11

Knowledge Management at NASA

Edward Hoffman, Jon Boyle, and Anthony J. Maturo

NASA has always made program and project management a central tenet of its approach to completing complex, multifaceted, and highly technical missions. Borrowing concepts of program/project management from the military in the late 1950s, NASA recognized that having an effective project management workforce was critical to the undertakings of the agency (NASA 1994). From the agency's beginning, project managers were tapped to direct the day-to-day work on NASA's missions and were responsible for overall mission success. Although most of NASA's first project managers were scientists, NASA began placing engineers in these positions on many of the earliest missions (Naugle 1991).

The early years of NASA witnessed the rapid evolution of a variety of systems and techniques for directing the combined efforts of thousands of individuals cooperating in close-knit programs in which government, universities, and private industry played mutually reinforcing roles. Many of the major learning experiences gained from NASA's earliest missions, such as the Apollo management system, were subsequently applied to the next generation of projects (NASA 1994). At the same time, with the success of the Apollo program and its unmanned mission precursors, it became recognized outside the agency that one of the valuable byproducts of the U. S. space program was the body of knowledge concerning management of large, complex development project activities (Kloman 1972).

Although the commitment to project management was clear from the agency's beginning, program administrators discovered early on the difficulty in determining how managers could best be selected, trained, and rotated (Kloman 1972). Compounding this problem was an inability to identify qualifications that distinguished the ideal candidate for project management assignments from other types of managers. In 1970, NASA commissioned

the National Academy of Public Administration (NAPA) to study ways to improve and refine the agency's project management techniques. After extensive research and interviews, however, the study found no scientific basis for drawing conclusions on the kinds of personal characteristics, skills, or management styles that best lend themselves to the responsibilities of being a program or project manager (Chapman, Pontious, and Lewis 1971).

In practice, NASA's project managers have always been differentiated from those in other management positions in the agency. First, these individuals have typically been engineers or technicians with no formal background or training in management. Second, their roles have primarily been involved with guiding cost, scheduling, and technical aspects of an engineering project with a definite beginning and end. Finally, these individuals have not been directly involved, as an engineering manager would be, in directing the day-to-day technical decisions about design, development, and testing of engineering systems, nor have they been responsible for a functional area that provides an ongoing product or service, such as marketing, accounting, or manufacturing (Duarte et al. 1995).

Preparation of project managers has been a conscious undertaking throughout NASA's history. For much of its early history, NASA had a tradition of using individual managers as the "conduit" for the transfer of project management learning experience. Writing about the history of project management on the Surveyor and Lunar Orbiter missions, Kloman (1972) pointed out that:

> Although each manager setting out on a new task may view his assignment as a completely new departure, he is actually part of a continuum. Just as he brings to his task his own past knowledge and experience, so his colleagues bring theirs. The successful project manager is one who is able to provide the kind of leadership that effectively taps this experience, focusing a common effort upon common goals through a progression of commonly accepted intermediary steps.

NASA successfully continued to rely on this tradition of preparing project managers for many years by transferring "lessons learned" from manager to manager, and using on-the-job experiences supplemented with targeted training for specific skills. However, mission failures beginning in 1988 doomed this effective but inefficient transfer of knowledge. In addition, national attitudes were working against NASA as a result of a series of failures that followed the Apollo program.

Outside of NASA, the idea of more and bigger government was an unpopular alternative for most people since the country's collective loss of in-

nocence resulting from events such as the Vietnam War and Watergate. Some came to the conclusion that government cannot provide all of the answers, and additionally it cannot be trusted. This was developing as a worldwide phenomenon. The worldwide public-sector expansion occurring after the end of World War II was accompanied by many international reform movements as a result of poor service delivery and other economic difficulties.

In the United States, Congress and the executive branches were taking steps to fundamentally change government work. Departments and agencies shifted to a focus on results, and were operating like businesses. Budget pressures, political realities, technological advances, and shifting priorities forced government organizations to change as rapidly as private-sector organizations in order to meet their mandates and responsibilities to the country. Out of this environment of change and technological advances grew the conceptual framework of knowledge management (KM).

