Original 2003—Version 8 as of September 2011

BUILDING THE GODDARD LEARNING ORGANIZATION
A Knowledge Management Architecture of Learning Practices to Help Goddard Function More Like a Learning Organization

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The Challenge to Learn

A learning organization knows how to process knowledge, appreciates the value of shared collective knowledge and grows stronger and more knowledgeable with each activity it performs. The Goddard Space Flight Center (GSFC) is facing knowledge management challenges similar to other organizations involved in complex technical work. In order to meet the challenges, take advantage of the new NASA exploration opportunities and to best utilize our available resources, Goddard needs to make a strong commitment to becoming the best learning organization it can be. To do so, all members of the Goddard organization need to be committed to building an organizational system and support structure that promote and facilitate continuous learning.

Fulfilling this commitment will entail improving the way we manage knowledge so it is useful to a broader range of people, developing new ways of sharing and transferring wisdom to those aspiring to leadership roles, and putting in place the tools, practices and structures that move us toward becoming a better learning organization. This document builds on existing Agency and Center plans to embed learning practices into the fabric of our work processes and extend Goddard's phenomenal success record.

The Vision for Space Exploration

> *The United States will develop the innovative technologies, knowledge and infrastructures both to explore and support decisions about the destinations for human exploration.*
>
> President George W. Bush, **Vision for U.S. Space Exploration: A Renewed Spirit of Discovery**, delivered on January 14, 2004

Knowledge is central to our new vision. Functioning more like a learning organization will help us take advantage of the knowledge we have already acquired. We are in a race with our own human capacities to learn, share and apply what we can conceive, design, and build. As the CAIB report pointed out, NASA has as many managerial limiting factors as it does technological constraints.

We are in a race with our own human capacities to learn, share and apply what we can conceive, design and build.

> *We are convinced that the management practices overseeing the Space Shuttle Program were as much a cause of the accident as the foam that struck the left wing.*
>
> Columbia Accident Investigation Board Report V. I p 11.

The need for a plan to manage knowledge and build a learning organization at NASA has been highlighted in a number of official documents. This plan for GSFC is in direct response to those challenges and builds on the draft Agency KM strategic plan[1]. Goddard must become an effective learning organization in order to carry out the next generation of space exploration.

Currently there are a number of KM related activities underway around the Agency (INSIDE NASA, Competency Management System and ONE NASA for example). This plan is intended to both help Goddard fit in with existing Agency KM initiatives and to push forward on its strengths and opportunities to build Goddard into the most effective learning organization it can possibly become.

Much of the post-Columbia discussion on change has been about the need to change the culture at NASA. The Agency is in the middle of a culture change initiative aimed at unlearning some old behaviors and adopting new ones. Old systems, once reliable enough are not so today. Faster, Better, Cheaper removed slack in the system as did budget cuts, privatization, competition for commercial space flight and shifting Federal budget priorities. The lack of a clear vision at NASA post-Apollo has also been cited as a reason the Agency has slid into operational stances it now finds under scrutiny in the CAIB Report. Consider the implications of this statement in the CAIB Report:

> *Based on NASA's history of ignoring external recommendations, or making improvements that atrophy with time, the Board has no confidence that the Space Shuttle can be safely operated for more than a few years based solely on renewed post-accident vigilance.*
>
> CAIB Report p13.

While the Agency is wrestling with the meaning of culture change and working through the Return to Flight and ONE NASA initiatives, Goddard must not sit by expecting our successes of the past to carry us through the times ahead. Therefore, it is imperative that we pay attention to the policy and political climate in which we operate. Consider these sentiments from just the last five years.

Goddard must not sit by expecting our successes of the past to carry us through the times ahead.

The President's Management Agenda

The Administration will adopt information technology systems to capture some of the knowledge and skills of retiring employees. Knowledge management systems are just one part of ***an***

[1] *Strategic Plan for Knowledge Management*, NASA Knowledge Management Team, April 2, 2002 (unsigned draft document) available on the NASA KM website at: http://www.km.nasa.gov/home/index.html

effective strategy that will help generate, capture, and disseminate knowledge *and information that is relevant to the organization's mission.*

NASA Integrated Action Team Report, Dec. 2000

Although NASA's efforts so far are commendable, the Agency must go further. In the current environment, effective management and sharing of knowledge is more critical than ever. ***The experience of prior managers is not uniformly well documented and made available for the benefit of newer or less experienced program and project managers*** *to effectively utilize in their situations.*

US General Accounting Office GAO-02-195, 2002

NASA needs to strengthen its lesson learning in the context of its overall efforts to develop and implement an effective knowledge management program. We recommend that the NASA administrator strengthen the agency's lessons learning process and systems by: ***articulating the relationship between lessons learning and knowledge management through an implementation plan for knowledge management****; designating a lessons learned manager to lead and coordinate all agency lessons learning efforts; developing ways to broaden and implement mentoring and 'storytelling' as additional mechanisms for lessons learning; enhance the Lessons Learned Information System; and track and report on the effectiveness of the agency's lessons learning efforts using objective performance metrics.*

Columbia Accident Investigation Board (CAIB) Report Aug. 2003

The Board concludes that NASA's current organization does not provide effective checks and balances, does not have an independent safety program, and ***has not demonstrated the characteristics of a learning organization****. (p 12)*

Shuttle management declined to have the crew inspect the Orbiter for damage, declined to request on-orbit imaging, and ultimately discounted the possibility of a burn-through. The Board views the failure to do so as an illustration of the lack of institutional memory in the Space Shuttle Program that supports the Board's claim… ***that NASA is not functioning as a learning organization****. (p. 127)*

Renewed Commitment to Excellence (Diaz Report) Jan 2004

NASA personnel need to achieve a high level of technical and managerial competency along with a high state of readiness to deal with the research, developmental and operational challenges inherent in the aerospace systems they manage and operate. In concert, ***the technical tools, information systems, and knowledge repositories of the Agency must be up to date and readily available to be used by personnel across the Agency****. (p. 11)*

The Agency should identify an appropriate approach for the future development of a knowledge management system and infrastructure to assure knowledge retention and lessons learned*. (p. 11)*

Office of Personnel Management: Expected Outcomes from KM

Organizations have an effective strategic knowledge management (KM) effort in place. Technology is used to support the knowledge management effort. Innovation and collaboration occur throughout and across the organization. (OPM Statement)

Clearly, the Administration and the public expect NASA to succeed using knowledge we have already acquired. This Plan is designed to meet that challenge.

Clearly, the Administration and the public expect NASA to succeed by using the knowledge we have already paid a high price to acquire.

Reality Check !

The U.S. Army has been working to reapply knowledge in the digital age during the current campaigns. In *Company Command* Nancy Dixon explains some early concepts the Army realized:

1. The knowledge of the Army profession resides primarily in the minds of its members.
2. Connecting members allows the knowledge of the profession to flow from those who know to those who need to know, from those with specific experience to those who need that experience right now.
3. Person-to-person connections and conversation allow context and trust to emerge and additional knowledge to flow.
4. Relationships, trust, and a sense of professional community are critical factors that set the conditions for effective connections and convesations.

