Chapter XIII
Challenges in Knowledge Management: Maintaining Capabilities Through Innovative Space Missions

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ABSTRACT

One of the key problems faced by organizations is that of managing knowledge. How does an organization improve and maintain performance by generating, maintaining, and sharing knowledge? High tech organizations are much more dependent on knowledge as a commodity than those in the manufacturing sector. NASA certainly is the epitome of a high tech organization. It faces complex and deep challenges, not the least of which is how to address the loss of knowledge as the workforce ages and retires. In addition, NASA faces the consequences of a program that, in the face of programmatic constraints, subsumes the process of generating knowledge to the demands of maintaining commitments. Those commitments may not provide the optimal path for generating knowledge relevant to the future success of the organization. For a space-faring organization, mission cadence is one of the key determinants of cost and risk. Mission cadence is also important, as it determines the number of people in the organization with direct and relevant experience with space missions. Under a constrained budget, mission cadence can be increased by reducing the size and scope of the missions. Small spacecraft missions can afford to be innovative and thus create a culture in which new ideas are welcomed and sought. These smaller missions can preserve and generate knowledge by training the next generation of scientists, engineers, and program managers.
INTRODUCTION

Knowledge management consists of the tools, techniques, and practices that enable an organization to improve and maintain its performance by generating, sharing, maintaining, and distributing knowledge. NASA is faced with a series of critical knowledge management challenges in the next decade. As the NASA workforce ages\(^1\),\(^2\) the expertise that enabled robotic and manned missions to the near Earth environment and to the other members of the solar system could be lost unless steps are taken to ensure continuity of experience. This paper will explore a path that is both programmatically and scientifically valid for managing that critical space-faring knowledge.

In addition to the highly visible human exploration program, NASA operates a less visible program of unmanned space science that generally offers a high science return on investment. These missions range from small rockets designed for suborbital flight (a few million dollars each) to the elements of the great observatory program at more than $1 billion. These robotic space missions are key to generating and maintaining core capabilities, not only by providing the training ground for the next generation of scientists, engineers, and managers, but also by providing a proving ground for testing and validation of new technologies. In this important role, they serve as reservoirs and proving grounds for the human exploration program.

In the near term, NASA faces a transforming challenge in order to address President Bush's *Vision for Space Exploration*: the organization must solve the budgetary and technical problem of the shuttle, come to closure on its international obligations to support the International Space Station, repair the Hubble Space Telescope, rebuild infrastructure damaged during Hurricanes Katrina and Rita, develop new vehicles to go to the Moon and Mars, develop the infrastructure needed to support these missions, and accomplish this mission within its current budget while still carrying out its scientific research and unmanned exploration missions. The goals of the vision for space exploration (VSE) places all current and future NASA science programs under tremendous budget pressure (Committee on an Assessment of Balance in NASA's Science Programs, 2006). The primary, long-term, non-budgetary challenge, then, is that of knowledge management, that is, maintaining the core capabilities required to carry out the broader agency role in space exploration.

At NASA science missions in space are, in many ways, carried out in a more entrepreneurial setting than the human exploration program. A satellite mission to the near-Earth space environment or another planet or solar system object is essentially a very sophisticated robot, though hardly an autonomous robot. The development and operation of these missions are managed either as *facility-class* missions by NASA centers, or their surrogates (e.g., the jet propulsion laboratory (JPL) or The Johns Hopkins University’s applied physics laboratory (APL)), or are lead by a principal investigator (PI) and PI’s organization, typically a university or other academic institution. To the average citizen, the rigorous and highly competitive manner in which these robotic space missions come to be may not be obvious. The science community participates in NASA-directed “roadmap” activities\(^3\) that provide a rough cut at a timeline for the development of facility-class missions. A facility-class mission is, typically, managed by a NASA center, such as TERRA or AQUA for Earth Science, or the Mars Rovers for planetary exploration. That mission is designed to provide data to meet broad, programmatically-driven science and measurement requirements. The priority of missions within a discipline is determined through a series of meetings, trade studies, and internal and external assessments. The timeline for these facility class missions, for example, the *Living with a Star Program*, may change in response to budgetary pressure or changes in priorities. In addition to these facility-class missions, which are ideally protected by the
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