The National Aeronautics and Space Administration (NASA) has attempted to instill effective KM practices through the NASA Academy of Program and Project Leadership (APPL) and its various incarnations since the late 1980s. The following narrative provides an appreciation of one part of NASA's KM effort and the continuing impact of this particular brand of KM on the organization, stimulating consideration of how organizations evolve in the use of knowledge to foster innovation, creativity, and performance in a federal government environment.

The First Generation of NASA Knowledge Management

In 1988, the *Challenger* tragedy was a watershed event for NASA. Enormous energy and thought went into understanding what went wrong and how to repair the NASA legacy of project excellence. There were numerous Tiger Teams (special interdisciplinary teams of experts convened to sove a specific problem), commissions, and boards originated with the single task of improving NASA project management. Out of this climate of introspection and commitment was conceived the notion of the Program and Project Management Improvement (PPMI) program, the precursor of NASA APPL. The initiative was sponsored by then deputy administrator J.R. Thompson, who assigned a training budget to this effort.

One full-time civil service employee, Dr. Ed Hoffman, was assigned to change the way NASA project managers were developed. On top of that, Hoffman was an anomaly at NASA, possessing a PhD in organizational development in an organization that valued engineering and technical excellence above all else. But Hoffman was smart enough to see that NASA was a project-based organization, and that anything that had to do with creating

and sharing knowledge across projects would provide a huge benefit to the organization.

The mission of the original PPMI effort was articulated as promoting project management excellence and competency in advance of NASA's need through training and development services. Any early observer of PPMI would see a traditional training and development office. Managing knowledge and using it to increase performance was still years away, and would not have survived without a strong career-development infrastructure first being in place. Therefore, the early years of PPMI were focused on establishing a robust and relevant curriculum of courses, defining and providing a baseline of knowledge and competence that would better prepare a future generation of NASA project professionals.

Hoffman planted the seeds of KM early on with the adoption of a strategy that training would represent only a fraction of the performance equation, no more than 10 percent of the preparation necessary for producing a successful generation of project professionals. The remainder of the performance equation was represented by real professional experience in NASA projects and a reliance on the knowledge of a previous generation of project talent who would serve as mentors, coaches, and expert guides. Unbeknownst to NASA overall at the time, but intentionally created by Hoffman, the foundation for understanding and better managing explicit and tacit knowledge had been created.

PPMI's goal was to provide sound fundamental skills. These fundamentals would then be developed and further sculpted through years of incrementally more challenging assignments at NASA field center locations. Overall engineering capability would be nurtured through progressive learning on increasingly challenging work with an abundance of experienced mentors ready and willing to offer any necessary guidance, tips, and encouragement. This was reflected through policy documents such as the first program plan for the PPMI:

> The primary mission of the PPMI effort is to develop NASA personnel through a number of parallel activities: developing and delivering formal classroom and on the job training, capturing and disseminating past Agency experiences, studies focused on current and future technical management requirements and skills and the documentation and communication of current and new program and project management methods.[1]

For Hoffman, such a mission was well conceived for the organizational setting at the time. NASA in 1990 was still a traditional leader in managing large, expensive, long-duration programs and projects. The history of Apollo,

Shuttle, Viking, and the Hubble Space Telescope offered technologically challenging programs that allowed a natural progression of learning in a more deliberate and hierarchical context. It was also personality dependent, with project managers building their reputations on smaller projects as they moved up the chain and were increasingly recognized by their peers. It was at this higher level of experienced practitioners that Hoffman recognized the need to leverage and transfer knowledge effectively and efficiently through some type of sharing mechanism.

In terms of anything beyond training, the initial PPMI career development efforts were necessarily limited in scope to traditional training approaches, reflecting the status of adult learning theory and technology at the time. PPMI provided a sound foundation for progressive preparation of project management capability, while individuals could expect the time to learn and fine-tune expertise in a work setting loaded with experienced professionals. In an environment of a few very large programs, with an abundance of project expertise cultivated through the challenges of Apollo and Shuttle, such a strategy was both logical and desirable. However, there was little sense in wasting effort in sharing of knowledge across the organization since NASA centers often viewed themselves as in competition with each other for dwindling resources. KM activities were thus limited in scope to noninstitutional individual successes within programs and projects.

