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AUDIT REPORT

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REVIEW OF NASA'S LESSONS LEARNED INFORMATION SYSTEM

OFFICE OF INSPECTOR GENERAL

National Aeronautics and
Space Administration

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Acronyms

APPEL	Academy of Program/Project and Engineering Leadership
FY	Fiscal Year
GAO	Government Accountability Office
JPL	Jet Propulsion Laboratory
LLIS	Lessons Learned Information System
NEN	NASA Engineering Network
NPR	NASA Procedural Requirements

OVERVIEW

REVIEW OF NASA'S LESSONS LEARNED INFORMATION SYSTEM

The Issue

Successful organizations develop systems to share information from past successes and failures as part of their knowledge management practices. NASA defines these "lessons learned" as knowledge or understanding gained by experience. This experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Sharing lessons learned can reduce risk, improve efficiency, promote validated processes, and improve performance in ongoing and future NASA projects.

Since 1994, NASA's principal mechanism for collecting and sharing lessons learned from Agency programs and projects has been an online, automated database called the Lessons Learned Information System (LLIS).[1] The information in LLIS is drawn from individuals, directorates, programs, projects, and any supporting organizations and personnel across NASA, including engineering, technical, science, operations, administrative, procurement, management, safety, maintenance, training, flight and ground-based systems, facilities, medical, and other activities. LLIS is one component of NASA's larger knowledge management and sharing system, which includes the online NASA Engineering Network (NEN), NASA's Academy of Program/Project and Engineering Leadership (APPEL) training, *ASK Magazine*, the Masters Forum, and the annual Project Management Challenge seminar.[2]

NASA's policy on lessons learned requires the collection, validation, assessment, and codification of lessons learned submitted by individuals, NASA directorates, programs

[1] The public can access LLIS at http://llis.nasa.gov/llis/search/home.jsp (accessed March 5, 2012).

[2] NASA launched the NEN website (https://nen.nasa.gov/web/nen/home) in 2005 to bring together the Agency's knowledge management and sharing system components, including LLIS. NEN provides NASA personnel a portal to access, create, and share lessons learned; interact with subject-matter experts and practitioners; search many NASA repositories of interest; and find tools and information resources. NEN's suite of information retrieval and knowledge sharing tools has the capability of searching for lessons learned across the Agency's multiple repositories, including LLIS. APPEL provides training to meet the learning and development objectives of the NASA program and project management and engineering communities. *ASK Magazine* is designed for program/project managers and engineers to share expertise and lessons learned with fellow practitioners. In the Masters Forum, participants share best practices and lessons learned with NASA employees and contractors. The Project Management Challenge seminar is an annual conference that examines current management trends and provides a forum for sharing lessons learned. In February 2012, the Office of the Chief Engineer announced that the Project Management Challenge conference would be discontinued in favor of other options, such as virtual seminars.

and projects, and any supporting organizations and personnel.[3] To this end, LLIS is designed to be searchable and available across the Agency to the broadest extent possible. The usefulness and value of LLIS is contingent on managers and engineers routinely consulting and submitting information to the system.

The Office of the Chief Engineer has primary responsibility for oversight of NASA's knowledge management and sharing system, including LLIS. A 2002 Government Accountability Office (GAO) report identified weaknesses in NASA's lessons learned and knowledge management processes.[4] Specifically, GAO found that NASA did not routinely identify, collect, or share lessons learned by its program and project managers. GAO also concluded that NASA lacked strong management commitment to knowledge sharing and needed a well-defined business plan for implementing a knowledge management and sharing system that encourages and facilitates easier access to information. The report contained seven recommendations, including a suggestion to enhance LLIS and develop a knowledge management plan to articulate the relationship between lessons learned and the Agency's overall knowledge management plan. NASA concurred with the recommendations and subsequently enhanced LLIS to accept submissions in multiple formats and improved the ability to search the system through the NEN website. However, NASA has yet to formalize a comprehensive knowledge management plan that articulates the role LLIS should play in the Agency's plan for knowledge management.

The NASA Office of Inspector General initiated this audit to examine the extent to which Agency managers use LLIS and how the system fits within NASA's overall knowledge management strategy. Details of our audit's scope and methodology are in Appendix A.

Results

NASA's project managers do not routinely use LLIS to search for lessons identified by other projects or routinely contribute new information to LLIS. We found NASA's policies regarding the input of lessons learned into LLIS have weakened over time; inconsistent policy direction and implementation for the Agency's overall lessons learned program; disparate levels of funding for LLIS activities across NASA Centers; and deficient monitoring of critical Center-based LLIS activities. In addition, we found the Chief Engineer's overall strategy for knowledge management, lessons learned, and LLIS is not well defined. Consequently, LLIS has been marginalized in favor of other NASA knowledge sharing system components and is of diminishing and questionable value.