From Company Command by Nancy Dixon, et.al. (2005). Center for Advancement of Leader Development and Organizational Learning. p21.

As a science and a technology Center, Goddard has always had an important role in communicating NASA's knowledge to the public. Goddard's Strategic Implementation Plan calls for the Center to ensure the continuity of the quality workforce that enables the Center to be the National Resource it is for Space Exploration.

We cannot assume that the skills and experiences developed across five decades of space exploration are genetically inherited… While each new generation of scientists and engineers builds on the successes of previous generations, there is a period of learning and overlap, much like the transition in a relay race, where one generation runs along beside the other until the handoff is made.
Goddard Implementation Plan FY2004 Page 5

Making that handoff happen is one key characteristic of a true learning organization. People hand-off knowledge to other people. A learning organization facilitates the sharing of knowledge among people in addition to sharing information among systems. Knowledge systems are necessary only as much as they enable people to share their knowledge more effectively or more efficiently with others.

The Goddard Response to the Challenge to Change

Part of the Agency's response to the 2002 GAO report[2] was the formation of a NASA Knowledge Management Team chartered to write a KM Strategic Plan for the Agency. Unfortunately, that document fell short of achieving effective change and remains in a draft form. In contrast, this Goddard Plan is designed to overcome the previous focus on IT as a KM driver and an over-emphasis on ***capturing knowledge from workers*** for the organization as opposed to ***facilitating knowledge sharing among workers***. On the sharing side, APPL[3] has led the way for the Agency with knowledge sharing activities that both bring people together (Master's Forums) and publish collective wisdom (ASK Magazine) from project managers.

This Goddard Plan is designed to overcome the previous Agency focus on IT as a KM driver with its over-emphasis on ***capturing knowledge from workers*** for the organization and instead focuses on ***facilitating knowledge sharing among workers***.

Goddard must become an organization that by design learns, evolves, creates and applies knowledge effectively and

[2] GAO Report on NASA. 2002.
[3] APPL is the NASA Academy of Program and Project Leadership. See http://appl.nasa.gov

efficiently. While other on-going efforts (like ONE NASA) are focused on removing obstacles in the way of functioning as a learning organization, this Goddard Learning Plan for focuses on the specific ways Goddard can leverage its strengths, and help to lead the way for the agency to becoming an organization that learns. This plan will help take us to a new organizational culture that will enable Goddard to continue to fulfill our unique mission for the American Public, NASA, and the scientific world all of whom have placed their trust in us to explore the frontier of space. This Goddard plan builds on that approach towards facilitating knowledge management as primarily a sharing activity, not a knowledge capturing function.

Goddard has moved ahead with the establishment of the Knowledge Management Office[4] and the hiring of a Chief Knowledge Management Officer for the Center. One of the primary goals of the GSFC KM Office is to formulate a center wide KM Architecture and Strategic Plan for building Goddard into the effective learning organization called for in the reports cited above. This Center Plan offers a reference point for coordination, focus and reflection to help ensure the many KM activities at Goddard work together to make the Center a truly effective learning organization. Working as a team, Goddard will continue to be a Center that manages its competencies, improves its processes and executes its duties with all minds fully engaged.

Reality Check !

Why do so many knowledge management efforts fail? Two Stanford professors offer this explanation:

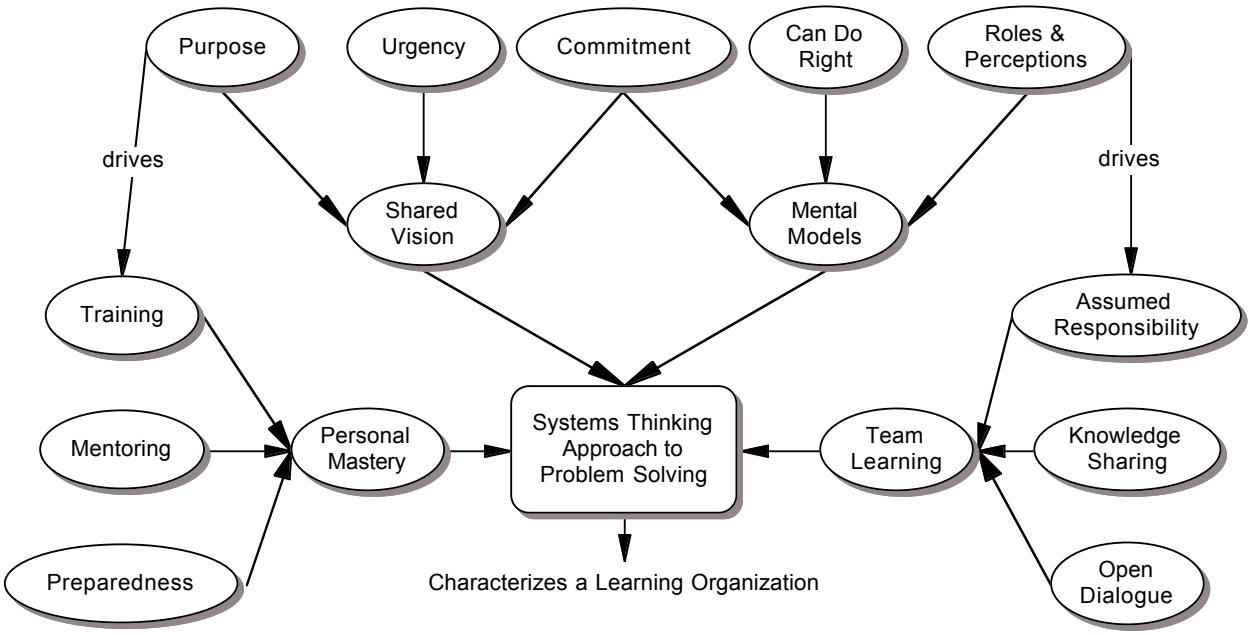
1. Knowledge management efforts mostly emphasize technology and the transfer of codified knowledge,
2. Knowledge management tends to treat knowledge as a tangible thing, as a stock or quantity, and therefore separates knowledge as something from the use of that thing,
3. Formal systems can't easily store or transfer tacit knowledge,
4. The people responsible for transferring and implementing knowledge management frequently don't understand the actual work being documented, and
5. Knowledge management tends to focus on specific practices and ignore the importance of philosophy.

From The Knowing-Doing Gap: How smart companies turn knowledge into action by Jeffrey Pfeffer and Robert Sutton. (1999). Harvard Business School Press. p 22

[4] The KM Office at Goddard is located in the Office of Mission Success in Code 170. See http://missionsuccess.gsfc.nasa.gov NOTE: the KM office became the Office of the Chief Knowledge Officer in 2006 and moved to the Director's Office. See: http://www.nasa.gov/goddard/ocko

A learning organization is able to adapt and change and thereby address the challenges in its path towards the successful attainment of goals. It can do that because all of its members are learners who engage their full intellectual capabilities and have access to the collective organizational knowledge. Peter Senge (1990) laid out the need for an organization to not only be excellent at personal mastery, mental models, shared vision, and team learning but also to have a well developed systems thinking capability throughout the organization. He called systems thinking the 'Fifth Discipline' that was needed to truly make a learning organization.