The Second Generation of NASA Knowledge Management

A new era of revitalization started in 1992 with the appointment of Dan Goldin as the new NASA administrator. Immediately upon taking leadership of NASA, Goldin initiated a dramatic remodeling of NASA program and project management adjusted to the political and budget realities of the time, emanating from the broader context of government reform efforts attempting to increase the efficiency and effectiveness of government organizations in their delivery of products and services to the public.

The era of managing projects in a faster, better, and cheaper (FBC) framework was established, doing more with less, greatly increasing the volume of project work, and doing it in a way that emphasized safety, innovation, low cost, speed, and quality. Such a demanding vision with seemingly inherent conflicts dramatically altered the nature of both project management and the way talent needed to be developed within the agency. The unspoken corollary to this type of management approach was that the raw material of knowledge, critical to innovation and better decision making, needed to move faster, better, and cheaper across the agency as well.

Goldin appointed a Program Excellence Team (PET) to strengthen and

streamline the policies and processes governing the management of our major system development projects and to issue a single comprehensive policy document to combine its program and acquisition management procedures. In essence, this team discovered ways to shorten and improve project management. The team was working in an environment where the *average time* from authorization to actual launch was about eight years, and the typical program cost and schedule overruns averaged a growth of over 60 percent from commitment estimates.

The PET cited eight major factors that drove NASA program cost and technical risk:

- Inadequate Phase B (formulation) requirements definition
- Unrealistic dependence on unproven technology
- Annual funding instability
- Complex organizational structures, including multiple/unclear interfaces
- Cost estimates that are often misused
- Scope additions due to "requirements creep"
- Schedule slips
- Acquisition strategy that does not promote cost containment

These factors were further aggravated by the fact that they did not represent anything that was not already understood. The organization possessed this knowledge, but did not realize it or did not possess the political willpower to solve the issues. In fact, over thirty previous NASA studies and working groups during the previous twenty years had consistently identified these factors as a drag on effective, efficient project management. This led to the establishment of the NASA Program Management Council (PMC) and Program Management Council Working Group (PMCWG), initiating the first critical task of forming a project management policy and guidelines document that would promote "faster, better, and cheaper" (FBC) projects. This was a problem tailor-made for KM to address, a strategic issue that could be focused on by providing existing organizational knowledge to decision makers at the right time and the right place.

Up to this time, the PPMI had been fundamentally a curriculum-driven entity, carrying on through the charter originally established subsequent to the *Challenger* mishap. The purpose was to identify workforce topics (e.g., project management, cost estimating, requirements definition, and systems engineering) and to design, develop, and implement training programs that would correct deficiencies in these identified areas. This led to a human resource development culture that emphasized curriculum, but without metrics toward performance and outcome success.

With the arrival of Goldin, it became increasingly clear to Hoffman that PPMI required significant modification. It was no longer reasonable to generate courses without a clear link to mission success and requirements. Therefore, he initiated a major effort to identify the core competencies required for success at different stages of a career, with the idea that senior-level employees required the capability to share knowledge as they progressed in the organization. Competency-driven project management development was inaugurated.

This approach centered on a formal career development strategy (eventually called the NASA Project Management Development Process, or PMDP) that was intended to link critical project competencies to NASA-sanctioned learning and education. This systematic analysis made it possible to match curriculum content to organizational customer requirements. It also created the first possibility to tie mission success to the transfer of learning which, in turn, made it possible to tie human resource requirements directly to mission success. It introduced the building blocks of KM to the agency, using the concepts of competencies, capability, knowledge sharing, expertise, innovation, creative and critical thinking, and information technology (IT) tools to enable organizational implementation of KM fundamentals. In this way, knowledge management was infused in NASA through identified standards of behavior described by competencies and performance capabilities. As Holtzman (1999) points out, "by establishing proven and accepted standards today, project management professionals can be better prepared for the challenges of the future."