[3] NASA Procedural Requirements (NPR) 7120.6, "Lessons Learned Process," March 22, 2005.

[4] GAO, "NASA: Better Mechanisms Needed for Sharing Lessons Learned" (GAO-02-195, January 30, 2002).

Managers Are Not Using LLIS

We found that NASA program and project managers rarely consult or contribute to LLIS even though they are directed to by NASA requirements and guidance. In fact, input to LLIS by most Centers has been minimal for several years. Specifically, other than the Jet Propulsion Laboratory (JPL), no NASA Center consistently contributed information to LLIS for the 6-year period from 2005 through 2010. For example, the Glenn Research Center and the Johnson Space Center contributed an average of one lesson per year compared to the nearly 12 per year contributed by JPL (see Table 1, page 9).

We surveyed project managers for 28 of NASA's 32 science and space flight projects launched between January 2005 and May 2011 to examine the extent to which they used and contributed to LLIS.[5] We found that these managers did not consistently search LLIS for lessons identified by other programs and projects that could potentially reduce risk to their projects. Specifically, only 16 of the 28 (57 percent) project managers indicated that they used LLIS during the project acquisition life cycle, with the extent of usage varying widely by project. We also found that the project managers did not routinely contribute to LLIS, with only 12 of the 28 project managers (43 percent) contributing lessons learned from their projects to LLIS.

The project managers we surveyed offered a variety of reasons for not using or contributing to LLIS, including their belief that LLIS is outdated, is not user friendly, and does not contain information relevant to their projects. They also cited competing demands on their time in managing their respective projects. Taken together, the lack of consistent input and usage has led to the marginalization of LLIS as a useful tool for project managers.

Policy Requirements Weakened Over Time. Over time NASA has relaxed its internal requirements regarding the level and timing of project managers' use of and contributions to LLIS. For example, program and project management policies issued in 2002 and 2005 required managers to provide lessons learned for input to LLIS "throughout the project lifecycle, for example, at major milestones."[6] In contrast, NASA's current policy, in effect since 2007, does not explicitly require the use of LLIS and does not require project managers to identify or archive lessons learned until project conclusion or closeout.[7]

Inconsistent Policy Direction and Implementation. NASA published NASA Procedural Requirements (NPR) 7120.6, "Lessons Learned Process," in 2005 to facilitate the capture of knowledge from individuals, projects, and programs. The NPR directs the

[5] The other four projects were excluded because the project manager was not available, they were demonstration projects, or another agency was responsible for the project's development.

[6] NPR 7120.5B, "NASA Program and Project Management Processes and Requirements," November 21, 2002. NPR 7120.5C, "NASA Program and Project Management Processes and Requirements," March 22, 2005.

[7] NPR 7120.5D, "NASA Space Flight Program and Project Management Requirements," March 6, 2007.

establishment of Center-level Lessons Learned Committees and describes the multiple-step process of inputting information to LLIS that involves project, Center, and Headquarters personnel. However, we found inconsistent implementation of these requirements across the Centers. For example, our survey of the lessons learned representatives at each NASA Center found that 8 of 10 Centers had not fully complied with the policy requirements when implementing their lessons learned processes and 4 Centers did not even have a Center-level Lessons Learned Committee. Further, we found that 6 of 10 Centers did not cross-reference lessons learned to their management or engineering standards, thereby further limiting the effectiveness of lessons learned for the Centers' programs and projects.

In addition to the formal guidance provided in the NPR, the Chief Engineer and Chief of Safety and Mission Assurance issued a letter in February 2009 encouraging active participation by NASA senior leaders in institutionalizing and sharing lessons learned across the Agency (see Appendix B). In contrast to the formal policy, the letter encouraged NASA leaders to convene workshops to discuss and capture lessons learned immediately after completing individual elements of a project's work while memories were fresh, rather than waiting until the end of the project's mission. However, according to the Chief Engineer the letter did not result in a measureable improvement of the Centers' use of the LLIS process to institutionalize lessons learned.

