Abstract
for a full-length paper

Goddard Conference on Space Applications of Artificial Intelligence
and Emerging Information Technologies
May 1995

Applicable topic areas:
Planning and Scheduling

The Mars Pathfinder Spreadsheet for Surface Operations Planning

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The Mars Pathfinder Surface Operations Planning Spreadsheet represents the first time that all the necessary mission-level knowledge needed for mission planning has been combined in a single tool at JPL. These include mission requirements and engineering requirements and constraints developed by analysis and by the subsystem tools.

While early assumptions about the project indicated there would be enough solar power so that planning for a substantial mission return should not be a problem, this assumption did not survive ongoing analysis. This result made careful resource and activity planning more necessary.

A spreadsheet was found to be an adequate tool for representing the required knowledge, although data input, output formats, and scenario development turnaround time are significant concerns. The spreadsheet system includes 10 Microsoft™ Excel® 4.0 spreadsheet formats and about 1,000,000 cells for the thirty day surface mission. Central to the system is a sheet of events calling for the spacecraft and rover to be in specific modes of operation at certain times, phrased in landing site local time, Lookup tables found in other sheets contain much needed information:

1. power state of each subassembly in each mode
2. amount of solar power by time of day
3. downlink data rates available and scheduled
4. view periods of earth from the landing site
5. sun angles by time of day at the landing site
6. correlation between time-of-day in local time and GMT
7. panoramic imaging requirements with compression
8. timing constraints, such as rover and computer speed
9. time-of-day thermal limitations, such as rover movement windows
10. a lander panorama planning sub function
11. telemetry overhead, such as bit overhead for packets and error correction

Predicted solar power, battery state, thermal state, timing of events and condition of the downlink queues are all recalculated for any entered change in the scenario and checked. Use of resources above threshold is flagged. Areas where a plan is too conservative, such as unused solar power available for transmission, or unutilized bandwidth, are also reported.

In addition the system provides means for output of spreadsheet summary reports by time period of many parameters of interest such as battery state of charge and current curves, data downlink status, and data acquisition by customer category and type. Mission progress can be tracked on a daily basis.

Future work includes incorporating additional thermal analysis capability, to the degree it continues to prove feasible. Additionally, now that the basic logic needed has been verified through the use of the spreadsheet, future work also includes incorporating this logic into Plan-IT-11, a specialized, interactive, spacecraft mission planning tool developed at JPL. This should aHow much faster execution, consideration of more scenario alternatives, more complete automatic screening of the results of proposed scenario changes, and a better surface mission.