As a result of this fundamental shift in thinking, Hoffman initiated several changes. There was an increased emphasis on career development, curriculum certification, benchmarking, and research, and a greater emphasis on job aids and tools. These represented a natural extension of the learning environment and also represented significant advances in adult learning theory, educational technology, and IT. While NASA was undergoing dramatic change, there would be a continuous demand to upgrade PPMI services and products. Once personnel started to consider the competencies necessary to increase project management capability, this would lead to requests for new courses, certification of learning and competency, online computer support, and intact-project team performance support. During these years, the groundwork would be laid for a significantly broader and different developmental organization than originally envisioned. In addition, assessment and certification began to be discussed more frequently as budget pressures grew. Crawford (1999) makes the case that assessment links learning outcomes with learning objectives in a meaningful way.

With this new set of issues and challenges, Hoffman quickly realized that

he needed more help, fast. He recruited Dr. Jon Boyle, an expert in human development from the private sector, and Mr. Anthony Maturo, a highly talented NASA training and development and budget expert at NASA Langley, to help to achieve the new organizational strategy. Boyle possessed deep experience in KM across the public and private sectors, and taught KM at the Virginia Tech graduate program in human development. Maturo also had extensive education and training experience, and knew the NASA culture and budget structure intimately.

The transition from a NASA "initiative" to a formal training "academy" was promoted by Administrator Goldin as part of an effort to cultivate program and project managers who could adapt to the new project environment with a significantly different mind-set and methodology. In 1999, the PPMI became formally known as the NASA Academy of Program and Project Leadership (APPL). The purpose of APPL was to provide total team and individual professional development support through training, developmental activities, and tools for the organizational benefit of developing and maintaining "world-class" practitioners of project management in advance of NASA's requirements. The mission of APPL shifted to providing outstanding and continually improving developmental activities and support for individuals and teams that accomplish NASA's programs and projects through career development activities and tools, performance enhancement projects, knowledge-sharing communities of practice, and cutting-edge research and development. KM had now become institutionalized in the mission of the organization as well as being defined as a critical competency and performance capability.

The importance of APPL increased substantially, since the number of projects increased as the workforce was decreasing. NASA reduced its overall civil service workforce by 26 percent between FY 1993 and FY 2000, and reduced the headquarters staff by 50 percent during the same period. Organizational restructuring and reductions resulted in a 52 percent reduction in supervisory positions and a 15 percent reduction in SES. On an agency-wide basis, the supervisor-to-employee ratio went from 1:6 to 1:10. These changes reduced the number of on-site mentors and experienced project managers, placing new demands for innovative and accelerated strategies to enhance learning and development.

APPL flourished under the era of FBC, contributing to significant gains in agency performance even as the agency's resources dwindled. APPL leveraged retiring NASA PMs and assigned them as mentors and coaches to active programs and projects, capturing lessons and success formulas and transferring these lessons across the agency. Partnerships that stimulated innovation were established with professional organizations such as the Project

Management Institute (PMI), and new leadership initiatives were implemented with universities and colleges such as the Massachusetts Institute of Technology (MIT). NASA APPL also moved to the forefront in implementing change for the agency, as evidenced by APPL's being selected to manage the rewrite of the organization's project management policy and procedures documents, NPG 7120.5b. As a result of the progress and accomplishments of NASA APPL, Hoffman, Maturo, and Boyle were highlighted in the November 1999 issue of *Fast Company* magazine as innovators in the human development field.

The Third Generation of NASA KM

During Dan Goldin's tenure, APPL provided multifaceted support to the leaders and teams that made up NASA project management. In normal times, such a strategy and commitment should endure. However, the current NASA environment proved again to be far too dynamic for Hoffman, Maturo, and Boyle to remain static in terms of APPL and still to meet the requirements of the workforce.