FIGURE 1: THE SENGE LEARNING ORGANIZATION MODEL



Senge's model links the need for shared vision, mental models geared toward learning, personal mastery of required skills and team learning in order to truly achieve the level of systems thinking required to develop a learning organization. Clearly communication, culture (openness) and structure are also integral to building a learning organization. What is not discussed in the Senge model are the infrastructure support systems necessary to enable a learning organization to function and the organizational power and politics insight needed to keep the focus on learning enabled outcomes. In *Working Knowledge*[5] Davenport and Prusak define many of the parameters of knowledge management that shape the KM discussion today. This Goddarad architecture builds on many of their insights.

McGill and Slocum[6] describe four types of organizations: knowing, understanding, thinking and learning. Knowing organizations are good at doing known things very efficiently. Understanding organizations are good at adapting to specific changes in the environment such as regulatory, consumer or political realities. Thinking organizations are good at problem solving. They systematically tackle and solve problems. Learning organizations though, are able to solve

[5] Davenport, T. & Prusak L. (1998). *Working Knowledge: How Organizations Manage What They Know,* Harvard Business School Press, Boston, MA.
[6] McGill, M. & Slocum, J. *Unlearning the Organization* in Organizational Dynamics, Autumn, 1993.

problems and apply the lessons to themselves, continually adjusting their own perspective and processes. Goddard (and NASA) is an excellent thinking organization that can solve problems presented to it. However, we must move on to become a true learning organization.

A Learning Organization is Willing to Take Risks

The CAIB Report also specifically calls out to NASA the fact that the organization is 'not functioning as a learning organization." ***If we truly function as a learning organization, then future Goddard projects should never accept risk or experience failure because the organization did not apply its own best knowledge.*** The measure of success will be how confident the organization is to move ahead into new areas of discovery and face new risks and uncertainties. An organization that isn't sure of its knowledge use will be more hesitant to move forward, fearful of repeating an avoidable mistake. To be successful, NASA must be willing to take risks to explore but without the organization itself getting in the way of technical or scientific success. While we focus on learning, we must be careful to avoid becoming obsessed with preventing failures. We have much more to learn from our successes than we do from our failures. We just don't know how to do that as well. One reason is we don't stop long enough to learn unless something (like a failure) makes us stop. We have to learn how to learn in process. Learning from all that we do is also a key characteristic of a high reliability organization. NASA's unique mission and the accompanying risks of space exploration demand high reliability in every task we undertake. An open learning culture is essential to high reliability and mission success.

The Goddard Learning Architecture

The route to building Goddard into the best learning organization it can be requires building the foundational pillars of well managed knowledge assets and open knowledge exchange. To be effective, the knowledge should be managed as close to the action as possible. Highly efficient centralized systems tend to strip validation and value from the knowledge flow. Knowledge flow must be effective before it can be efficient.

The Goddard approach to knowledge management intends to go beyond 'first generation KM which is characterized by single loop learning. McElroy (1999) concludes that "conventional knowledge management practice, then, boils down to little more than getting the *right information to the right people at the right time*. Think *single*-loop learning." [italics in original]. Shukla and Srinivasan (2002) go further and state "The purpose of first generation KM programs is to improve operational efficiency of the employees by enhancing access to rule sets." This plan and architecture then, is focused on getting Goddard to second generation knowledge management that is clearly double-loop learning and includes the what and why (the context) of the knowledge, not just the rule. This brings the focus back to effectiveness, rather than simply making KM about automation driven efficiency.

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Reality Check !

Knowledge Management Is Both a Goal and a Means [excerpts from whole text]

By Vice Adm. Herbert A. Browne, USN (Ret.)
May 2005
Source:
<http://www.afcea.org/signal/articles/anmviewer.asp?a=903&z=39>http://www.afcea.org/signal/articles/anmviewer.asp?a=903&z=39

The network-centric Free World is placing a greater emphasis on intelligence than ever before-both for battlespace military operations and for winning the war on terrorism. However, while much attention has been focused on intelligence collection, processing and dissemination, it is knowledge management that will win or lose conflicts in the future.

[deleted section]

The old paradigm of data becoming information becoming knowledge is fading in this era of a networked force. Diverse forms of intelligence, whether raw or processed, are being shipped across the network. No longer does the value of data increase only as it moves up the processing chain. Now, its value is determined not by its form, but by its usefulness to the customer. The key to achieving the full value of all of this data is knowledge management, and its importance in turn is enhanced by what it leads to.

Knowledge management is not the end of the line for information exploitation. When a user is dealing in knowledge management, that user is dealing in the "now." But beyond the now is a step called wisdom. It allows a user to take the now-or even the past-and make accurate predictions about what is going to happen in the future.

This capability to look into the future may be the most indispensable element of knowledge management. If all that national security personnel do with knowledge management is use it to define what has happened in the past, then we are failing to capitalize on the power of a data rich network.

Knowledge management must permit the decision maker to focus on that given moment in time and then allow logical projection to move forward to the future

