Commentary on: "A Retrospective Snapshot of the Planning Process in MER Operations"

David E. Smith
NASA Ames Research Center
M.S. 269-2
Moffet Field, California 94035-1000
david.smith@nasa.gov

With contributions from **John Bresina**, **Ari Jonsson**, *and* **Kanna Rajan**

Taking a retrospective look at any complex process like MER operations is a valuable thing to do, but also quite difficult. This paper describes the current extended mission process fairly completely, identifying the tools and elements involved. Unfortunately, the article badly misses an opportunity to help future developments. The paper dismisses automated and intelligent planning technology without much consideration of why such technology is not being used in the extended mission and what could be done to make it more useful. The differences between the primary mission and the extended mission are substantial – there were about 500 people co-located at JPL for the primary mission; this is now down to a skeletal operation of less than 20. This has necessarily implied that the tasks are simplified as much as possible.

In the early days of MER operations, the planning technology did add a lot of value, by allowing scientists and engineers who had limited experience with commanding the rovers to generate quite good and efficient plans that achieved a great deal of science in a short amount of time. Since then, something must have changed and it would be valuable to understand that. There are a number of possibilities:

1. The mission has become so long and the staffing and the budget constraints so tight that plan efficiency is no longer a key concern
2. People became so good at planning that the technology is no longer needed
3. The technology was too difficult to understand and use for the extended mission
4. People like doing the planning and feel that the automation is taking away from them some key role they feel they should play in missions

An answer to this question is essential to understand why the process has evolved into the current state, and how planning technology can best meet the needs of future missions..

As a start in answering some of these questions, it would be worthwhile to do a careful characterization of the differences in the plans that were built in the first 90 sols of the mission to the plans being built now. The paper mentions that the process changes required a reduction in the opportunities to move the rover or move the IDD. What is the quantitative difference in the distance driven, the amount of IDD-activity/contact-science, and the amount of remote science activity? Do the integrated command sequences have a less complex structure now; e.g., less interleaving of different types of rover activity such as remote science with IDD movements and contact-science? Is there a difference in science return per sol (perhaps not easy to quantify)? Are the scientists more restricted in what they can request, or are they less concerned with squeezing as much science in each sol as they were at first when it was unknown how long the mission would be.

The extended mission process raises other broader questions as well. For example, why are so many parts of the MER planning process still done using Excel spreadsheets? I would speculate that:

1. the person(s) with the expertise knew Excel
2. there was no money, personnel, or time available for any more serious software development

An unfortunate consequence of this seems to be that there is manual or poorly automated data exchange between these components and other parts of the planning process.

There are also many, many stages to the MER planning process. Is this because all these stages need to be considered separately and sequentially, or is it because we have not figured out how to solve the combined problem in an effective manner? For example, the ability to predict resource usage and check resource limitations earlier in the planning process would presumably improve the ability of the scientists to make effective choices, and reduce the need to iterate or backtrack at later stages. Fundamentally, what is needed is a deeper examination of the interaction and the data flow between various stages in the planning process. This would likely tell us where there needs to be tighter integration between stages, and where planning stages need to be combined.

For individual stages in the process, we need to ask the question as to how or if we could further automate the process, and whether or not the effort would be justified. As a specific example, even during the primary mission, MAPGEN automated plan completion was never used. Instead plans were developed incrementally with humans adding activities and resolving conflicts incrementally. Is this because the system was not able to effectively model the user pref-

erences and optimization criteria, and therefore cannot generate good enough plans automatically? Or is it because the system is unable to explain its plans so that the engineers and scientists can understand the reasons for the choices and constraints in the plan?

These are the kind of questions we need answers to, so that we can do a better job of designing and integrating planning software into mission operations.