Perhaps if the changes taking place in project management were the only changes occurring in NASA, the transition would be smoother for both the organization and the individual practitioners. In reality, Hoffman realized that NASA was proceeding through accelerated change in virtually every facet of the organization, and was reflecting other changes in the greater business environment that were occurring worldwide. The APPL management team was grappling with a new extended list of challenges:

- Implementing the President's Management Agenda (PMA)
- Implementing the President's Vision for Space Exploration
- Adjusting to new NASA administrators
- Transferring APPL from Human Resources to the Office of the Chief Engineer
- Aligning to the federal Human Capital Plan (HCP)
- Adjusting to the increasing importance of a knowledge management strategy
- Adjusting to a revamped project management policy and procedures (NPG 7120.5c)
- Reacting to pressure to operate in a businesslike mode
- Emphasizing competition to increase productivity
- Shifting from FBC to a results-oriented approach
- Coming to terms with shrinking budgets
- Coming to terms with shrinking human resources

- Adjusting to fewer experienced personnel
- Implementing the Government Performance and Results Act (GPRA)
- Adjusting to higher customer and stakeholder expectations
- Shifting to performance-based contracting and budgeting
- Implementing full cost management
- Adjusting to new technologies
- Adjusting to a dramatic increase in the number of projects
- Reacting to a need for better strategic planning and management
- Shifting program management to the centers and then back to HQs
- Revamping commercialization and technology-transfer processes and procedures
- Creating more international partnerships
- Adjusting to a higher employee-to-supervisor ratio
- Increasing reliance on electronic government and information technology
- Reacting to career volatility
- Adjusting to an overall increase in speed, uncertainty, and scarcity of time
- Adjusting to greater project complexity
- Addressing a demand for speed and low cost
- Addressing a demand for accelerated leadership development
- Addressing increased concern about the competency and capability of the project workforce
- Integrating systems engineering and project management

At the level of a project manager, the rapid pace of change impacting social, technical, strategic, and administrative systems seems to be a volcano of activity. Much of the fallout from this activity is placed squarely on the shoulders of the project management workforce. In a short span of time, the responsibility of project managers shifted from a pure focus on mission (technical, business, safety, and customer satisfaction) success to responsibility for business management, commercialization, new technology identification and development, customer satisfaction, strategy, and much more. Hoffman, Maturo, and Boyle realized that this is an intractable issue to address without putting an integrated KM infrastructure into place, since even the current environment represents a total change from only ten years earlier.

In terms of the President's Management Agenda, the strategic management of human capital is the number one issue. This is because as much as 50 percent of the current federal workforce is eligible for retirement over the next five years. As in most agencies, the recent and continued retirement of experienced personnel puts NASA at risk, due to the loss of valuable knowledge and expertise that is critical for continued mission success. NASA, along with twenty-three of the twenty-six executive agencies, received red-light status on the Office of Man-

agement and Budget (OMB) Human Capital Scorecard at the beginning of 2002. Additionally, at a time when experience and talent is at a premium, there is an increasingly young and inexperienced workforce in place.

At a time when innovation and creative approaches are needed, many of the most experienced project managers lack the preparation that comes with education and training. They cannot depend on having a ready pipeline of college students equipped with technical and engineering degrees on hand. Having succeeded in an environment of slow change and stability, some of these managers may be ill equipped to flourish in a workplace that demands a wide array of competencies and flexibility, because they have not received the educational preparation gained by project personnel.

In the early 1990s, the vast majority of NASA's project managers were "homegrown." In 1993, for example, three out of four of NASA's senior project managers had started as entry-level engineers in an engineering organization, and all had worked for NASA by the middle stage of their careers (Duarte et al. 1995). The majority of these project managers had been with the agency for fifteen to twenty-five years, and these were the "mentors" who were being asked to pass on their knowledge and wisdom from lessons learned to prepare the next generation of project managers.

By 1998, NASA had more scientists and engineers over the age of seventy than below the age of twenty-five (NASA 2001). The number of scientists and engineers under age thirty-five leaving NASA was three times greater than the intake of the same age group over the prior several years. During the post-*Challenger* period, FY 1988 through FY 1991, the hiring of scientists and engineers averaged about 1,000 per year. However, the number of scientists and engineers hired over the whole period from FY 1992 through FY 1997 totaled only 1,150.