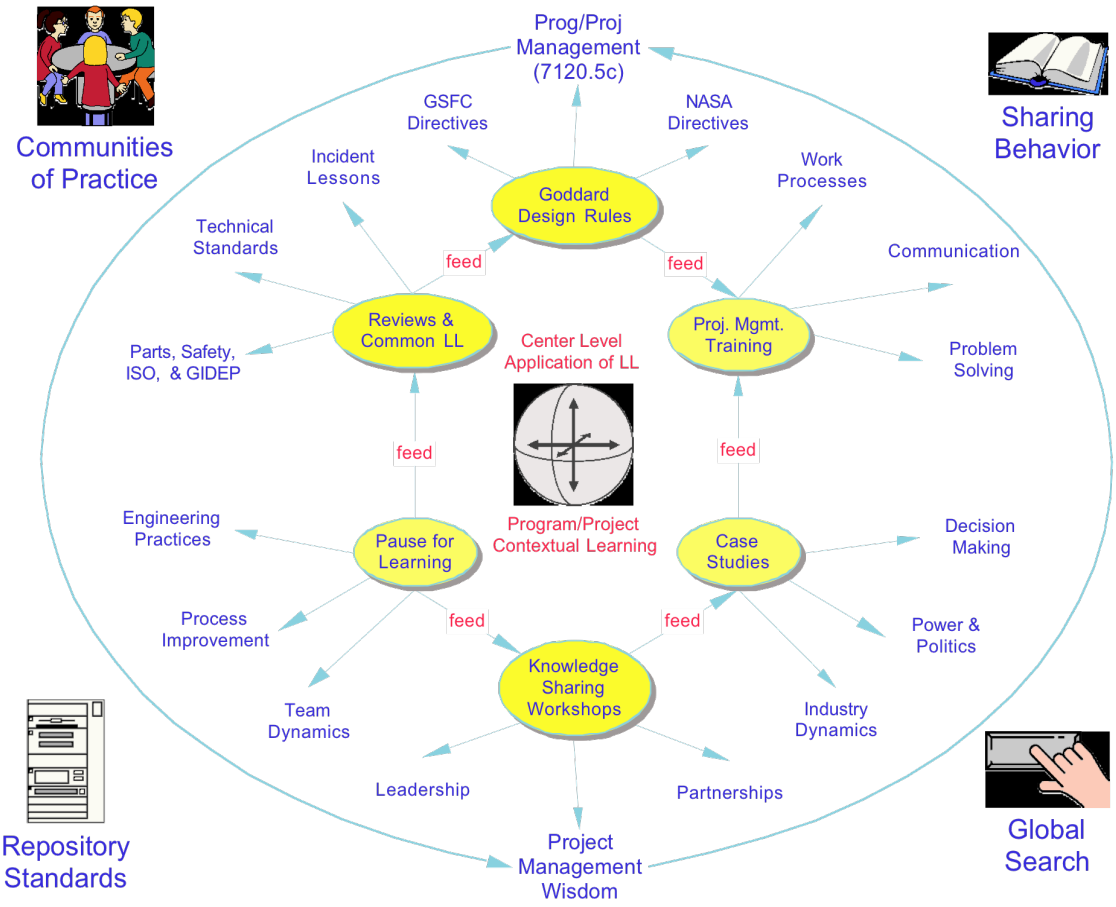
Experts simply cannot put together the technology that is required to sample an enormous database and permit users to connect the dots and arrive at a knowledge goal. That goal is not so easy to attain. Investment must be made in both people and time.

[section deleted]

Knowledge management is vital for the "now." Hopefully, we will get to the point where not only are we developing tools for knowledge management but developing tools to help provide the wisdom necessary for our decision makers to do what is required to defend the Free World

Figure 3 shows the six core practices of the KM Architecture at Goddard. The top three lend themselves to centralized management where review processes, lessons learned and training decisions need to be made for the good of the center. The lower three are tied to the project life cycle and need to be aligned with work flow processes in order to be effective. Importantly, the lower half is essential for informing the upper half with valid content. Lessons learned extracted from the organization and devoid of context are often meaningless and probably useless.

FIGURE 3: KNOWLEDGE MANAGEMENT ARCHITECTURE FOR GODDARD



The core of Goddard knowledge resides in the work units and projects where it is being generated. The key to managing knowledge is not to extract it from its origins but to facilitate its use both at the source and within communities of practice across the organization. KM systems don't so much create communities as they facilitate their existence and function. The communities are defined by function or task. KM should help Goddard communities (project teams, work units, domain groups etc.) behave and function like learning organizations generating, sharing, using and preserving their knowledge. The divisions and other work units at Goddard will be the primary owners and holders of their respective knowledge. The KM office will help provide means and motivation to share that knowledge first with the Goddard community and subsequently with the Agency and the public. This plan is intended to help Goddard put in place practices that will facilitate the flow of knowledge and help build the feedback learning loops that characterize a learning organization (Senge, 1990).

Knowledge management then is helping the organization utilize its knowledge. The Goddard Plan for Building a Learning Organization being pursued here means that Goddard will seek to build systems, organize its work and workforce and lead by example in ways that enhance learning at every level of the organization. There are three goals of the plan for Goddard to become a better learning organization: 1) We Must Manage Our Knowledge Assets Effectively, 2) We Must Facilitate the Effective & Efficient Reapplication of Knowledge, and 3) We Must Continually Work to Build a Learning Organization Culture.

GOAL 1: Manage Knowledge Assets

Managing knowledge assets involves finding, tagging, structuring and filtering the content of knowledge generated and used at Goddard. Goddard works with science, engineering and project knowledge. Each has a different structure. An appropriate structure of our knowledge is critical for making it accessible in a timely and convenient manner. Goddard is building a distributed knowledge system whereby the communities, collections and networks of knowledge can be maintained locally but made available to the center as needed. Managing knowledge effectively does not mean creating a one-size-fits-all standard format for all knowledge. That type of approach will actually exclude much useful knowledge from the system because it is inherently driven by efficiency rather than by effectiveness.

NASA is the type of organization where much knowledge is fluid and constantly under review. We do not operate everything from proven practices repeated thousands of times as in manufacturing. Almost every job still relies on intuition, experience and judgment. Our knowledge collection processes must reflect this reality and collect wisdom that is useful to those who may need it in solving the challenges in front of them. Our systems must make it easy for project managers, scientists and engineers to record, review and share what they have learned. But knowledge management does not substitute for individual learning capacity. Our systems must augment human capacity, not seek to replace it with rules and procedures.

Knowledge management does not substitute for individual learning capacity. Our systems must augment human capacity, not seek to replace human thinking with rules and procedures.

GOAL 2: Facilitate Knowledge Application

Facilitating knowledge application is dependent on having appropriate systems to deliver knowledge as needed to users. The systems must be convenient, attractive, easily navigated and present knowledge in recognizable forms. Technology systems are as important as social systems for sharing and delivering knowledge in a timely manner. We must build a robust global

Our index and search systems will discover what is at Goddard but the appropriate control of that information and knowledge will remain with the owners.

search capability across the center. Everything we do at Goddard must be findable by other people at Goddard. That does not mean everything is accessible. Finding (knowing something exists) is not equivalent to granting unfettered access. Our index and search systems will discover what is at Goddard but the appropriate control of that information and knowledge will remain with the owners. Modern information systems make doing both possible.

Beyond simple searches we will also build creative ways to both connect knowledge (an ontology built into our repository designs) and to be stimulated by knowledge (visual representations of knowledge domains). We will build searches based not on characters and words alone but on meaning. The sheer volume of data will overtake us if we don't build the smart systems for continually discovering what we already have learned somewhere else. Learning takes place when the human mind makes a new connection across knowledge domains. Our presentation of knowledge will allow for and stimulate as much cross-domain recognition as possible with visualizations, suggestions and cross references. Finally, our tools will not create more work but will help our people get their important work done with more knowledge resources at hand thereby helping to reduce and mitigate the inherent risk in the business of space exploration.

Knowledge should be organized as closely as possible to the work processes that it impacts.

GOAL 3: Build the Learning Organization

Building the learning organization requires a set of policies, behavior expectations and a structure to the collective knowledge. Policies help set expectations for valuing knowledge collection and sharing. To be effective, learning behavior must be modeled by organizational leaders. Members of a learning organization take time to reflect, learn and share. They take time to comment on insights of others. They share incomplete ideas hoping others will fill in gaps or point out omissions. This type of behavior generates the cross domain innovation necessary to solve unique challenges such as those adopted in NASA's mission.

Learning behavior must be modeled by organizational leaders.