Disparate Funding Support. We found disparate funding levels for LLIS activities at the Centers. The Chief Engineer provides most of the funding to support each Center's lessons learned process.[8] Total LLIS funding for fiscal year (FY) 2011 across NASA was $782,000, with funding at the Centers ranging from a low of $21,785 at the Ames Research Center to a high of $305,095 at the Kennedy Space Center. At 8 of the 10 Centers, funding is only a fraction of the amount needed to support one full-time employee. However, we found little evidence of correlation between funding levels and the number of lessons learned that Centers contributed to LLIS. For example, JPL received $70,000 between FYs 2008 and 2010, while Glenn received approximately $470,000. Nevertheless, over those 3 years, JPL contributed 35 lessons learned to Glenn's 5.[9]

Lack of Monitoring. Since the issuance of NPR 7120.6 in March 2005, the Chief Engineer has completed an Agency-wide assessment of the lessons learned process just once, in 2010. We found that assessment to be inadequate because it did not review and evaluate whether the Center-level Lessons Learned Committees administered and oversaw the lessons learned process or whether the Committees promoted use of lessons learned throughout a project's life cycle.

[8] Only the Dryden Flight Research Center and JPL provided supplemental funding to support their LLIS process.

[9] The Chief Engineer's Advanced Planning and Analysis Division Manager stated that the funds provided to Kennedy also support lessons learned managerial functions at Headquarters and funding to Glenn supports Agency-wide knowledge sharing activities in addition to the Center Manager function.

NASA Lacks a Comprehensive Strategy for Knowledge Management

As noted above, LLIS is one component of NASA's knowledge management strategy. However, we found that NASA's strategy and plans for lessons learned and LLIS are not well defined. The Chief Engineer acknowledged that the lessons learned process and LLIS have not received the attention needed to enable them to function as originally designed and that his efforts to energize the NASA workforce in this effort, including the joint letter in 2009 and the 2010 assessment, have resulted in little measureable improvement in Centers' use of the process or system. Finally, although he indicated that the NEN website will be a key element of any future strategic knowledge management plan, he conceded that how LLIS will fit into this future strategy has not been determined.

Conclusion

LLIS is underutilized and has been marginalized in favor of other NASA knowledge management tools such as *Ask Magazine* and the annual Project Management Challenge seminar. Users told us they found LLIS outdated, not user friendly, and generally unhelpful, and the Chief Engineer acknowledged that the system is not operating as originally designed. Although we believe that capturing and making available lessons learned is an important component of any knowledge management system, we found that, as currently structured, LLIS is not an effective tool for doing so. Accordingly, we question whether the three quarters of a million dollars NASA spends annually on LLIS activities constitutes a prudent investment.

Management Action

We recommended that the Chief Engineer develop and implement a cohesive strategic plan for knowledge management and sharing, particularly with respect to lessons learned. As part of this plan, we recommended that he determine if or how LLIS fits into this plan and revise the applicable Agency policies accordingly, including:

- NPR 7120.5D – To establish program/project management requirements that align with NASA's strategic vision for institutional knowledge management and sharing.

- NPR 7120.6 – To align Center and program/project management practices and improve the collection and dissemination of lessons learned Agency-wide by establishing requirements that can be supported by available resources.

In response to a draft of this report, the Chief Engineer concurred with our recommendations and stated that his office, in accordance with a recommendation from NASA's Aerospace Safety Advisory Panel, will assign an Agency Chief Knowledge Officer to develop and implement a strategic plan for knowledge management, including

LLIS.[10] The Chief Engineer also noted that LLIS is but one tool that NASA uses to capture knowledge and that he considers it a worthwhile investment. Finally, he stated that his office will consider what changes are needed to NPR 7120.6 and incorporate any changes in other engineering and program and project management requirements documents.

We find the Chief Engineer's proposed actions responsive to the intent of our recommendations and therefore will close the recommendations upon completion and verification of the proposed actions. However, because we continue to question the viability of LLIS in its current configuration, we urge the Chief Engineer to further consider LLIS's role in NASA's larger knowledge management system as part of the implementation of his proposed corrective actions. Management's comments are reprinted in Appendix C.

[10] NASA established the Aerospace Safety Advisory Panel in 1968 to evaluate safety performance and advise the Agency on ways to improve that performance.

CONTENTS

INTRODUCTION

Background

NASA describes knowledge management as "the methods an organization uses to retain and pass along the knowledge produced by its workers, including libraries, archives, in-house magazines, and mentoring." Effective knowledge management activities foster an environment in which the right information gets to the right people at the right time in ways that measurably improve performance.

Over the years, NASA has identified three primary goals for its knowledge management systems and processes:

1. Sustain NASA's knowledge across missions and generations;
2. Help people find, organize, and share NASA's existing knowledge; and
3. Increase collaboration and facilitate knowledge creation and sharing of lessons learned.