By the mid-1990s, the group of senior project managers represented an "age lump" of personnel, all about the same age, who had joined NASA in the 1970s and 1980s. As often happens with an age lump phenomenon NASA has experienced a crisis of continuity as these individuals retire, exacerbated by early retirements and buyouts that have characterized the downsizing of NASA since 1993. A recent report on the FBC policy by the NASA Office of Inspector General (NASA 2001) noted that:

> By 1998, the effects of NASA's downsizing efforts began to take their toll. The downsizing affected program delivery because managers could not recruit new staff to correct skill imbalances and to bring new ideas to the workforce. In addition, the Agency-wide buyouts encouraged the loss of highly experienced managers and created a void in management and technical expertise. (16)

In the wake of criticisms launched as a result of high-profile failures in the Mars Program, coupled with reports of wiring issues on the Shuttle, NASA administrator Dan Goldin testified to the Senate Subcommittee on Science, Technology, and Space in March 2000 that NASA had experienced "less than desired effectiveness" of project management and systems engineering practices with respect to the failed missions. In that testimony, he reported that:

> a major cultural change was underway. Programs were staffed with next-generation managers without always making sure that they had been adequately trained and mentored. What was needed was access to resources from lessons learned from past experience and the use of new tools and techniques.

The Inspector General's FBC policy report further noted that, faced with budget cuts and downsizing since the mid-1990s, NASA had been focused on overall staff reduction and had not given sufficient consideration to the alignment of human resources with its strategic goals. The workforce had been reduced, resulting in a loss of experienced personnel in all skill categories. As a result, NASA had not determined the appropriate number of staff and competencies needed to effectively carry out strategic goals and objectives for its programs and was now at risk of losing core competencies. It was noted that 25 percent of that time's most experienced managers would reach retirement age in 2005. The Inspector General's report concluded that:

> As part of workforce planning, management should consider how best to retain valuable employees, plan for their eventual succession, and ensure continuity of critical competencies and capabilities.

The Fourth Generation of NASA KM

In 2003, the *Columbia* tragedy represented another watershed event for NASA. Again, enormous energy and thought went into understanding what went wrong and how to repair the NASA legacy of project excellence. The Columbia Accident Investigation Board (CAIB) was chartered, led by Admiral Harold W. Gehman, and found that NASA management and culture were as much to blame as the technical cause of falling foam shattering reinforced carbon-fiber wing panels (CAIB 2003). Out of this climate of introspection and commitment, NASA APPL was ordered to transition into the Office of the Chief Engineer (OCE) due to its importance to project practitioners and its track record of success. Hoffman, Maturo, and Boyle were now in a place

where increased responsibility and scrutiny would be the norm, but where increased credibility was available due to the position of the OCE within NASA. Again, human capital experts were placed into senior-level positions within an organization that valued engineering and technology above all else.

The new organization became the Integrated Learning and Development Program (ILDP), an appropriately engineer-titled organization, and includes not only project manager development but system engineering and engineering discipline development as well. The new transition continues the transition states that drive the organization:

- From classroom training to total system performance support
- From training success to mission success
- From event-driven to outcome-driven activities
- From how to think to how to behave
- From classroom to virtual learning
- From stable systems to managing change and uncertainty
- From training the individual to learning as a team
- From one best way to competition
- From knowledge hoarding to knowledge sharing

Hoffman is currently guiding APPL (now ILDP) through a process of adaptation and growth in order to meet the demands of the President's Vision for Space Exploration. There is a need for a closer relationship to mission success by offering competitive services and products that support the practitioners in the work they do, resulting in a transition from Human Capital to the Office of the Chief Engineer during 2004. However, Hoffman continues to emphasize a few core issues that help clarify ILDP's role in NASA's project environment.