Success for this plan means executing well against the two foundational goals of managing and facilitating knowledge and then building on top of those the components of a true learning organization that sustains the learning culture and the requisite operational flexibility. Knowledge Management at Goddard must operate within a comprehensive system that encourages individual learning and collective application.

To function as a learning organization Goddard must have a structure for its knowledge, behavioral standards, and policies and procedures that support and drive learning behavior. This will require learning and knowledge management activities to be coordinated more at the center level. This does not mean all Goddard knowledge needs to be structured at the Center level. Knowledge should be organized as closely as possible to the work processes that it impacts. Thus projects, engineering branches and science groups should keep their knowledge organized primarily for their use. Knowledge of more general use can then flow up from those systems to the Center and Agency. The aggregate Center system will only be as valuable as the sub-systems.

To fully function as a learning organization Goddard must strive to achieve the functional characteristics that make an organization continuously learn and apply its knowledge. In addition to thinking in a systems manner towards all problems, Goddard must also increasingly value collective knowledge, better integrate work processes and learning processes, and build systems that enhance human potential.

Valuing collective knowledge means rewarding, celebrating and pursuing activities that help Goddard to know more. This is a leadership and expectations initiative. Integrating work and learning is a caring initiative that allows people to learn, share and grow while they work, not just rewarding them when they are done. To build systems that enhance human potential means we must resist deskilling solutions that remove human creativity from the workplace. Knowledge management is not about automating human thinking processes but augmenting them to be more productive.

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The architecture for building the learning organization at Goddard has six practice areas, two fundamental supporting pillars and two organizational learning outcomes which will help us gauge our progress toward functioning more like a learning organization. Each of these ten items will now be addressed in detail.

Reality Check !

An architecture is “the structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time.”
So…
A second generation KM Architecture must show how learning will occur across the organization to produce a continuous knowledge supply, not just how current knowledge will be efficiently harvested with no thought to replenishment. Sustainment must be part of the design if the results are to last longer than the current version of KM software deployed. All three phases of the knowledge life cycle must be supported: knowledge production, knowledge diffusion and knowledge use. As smart as a KM system may be, it will never be smart enough to fool the people expected to use it.
See McElroy (2000) for more insight on knowledge cycles in organizations.

Supporting Pillars for Knowledge Management

PILLAR 1: Global Intranet Search Capability[7]

Global search simply means someone at Goddard should be able to find where information and knowledge is located either through a web based search of documents, an expertise directory (finding the person who knows) or a social network (finding the group already working on the issue). Since the agency is putting together a comprehensive Competency Management System to track employee knowledge, skills and abilities, so Goddard will only need to augment that system with Goddard specific competencies and knowledge areas. We do need to organize our own knowledge at Goddard, much of which resides behind electronic firewalls (closed servers) or social firewalls (closed groups). The goal is not to break up these natural groups but to facilitate their internal group sharing as well as the posting of their knowledge and availability. Control of the knowledge must still reside with the owners.

As a first step, we must implement a simple intranet search capability across Goddard. This will not only deliver keyword searches of all Goddard sites, but also drive discussion of openness of sites, control of content and access privileges. These issues must be resolved for knowledge management to be effective center-wide. The objective of an intranet search application, simply put, is to give employees access to relevant information in a timely manner. This differs from commercial Internet search services in that an intranet search allows employees to access information that isn't public, such as that behind a company firewall.

Employees find information by navigating through different websites ("browsing"), or by querying keywords against an index ("searching"). According to industry web expert Jakob Nielsen, any midsize or large intranet will contain so much information that it is not realistic for users to find it all by pure navigation. In his testing of employee productivity with intranets, the quality of search accounted for 43 percent of the difference in time on task between intranets with high usability and low usability.[8]

An intranet search application supports E-Government. The 2003 E-Government Strategy has as one of its goals Internal Efficiency and Effectiveness (IEE). IEE emphasizes modernizing internal processes and utilizing industry best practices to improve effectiveness and efficiency and increase employee satisfaction and retention. An intranet search application would help achieve this. A Center initiative will look at leading products and charter pilots of best fit tools to address this need.

PILLAR 2: Digital Repository Standards[9]

Historically, project documentation has been managed by each individual project within an Enterprise. The project documents (text, images, video clips, software, etc.) are stored and managed in project libraries using commercial off-the-shelf, internally developed or contractor developed systems. This practice provides the project manager with flexibility within the NASA

[7] See White Paper on *GSFC Global Search Engine* at: http://smo.gsfc.nasa.gov/knowman/whitepapers.html
[8] "An Interview With Jakob Nielsen on Designing Web Sites for the Intranet," Information Today March/April 2003, http://www.infotoday.com/IP/may03/interview.shtml
[9] See White Paper on Digital Archives at: http://smo.gsfc.nasa.gov/knowman/documents/whitepapers/Digital_Archive_Architecture.pdf

guidelines and direct access to the documents during the course of the project. However, the diversity of systems results in the compartmentalization of project documentation. Valuable knowledge assets may be lost, especially when the people involved with the project, who acted as information gatekeepers, are no longer available to perform this function. This approach to project management leads to a lack of interoperability, limited access to knowledge assets in the short term, and the inability to use this explicit knowledge in support of a learning organization.

In addition to the significant impact that a digital archiving and preservation system could have on NASA's ability to share information and create a learning organization, such an approach to government information management is called for in the E-Government Act of 2002 Section 207 (E-government Act, 2002). In order to implement the Act, the Office of Management and Budget has created several committees including the Interagency Committee on Government Information (CIO Council, 2004). The major components of a successful government information archive outlined below are also under development by working groups under this committee. These requirements are also the specific embodiments of the high-level requirements of the Federal Enterprise Architecture, particularly the Data Reference Model.

There are six components of a successful archiving system: 1. Overall architecture based on the Open Archival Information Systems Reference Model (OAIS RM), 2. Ingestion (an agreed upon mechanism for ingesting information into an institutional repository), 3. Archival storage (media stability and preservation), 4. Data management including a metadata structure, taxonomy and persistent identification, 5. Retrieval (search capability & rights management), and 6. Repository management including policy formulation, enforcement and sustainability.

The first component, the OAIS RM is an overarching architecture and an ISO Standard that provides a framework to describe the remaining components. Both safety and mission success in NASA require a comprehensive Enterprise wide policy for electronic preservation. The Goddard Archive Plan will lay out the critical considerations necessary to make sure that electronic means are used to support new exploration initiatives. A smart archive system does not replace Configuration Management or Records Management. It supports those tasks making their output valuable to the Enterprise, the Program and the Agency.

Role of the Goddard Library

To manage our documented knowledge assets requires being able to identify them, access them and make sense of them in order to apply the knowledge to current needs. Activities in this area started with the Goddard Library[10] moving from a traditional library role to one of Center Knowledge Management Operations Center as the primary supporting organization for the two pillars of this plan. The Library at Goddard has energetically embarked on a transformation to help the Center actively manage its knowledge. The Library has already developed a common metadata core, digital archiving systems for videos, images and reports as well as desktop tools designed to help people find information easily at Goddard. The Library represents the Goddard way of integrated solutions combining the best of information technology and management with library science and emerging knowledge management concepts.

