targets were found to outgas excessively under the thermal and vacuum conditions of interest; this finding prompted the investigators to consider optically equivalent or superior, lower-outgassing alternative target materials. The document lists several materials found to satisfy the requirements, but does not state explicitly whether the materials can be used individually or must be combined in the proper sequence into layered target structures. The materials in question are an aluminumized polyimide tape, an acrylic pressure-sensitive adhesive, a 500-Å-thick layer of vapor-deposited aluminum, and spherical barium titanate glass beads having various diameters from 20 to 63 μm .

This work was done by Jason N. Gross, Henry Sampler, and Benjamin B. Reed of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15373-1

Planning the FUSE Mission Using the SOVA Algorithm

Three documents discuss the Sustainable Objective Valuation and Attainability (SOVA) algorithm and software as used to plan tasks (principally, scientific observations and associated maneuvers) for the Far Ultraviolet Spectroscopic Explorer (FUSE) satellite. SOVA is a means of managing risk in a complex system, based on a concept of computing the expected return value of a candidate ordered set of tasks as a product of pre-assigned task values and assessments of attainability made against qualitatively defined strategic objectives.

For the FUSE mission, SOVA autonomously assembles a week-long schedule of target observations and associated maneuvers so as to maximize the expected scientific return value while keeping the satellite stable, managing the angular momentum of spacecraft attitude-control reaction wheels, and striving for other strategic objectives. A six-degree-of-freedom model of the spacecraft is used in simulating the tasks, and the attainability of a task is calcu-

lated at each step by use of strategic objectives as defined by use of fuzzy inference systems. SOVA utilizes a variant of a graph-search algorithm known as the A* search algorithm to assemble the tasks into a week-long target schedule, using the expected scientific return value to guide the search.

This work was done by Jim Lanzi, Scott Heatwole, and Philip R. Ward of Goddard Space Flight Center and Thomas Civeit, Humberto Calwani, Jeffrey W. Kruk, and Anatoly Suchkov of Johns Hopkins University. Further information is contained in a TSP (see page 1). GSC-15436-1

Monitoring Spacecraft Telemetry Via Optical or RF Link

A patent disclosure document discusses a photonic method for connecting a spacecraft with a launch vehicle upper-stage telemetry system as a means for monitoring a spacecraft's health and status during and right after separation and deployment. This method also provides an efficient opto-coupled capability for prelaunch built-in-test (BIT) on the ground to enable more efficient and timely integration, preflight checkout, and a means to obviate any local EMI (electromagnetic interference) during integration and test. Additional utility can be envisioned for BIT on other platforms, such as the International Space Station (ISS).

The photonic telemetry system implements an optical free-space link with a divergent laser transmitter beam spoiled over a significant cone angle to accommodate changes in spacecraft position without having to angle track it during deployment. Since the spacecraft may lose attitude control and tumble during deployment, the transmitted laser beam interrogates any one of several low-profile meso-scale retro-reflective spatial light modulators (SLMs) deployed over the surface of the spacecraft. The return signal beam, modulated by the SLMs, contains health, status, and attitude information received back at the launch vehicle. Very compact low-power opto-coupler technology already exists for the received signal (requiring relatively low bandwidths, e.g., ≤ 200 kbps) to enable transfer to a forward pass RF relay from the launch vehicle to TDRSS

(Tracking and Data Relay Satellite System) or another recipient. The link would be active during separation and post-separation to monitor spacecraft health, status, attitude, or other data inventories until attitude recovery and ground control can be re-established. An optical link would not interfere with the existing upper stage telemetry and beacon systems, thus meeting launch vehicle EMI environmental constraints.

This work was done by K.B. Fielhauer and B.G. Boone for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14832-1

Robust Thermal Control of Propulsion Lines for Space Missions

A document discusses an approach to insulating propulsion lines for spacecraft. In spacecraft that have propulsion lines that are located externally

with open bus architecture, the lines are typically insulated by Multi Layer Insulation (MLI) blankets. MLI on propulsion lines tends to have large and somewhat random variances in its heat loss properties (effective emittance) from one location to the next, which makes it an un-robust approach to control propulsion line temperatures. The approach described here consists of a “clamshell” design in which the inner surface of the shell is coated with low-emissivity aluminized Kapton tape, and the outer surface is covered with black tape. This clamshell completely encloses the propulsion line. The line itself is covered with its heater, which in turn, is covered completely with black tape.

This approach would be low in heater power needs because even though the outer surface of the prop line (and its heater) is covered with black tape as well as the outer surface of the clamshell, the

inner surface of the clamshell is covered with low-emissivity aluminized Kapton tape. Hence, the heat loss from the line will be small and comparable to the MLI based one.

In terms of contamination changing the radiative properties of surfaces, since the clamshell’s inner surface is always protected during handling and is only installed after all the work on the prop line has been completed, the controlling surface, which is the clamshell’s inner surface, is always in pristine condition.

This proposed design allows for a much more deterministic and predictable design using a very simple and implementable approach for thermal control. It also uses low heater power and is robust to handling and contamination during and after implementation.

This work was done by Pradeep Bhandari of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47441