First, at a most fundamental level, the core values of NASA are achieved through science, engineering, and the management of projects. These core competencies are essential in that the existence of NASA is based on the capability of these disciplines. Everything else derives value from contributing to these critical core competencies. Second, there is a significant opportunity to develop a sharpened coordinated focus on the domains of program and project management and engineering to support these critical NASA core competencies, and to achieve better organizational integration and coordinated activity through KM tools and processes. Third, the window of opportunity to achieve this improved focus on project and engineering excellence is rapidly closing. NASA historically seems to be easily distracted by generic institutional changes that redirect energy, focus, and attention from the critical core competencies. For NASA, an uncoordinated abundance

of strengths and resources in human capital across independent centers can serve to camouflage real problems and embedded systemic weaknesses agency-wide.

Hoffman, Maturo, and Boyle are now moving the new organization toward serving as an agency-level KM office that provides recognition, prioritization, and mobilization of developmental efforts in an integrated fashion under an integrated and cohesive framework. The overall framework consists of four separate but integrated engines of developmental innovation:

- The career development business area provides products and services around professional development competencies and training and development opportunities for increasing levels of expertise and capability in NASA.
- The performance enhancement business area brings world-class experts and learning design directly to NASA's programs and projects, bringing knowledge, wisdom, learning, and support to the practitioner and project team when they need it, where they need it, and how they need it, increasing practitioner learning while simultaneously increasing the probability of project success.
- The knowledge sharing business area builds and supports NASA communities of practice for the express purpose of promoting leadership development through mentoring and teaching, capturing and communicating knowledge and wisdom from the best practitioners, and enhancing open communication and dialogue, employing the tools of *Master's Forums, Transfer Wisdom Workshops* and the award-winning *ASK Magazine,* compiling best practices from practitioners through the ancient art of storytelling, edited by one of the most respected names in KM, Larry Prusak.
- Research in project management and systems engineering through the Center for Program and Project Management Research (CPMR), a cosponsored activity between the Universities Space Research Association and NASA, focusing on applied research on NASA issues, importing new ideas and innovation into the organization, and stimulating the other business areas.

The focus and initiatives of KM are contained in the knowledge sharing (KS) business area. Let's take a closer look at these key elements.

Key Elements of the NASA Knowledge-Sharing Approach

Over their many years of experience, senior program and project managers naturally accumulate a reservoir of critical knowledge. The purpose of ILDP's various knowledge-sharing activities is to capture, code, certify, house, and

disseminate this knowledge and leverage the experience of these practitioners. In this way, through agency leaders and experts, ILDP cultivates the current NASA skill sets and supports developing project and program leaders who will take the place of retiring NASA personnel. Ultimately, KS develops a knowledge-sharing community of program and project managers within the agency that shares lessons learned, transfers best practices, archives critical project data, and develops leadership skills.

The key elements of the ILDP KM strategy include the following conceptual guidelines for the design, development, and implementation of KS products and services:

- Successful and experienced project practitioners are the central source of knowledge creation and sharing.
- New strategies will go through a period of piloting (testing) and the determination of success will be based on practicing project professionals.
- Knowledge sharing will be successful only if participants are primarily NASA's most successful experienced and emerging project leaders.
- The primary role of senior practitioners is sharing knowledge, and ILDP's responsibility is to provide effective and efficient forums for leadership development and networking.
- Meaningful impact only happens at the local level, where strategies should be tailored to maximize the benefit to project managers, project team members, and project organizations.
- Knowledge sharing can be successful only if it is based on the development of a personal relationship and a process of genuine dialogue among participants.
- Reflection, dialogue, storytelling, and sharing of experiences are the best mechanisms to facilitate forums and construct online resources.
- Contributors to knowledge sharing and mentoring are highly valued and will be appropriately appreciated, recognized, and rewarded by the agency.

The expected benefits that result from implementation of the KS strategies are:

- Transform tacit knowledge into explicit knowledge to support current NASA skill sets and mission success.
- Disseminate knowledge within NASA to support the President's Vision for Space Exploration.
- Disseminate knowledge outside of NASA to support citizen-centered government as directed by the President's Management Agenda.