[10] The Goddard Library won the Federal Library of the Year Award in 2002 because of its forward thinking and innovative development of electronic services and its progressive knowledge management orientation.

Program/Project Learning Practices

PRACTICE 1: Pause And Learn (PAL)[11]

Goddard has embarked on a program to adopt the U.S. Army's After Action Review (AAR) concept to project management. While many teams and groups at NASA meet and discuss events after they happen, NASA has no formal process to guide the meaningful collection of learnings in the way AAR's function.

> An AAR is "…a professional discussion of an event, focused on performance standards, that enables ***soldiers to discover for themselves*** what happened, why it happened, and how to sustain strengths and improve on weaknesses" [italics added]
>
> A Leader's Guide to After-Action Reviews, 1993 p 1.

The Army learned from years of experience with After Action Reviews (AAR) that much of the value in the AAR exercise comes from several key design parameters. First, the focus of the AAR is specific to 1) What happened (events), 2) Why did it happen (cause), 3) How can we improve (action). Second, the AAR is a participant discussion. AAR's replaced traditional top down lecture critiques. What was valuable about AAR's was the voice of the team members themselves offering up their views and ideas. Third, the AAR is close to the action in time, space and personnel. Fourth, the AAR does not function as a career review. It is a non-attribution team review of what happened. The team members participate because they feel free to speak. Finally, the AAR is part of the overall process whether it is a training exercise, a simulation or a field operation. The action is not complete until the AAR has been conducted. The AAR is a fundamental part of the process built into the project. The AAR method replaced sterile lecture type critiques delivered by judges often some time after the end of the events. The participants were not energized and sometimes defensive about these reviews.

We have adapted the process and called it "Pause And Learn" because the exercise is not performed at the end of a mission but at an event, milestone or review step. Before going on to the next task, the team is brought together to pause and focus on learning from what they have just accomplished. The PAL can be described as a 3-step process outlined below. Key is having knowledgeable facilitators that are familiar with the topic, the people and process.

Step 1

- Identify when PALs will occur
- Determine who will attend PALs
- Select Moderators, Rapporteurs
- Select potential PAL sites
- Review the PAL plan

Step 2

- Review what was supposed to happen
- Establish what happened (esp. dissenting points of view)
- Determine what worked well and what didn't go so well
- Determine how the task could/should be done differently next time

[11] See White Paper on *Pausing For Learning: Adapting the After Action Review Process to NASA* at: http://smo.gsfc.nasa.gov/knowman/documents/whitepapers/Pausing_For_Learning.pdf

Step 3

- Review objectives, tasks, and common procedures
- Identify key events
- Rapporteurs collect *ALL* observations
- Organize observations (identify key discussion or teaching points)

The PAL process is the critical foundation for learning from the project lifecycle. PALs should occur after major events, milestones and reviews. The material generated first and foremost belongs to and is meant for the team. Out of their notes and lessons there is a potential for important lessons, insights and wisdom to flow to other projects through the other practices. Without this foundational practice in place, the architecture for learning has little chance of being highly successful. To clarify this flow concept refer to Figure 3 *Knowledge Management Architecture for Goddard*. If learning is done at this level throughout the project life, gathering lessons learned after launch, or post mission will mainly be a review of the PAL data. In addition, the bias of hindsight will be removed by using data collected close to the event time.

Reality Check !

The U.S. Army has been working to reapply knowledge for more than 20 years through an After Action Review process. In *Company Command* Nancy Dixon explains the importance of context:

"Elements such as the situation in which the lesson was learned, the outcome, the time-frame, and who was involved all add to an understanding of the lesson's context. This type of contextual knowledge is inseparable from content. In fact, we would go so far as to say that **content without context is empty and powerless to affect learning**. We want every piece of content and every lesson to be enriched with the context in which that lesson was developed and learned."

From Company Command by Nancy Dixon, et.al. (2005). Center for Advancement of Leader Development and Organizational Learning. p29.

PRACTICE 2: Knowledge Sharing Workshops

A learning culture thrives on opportunities to share and learn from each other. It attracts those interested in learning together because they know that they will be personally challenged only if they are active participants in the learning culture. Knowledge Sharing Workshops are an opportunity to model that kind of behavior for Goddard. At each workshop, senior project leaders share their insights, what they learned and what they might do differently based on their

recent project experience. These workshops are attended by emerging project leaders at Goddard who want to learn the wisdom necessary to succeed as project managers.

Participants are invited to the workshops through senior management contacts and an invitation email list. The facilitator meets with the panel prior to the workshop and prepares talking notes with them for use at the workshop. The panel does not make any formal presentation but rather speaks from their personal experiences. The workshop participants discuss among themselves the issues raised and formulate questions to ask the panel in order to learn more. These sessions are not recorded because they are a modeling exercise (encourage more open and practical sharing; not more slides and reports) and because we want panelist and participants to be completely free to bring up issues however sensitive or unresolved they might be. These workshops do not take the place of technical seminars, review board reports or senior management reviews. They are meant to encourage similar behavior within the projects and divisions. Candidate material for lessons learned or even ASK magazine articles may come from the workshops.

Goddard has been holding Knowledge Sharing Workshops since early 2003. They are held approximately 6 times a year. A Knowledge Sharing Workshop is two hours in length. The first 30 minutes the panel briefly tells their role in the project and their most memorable experiences. Then for 30-40 minutes the participants discuss in groups what those lessons mean to them. During the second hour, the panel responds to questions from the groups. The session is facilitated to keep on topic and time. The panel is made up senior project personnel who were directly involved in the project. It is primarily individuals telling their own story of what happened and what they learned. Usually the workshop is focused on a project that is in operations or has experienced a significant event (could be failure, cancellation or surpassing success). The main point of the workshop is to allow people to hear the 'rest of the story' and to make connections with their own work for immediate reapplication of lessons from the experiences shared.