- Change NASA culture to enhance networking and collaboration and create a greater desire for knowledge.
- Accelerate leadership development to meet the human capital and succession planning needs of the agency.
- Support and improve the image of NASA here and around the world.
- Inspire and energize people to emulate successful practitioners and thus improve performance and results.
- Develop practitioners to become more reflective, to support and improve program and project outcomes.
- Technology must be driven by the needs of participants, not the other way around.
- Make knowledge sharing an integral part of people's work; it must be kept simple and natural, and it must be part of performance reviews.
- Expect that different divisions and departments may want to do things differently, but that a case can be made for identifying what data and processes can be standardized and centralized, to avoid costly repetitive efforts and more effectively share information across facilities.

Transfer Wisdom Workshops

Project management Transfer Wisdom Workshops (TWWs) are held at individual centers. They are one-day workshops based on small-group discussions of mini case studies from the experiences of top NASA project managers, and serve to populate a story database. The ILDP team facilitates the discussions as practitioners analyze the applicability of the stories to the challenges of their own center to support new and upcoming program and project managers. Follow-up to the workshops includes the distribution of a community document containing the pictures and contact information of the attendees to enable future knowledge sharing. The feedback from the workshop is compiled into a report and shared with the center contacts in order to capture lessons learned and provide a better product for the next workshop.

ASK Magazine is distributed quarterly both as an online magazine on the APPL Web site and as a hard-copy NASA publication. It is an award-winning vehicle intended to create a knowledge base for present and future NASA project managers. *ASK* provides a medium for implicit knowledge translated to explicit knowledge through the ancient art of storytelling. Its articles include project management stories, lessons learned, interviews, book reviews, and a column on best practices, which serve as resources for higher levels of achievement and results. The stories in *ASK Magazine* also form the basis for the learning in the TWWs.

The Leaders as Teachers and Mentors initiative supports the development of human capital by leveraging the knowledge and experience of an identified set of current and retired agency leaders and experts to serve as teachers and mentors to the current and future generations of NASA practitioners. It offers senior and retired NASA practitioners the opportunity to share their knowledge, skills, and expertise as they give back to the agency through guest lecturing, teaching, consulting, and mentoring. The program framework includes established processes, recognition/reward systems, a candidate expertise database, and a file of opportunities for teaching, mentoring, and skills development of these leaders as well as the practitioners they serve. Project managers that are currently participating in other APPL knowledge sharing programs are recruited to participate in the Leaders as Teachers and Mentors initiative and are recognized by the agency for their contributions. They also serve as a source for referrals for other teachers and mentors.

Conclusion

Hoffman, Maturo, and Boyle are still working at the new ILDP effort and implementing KM. The years have literally rocketed by (appropriate to working at NASA). Since the first PPMI effort in 1988, KM efforts, gradually implemented, have borne fruit in allowing practitioners to turn implicit knowledge to explicit and to possess mechanisms to share this knowledge and wisdom across the organization and indeed around the world. Most of the effort now is spent on integrating KM practices and procedures across all developmental activities in ILDP. The stories generated through KS serve as a catalyst for many program and project improvements, and the sources of these stories continue to expand internationally from project managers across industry, academia, and the government.

In talking with Hoffman, it can be seen that he still has the passion for the work, and that the emphasis on serving practitioners in a practical way is the key to success for NASA. Reflecting on the history of KM at NASA he remarked:

> I never expected the success that we had over the past years. Who would have thought that cutting-edge human development and organizational development concepts would find a home in such a technically oriented organization as NASA? But as reports such as the CAIB continue to point out, it's all about the culture. KM tools and techniques allow us to share knowledge in a way that helps to prevent accidents like the *Columbia* from happening in the first place.[2]

Notes

1. As quoted on the NASA website, "History of the NASA Academy of Program/Project and Engineering Leadership (APPEL)." Available at http://appel.nasa.gov/node/12.accessed September 2006.

2. Personal discussions with the author, May 1–15, 2006.

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