PRACTICE 3: Case Studies[12]

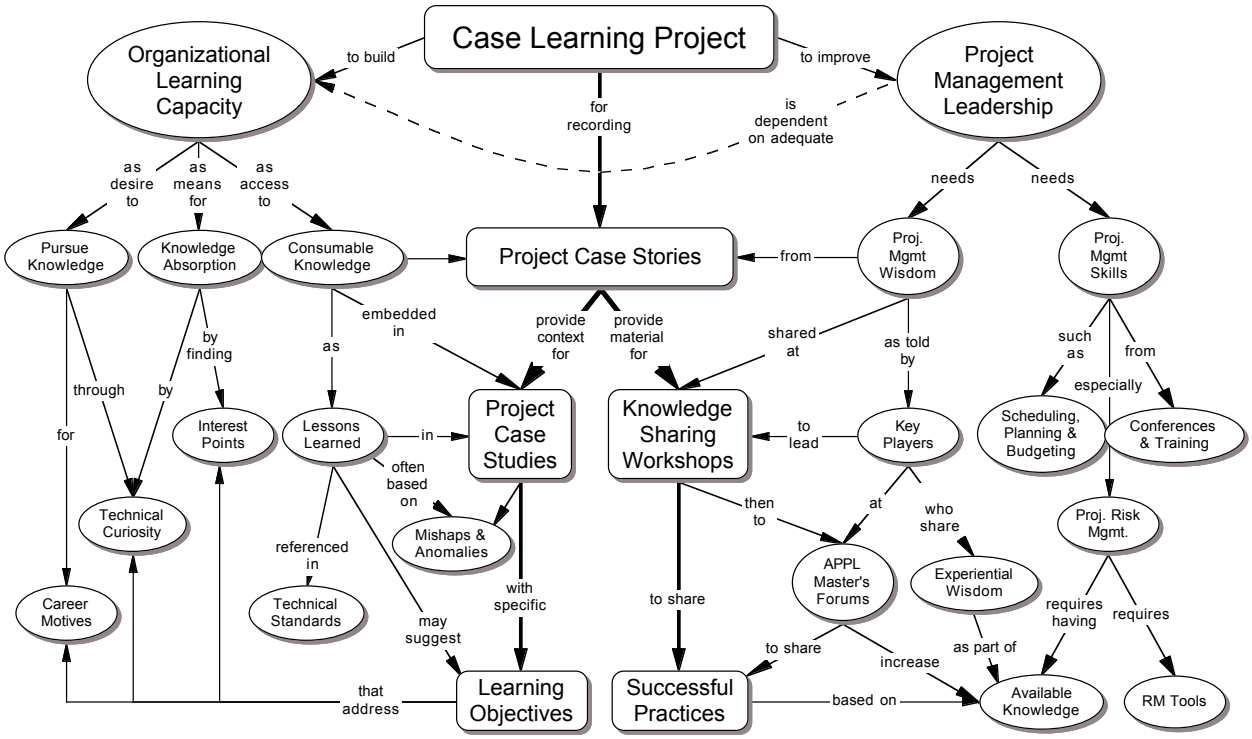
Organizational learning takes place when knowledge is shared in usable ways among organization members. Knowledge is most usable when it is contextual. NASA has processes for recording and sharing parts, safety and routine process knowledge across disciplines through training, lessons learned and information databases. What is less well developed is the sharing of contextual project management knowledge. To build organizational learning capacity around project management, the context of the project stories must be brought into the knowledge management system. A case story is the primary vehicle to do this.

Documented case stories provide a context for key players to present material, reflect on project management insights and share contextual knowledge in a meaningful way. The case teaching method provides means for developing systems thinking skills needed by a learning organization. While the CAIB and Diaz Reports call for Agency wide interoperability of databases to facilitate learning, the Case Learning Project goes beyond that starting point to provide the means for people to seek out that knowledge by exposing them to the usefulness of learning from others' experiences across the agency. While case learning is not as common in engineering and scientific fields as it is in policy or business, project management wisdom is

[12] Some case studies are available on the APPEL website at: http://APPL.nasa.gov

really an ideal subject for the case learning method. Some resistance to case learning with its inherent ambiguity can be expected from professionals much more accustomed to being 'told the right answer' than wrestling with multiple equal outcome paths. Figure 4 maps out the role of cases in the learning plan for Goddard.

FIGURE 4: THE ROLE OF CASE STORIES IN ORGANIZATIONAL LEARNING



Case stories are best told by the key players in that story. Case stories are written by interviewing the key players on a project in addition to collecting historical documents and reports. A professional writer produces a written case story incorporating human elements, technical aspects and lessons learned. From the case stories one or more case studies are then extracted. The case study is written to allow one or more key players from the case to tell their story and interact with participants in a learning environment.

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A case study for teaching focuses on a specific aspect, event or time horizon in the life of the project. Each study has one or more learning objectives that can be used in a discussion, presentation or self-reflection. The case study also provides links (on-line) to the sources, referenced competencies or technical details (such as designs, test results, or configuration management documents) to enable the reader to probe further questions that arise in the reading

of the case. We have begun to use the cases at Goddard in training courses, at conferences and in Knowledge Sharing Workshops.

Case studies are another form of a knowledge transfer channel. They are constructed opportunities for conversations to happen. They allow learning to happen at several levels. Participants often learn details of other projects or events that they did not know of beyond headlines. They also get to meet the people who were intimately involved with those events. They are placed in a position to think through the decisions those people had to make a the time. Thus, they get the benefit of learning from the decision making process itself, what they will experience in their work, rather than just hearing filtered after-the-fact explanations. Finally, hearing the rest of the story directly builds trust, opens relationships and fosters a sharing environment. All of these benefits are lost with traditional captured lessons learned that are devoid of context. Lessons learned systems are good for information management, keeping track of things we know but by themselves foster little organizational learning. Learning takes place within context. The case learning approach to knowledge management helps create that context.

Case studies as used in academic settings also help get out the story of NASA. Unless we actively tell the story of how NASA works, college students will learn about NASA only from press accounts of mistakes and accidents. A case about Goddard has been released for use in the business management field by Darden Publishing[13] as a first step in this direction. APPL has also published a number of cases on their website that academic institutions are free to use. Goddard is working to make its case studies suitable and available for use in aerospace and engineering management programs.

Center Learning Practices

PRACTICE 4: Review Processes and Common Lessons Learned

Lessons and insights that come from the project work done at Goddard need to be collected, analyzed and disseminated across the Center. These lessons might range from small but critical parts items to safety procedures, contract issues and physical or engineering discoveries. Many of these insights occur during or in preparation for reviews throughout the project life cycle. These reviews should and could be learning opportunities for the team and others with little marginal effort by collecting the lessons and insights that are mentioned and taking time to pause and learn from those things that have been resolved or mitigated. It is important to note that much of this type of information has an appropriate home in a database, publication system or other reporting mechanism such as the Goddard Problem Reporting System (GPRS). Data trends and reports from GPRS and other reporting systems will be able to offer candidate material for lessons learned and potential workshop or case study content.

The mandatory reviews conducted across all projects allow a snapshot view at key events and gateways. The review process could also offer the ability for Center Management to look across all projects and programs for common lessons experienced. Lessons Learned at the Center level will be looking across all incidents, reports, collected PALs, Workshops and Case Studies to produce a Common Lessons Learned Annual Report (CoLLAR). This report will highlight trends, new insights, and common themes to lessons that might span disparate projects. The

[13] The cases are available for free use inside NASA. They are also available for purchase at www.darden.edu/

recommendations out of the CoLLAR will be directly passed to senior management for input to project management policy and training. The Lessons Learned action at Goddard also entails ensuring that lessons arising from project work are entered into the NASA Lessons Learned System[14] in a timely manner for access and use across the Agency. Collecting the lessons at the Center level will facilitate that process as now lessons are entered directly by individuals at the project level with little coordination across the center. This process will be formalized for connecting the gathering of lessons from projects in accordance with the NPR 7120.6 released in March 2005.

PRACTICE 5: Management Training

The training of project leaders is crucial to the future success of Goddard. Goddard must take an aggressive approach to assure that its project leaders and line managers have the fundamental skills and the collective wisdom of experienced leaders available to them. To this end we have developed the Road to Mission Success[15] a course to incorporate the requisite project management skills and the embedded Goddard wisdom as gleaned from cases, PALs, workshops and other sources of lessons. Senior managers are involved in delivering the content and cases.

The cases and vignettes developed for the course will also be available for use in other Goddard and NASA training activities so that lessons learned at Goddard are disseminated as widely as possible across the Agency. Cases from Goddard have already been used in training at Goddard, in conferences and at workshops. These cases about project experiences will also be used externally in academic settings where appropriate. The course will become an integral component of many of the leadership training programs in existence across the center but will provide a common, consistent exposure to how the Center functions and conducts its business.

PRACTICE 6: Goddard Design Rules[16]

The practice that enables project management guidance at the center level will be the Goddard Design Rules (GDR) owned by the Office of Mission Success. The Goddard Design Rules (also referred to as the GOLD Rules) are formulated from the best rules and practices of the different engineering divisions at the Center. These rules are mandatory for all projects. A waiver process exists for projects that are operating outside the intended scope of the rules or otherwise need relief from compliance. The rules are updated through a rule change process. The learning practices at Goddard and especially the Review Processes inform the rules change process on at least an annual basis.

In addition to Design Rules, the practices for managing flight projects (not a document at this time) will be informed through the sharing of wisdom in workshops, through cases and in training opportunities. The rules and practices we use will continually be informed by the wisdom and knowledge we learn in the course of carrying out our work. To keep the context current, all rules are linked to the cases, lessons learned or mishap reports they originated from.

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[14] See NASA Lessons Learned at http://llis.nasa.gov

[15] A brochure describing the Road to Mission Success workshop series is available on the Office of Mission Success website at http://missionsuccess.gsfc.nasa.gov

[16] GSFC Design Rules and Processes are Documented on the Office of Mission Success website at http://missionsuccess.gsfc.nasa.gov

Learning Organization Outcomes

OUTCOME 1: Communities of Practice

Communities of practice are spontaneous, interactive support groups that form across organizational boundaries and often outside traditional or formal channels of communication in order to address common concerns and challenges. They might be related to career worklife, competitive marketplace dynamics, technology, professional development, innovation and experiment or a host of other organization topics. Smart organizations provide tools as needed for these groups to form, operate and sustain themselves toward meaningful ends. Communities of practice are not a tool that can be wielded at will by management. Rather they are the outcome of a culture that desires to solve or mitigate problems together rather than individually. They appear when people feel free and motivated to cross organizational boundaries to find solutions. They flourish when they become meaningful ways people grow, achieve goals and find collaboration rewarding. Measuring how many and how productive these groups are at Goddard will be a valuable metric of culture change.

Part of the implementation plan will be to assure that the Center is doing all it can to facilitate the effective formation and operation of numerous communities of practice. CoPs need primarily time and permission to function with some simple support tools for collaboration, private workspace and communications. The Agency tool, PBMA[17] functions as a facilitating tool to enable CoPs to operate easily at Goddard. When they do function well, they need recognition for their effective collaboration and their accomplishments and a light touch from management.

OUTCOME 2: Sharing Behavior[18]

Sharing behavior is also an outcome of providing the means for people at Goddard to share, collaborate and take pride in collective results. Though it may be thought of as an antecedent to good knowledge management, like communities of practice, demanding it can be counter-productive. Sharing behavior is something people do when the circumstances warrant it. The goal of the organization with respect to knowledge management and learning organization is to create those circumstances where sharing behavior is the preferred response by members. This means in addition to the pillars and practices outlined here, obstacles to sharing behavior must also be addressed. Measuring sharing behavior will be an important metric as to whether there has been significant change and whether the plan is working.

Sharing behavior is an organization attribute that attracts bright people. Intellectually curious people often know that they have the best chance of being stimulated, creating new knowledge or participating in exciting discoveries where a team or community of like-minded thinkers are engaged in open and honest sharing of their ideas, insights and experiments. Goddard wants to continue to attract these people in line with the Human Capital Plan to sustain and build on the competencies that have characterized the Goddard Spaced Flight Center for fifty years.

[17] PBMA, Process Based Mission Assurance is a fully deployed and capable tool that allows for controlled groups across NASA. It is currently in widespread use and available to all of NASA at no cost. http://pbma.nasa.gov
[18] Refer to ONE NASA website for reference to collaboration outcomes desired at: http://www.onenasa.nasa.gov/OneHome.htm

Implementation Plan Matrix

Table 1 is a matrix of the three goals and the eight elements of the Architecture. (The outcomes are not listed because they relate to all the actions, not specific ones). The cells list the tactical actions related to each of the goals that are underway or planned.

TABLE 1: MATRIX OF GOALS, PRACTICES AND TACTICS

GOALS ***Pillars/Practices***	***GOAL 1: Manage Knowledge Assets***	***GOAL 2: Facilitate Knowledge Application***	***GOAL 3: Build the Learning Organization***
PILLAR 1: Center Global Search Capability	Adopt common meta-data tags across the Center.	Provide desktop global search to all employees.	Index all Goddard knowledge respecting ownership rights.
PILLAR 2: Center Digital Document Repository Standards	Build a digital archive system. Build a Center Doc. Mgmt. System.	Develop semantic search indices across the Center	Projects develop document repositories based on Center standards.
PRACTICE 1: Pause for Learning	Provide facilitators to conduct PALs through-out project life-cycle.	Develop PAL GUI system to represent project knowledge as lessons learned.	Use PAL as a leader development tool for communication and dialogue.
PRACTICE 2: Knowledge Sharing Workshops	Experienced project managers share their stories orally with emerging leaders.	Make workshops so valuable that emerging leaders will not want to miss the learning available.	Modeling by leaders of the acceptability of sharing mistakes and missteps of project management.
PRACTICE 3: Case Studies	Writing down the events, history and circumstances of a project life story.	Getting project mgrs to talk about their project experiences in training exercises.	Making sure all of GSFC is familiar with the learnings from our history.
PRACTICE 4: Project Management Training	Making stories into teaching cases. Collecting critical project documents to support the cases.	Develop and conduct a training course on the way Goddard does business based on case studies	Encourage the telling of stories at all levels (seminars, reviews, workshops, and training opptys)
PRACTICE 5: Goddard Design Rules	Establishing Design Rules for Goddard to make top level rules & procedures highly visible.	Moving LL and Best Practices into a process for updating rules and procedures.	Setting up an Office of Mission Success to monitor learning activities and knowledge mgmt.
PRACTICE 6: Review Processes and Common Lessons Learned	Capturing nuggets and lessons from incidents, accidents and reviews.	Mining records for insights, trends and rules. Making LL convenient to use.	Specifying use of LL in 7120.5 and related documents. Reporting CLL annually.

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