Lessons learned preserve institutional knowledge and communicate experiences that can potentially reduce risk and improve efficiency and performance. NASA defines a lesson learned as knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. These lessons may come from a variety of mission areas, including engineering, technical, science, operations, procurement, management, safety, and ground-based systems. The collection and dissemination of lessons learned is intended to contribute to the continuous improvement of program/project management and engineering, as well as to the prevention or reoccurrence of known problems.[11]

NASA policy requires that lessons learned be assessable and searchable across the Agency to the broadest extent possible.[12] To that end, NASA requires the capturing of lessons learned, establishment of Lessons Learned Committees at the Center level, and infusion of lessons learned into Headquarters and Center documentation and training so managers are better able to make informed decisions, avoid repeating costly mistakes, and successfully repeat positive achievements.

Historically, NASA's principal mechanism for collecting and sharing lessons learned from programs, projects, and missions Agency-wide has been the Lessons Learned

[11] NASA Policy Directive 7120.4D, "NASA Engineering and Program/Project Management," March 16, 2010.

[12] NASA Procedural Requirements (NPR) 7120.6, "Lessons Learned Process," March 22, 2005.

Information System (LLIS). First established as a paper-based system in 1992 and operating as an automated web-based system since 1994, LLIS is intended to facilitate the capture and sharing of lessons learned across all NASA Centers.[13] The primary purpose of LLIS is to provide a searchable repository of information that allows NASA managers to learn from past activities. LLIS is part of NASA's wider knowledge management and sharing system, which includes:

- The NASA Engineering Network (NEN), a website launched in 2005 to bring together the Agency's knowledge management and sharing system components (https://nen.nasa.gov/web/nen/home). NEN provides NASA personnel the capability to access, create, and share lessons learned; interact with subject matter experts and practitioners; search many NASA repositories of interest; and find tools and information resources. NEN's suite of information retrieval and knowledge sharing tools has the capability of searching for lessons learned across the Agency's multiple repositories, including LLIS.

- The Academy of Program/Project and Engineering Leadership (APPEL), provides training to meet the learning and development objectives of the NASA program and project management and engineering communities.

- *ASK Magazine*, designed for program and project managers and engineers to share expertise and lessons learned with fellow practitioners. Published four times yearly, the magazine includes articles about meeting the technical and managerial demands of complex projects, as well as insights into organizational knowledge, learning, collaboration, performance measurement and evaluation, and scheduling.

- The Masters Forum, a program designed to share best practices and lessons learned. The forums are interactive 3-day events where project managers and engineers learn from fellow practitioners who are invited to share their experiences on high-profile projects, including the Space Shuttle, International Space Station, and Constellation programs.

- The Project Management Challenge seminar, designed to examine current management trends and provide a forum for knowledge sharing and exchanging lessons learned on project management issues. Approximately 20 percent of NASA managers attend the annual Project Management Challenge seminar.[14]

[13] The public can access LLIS at http://llis.nasa.gov/llis/search/home.jsp (accessed March 5, 2012).

[14] In February 2012, the Office of the Chief Engineer announced that the seminar would be discontinued.

Development of NASA's Lessons Learned Policy

In December 2000, the Chief Engineer issued a report identifying the need to improve communication across the Agency, including improving knowledge management practices.[15] The report noted several initiatives underway to improve the sharing of knowledge but emphasized that more needed to be done to promote the continuous capture, dissemination, and use of Agency knowledge. The report stated that the primary mechanism for promoting knowledge management should be an improved lessons learned tool.

The following year, the Government Accountability Office (GAO) surveyed all NASA program and project managers and found fundamental weaknesses in the collection and sharing of lessons learned Agency-wide.[16] Specifically, GAO found that lessons learned were not routinely identified, collected, or shared by program and project managers. In addition, many respondents indicated that they were dissatisfied with NASA's lessons learned processes and LLIS. A 2002 GAO report made a number of recommendations to strengthen the Agency's lessons learned processes and systems, including enhancing LLIS, implementing a plan that articulates the relationship between lessons learned and NASA's overall knowledge management objectives, and designating an Agency-wide lessons learned manager.[17]

In response to the GAO report, NASA chartered a NASA Knowledge Management Team, consisting of 38 employees from Headquarters and the Centers, to review NASA's knowledge management activities. One of the early pilots implemented under the Team was a redesign of LLIS to better infuse lessons learned into day-to-day project activities. Moreover, in April 2002, the Team issued in draft a "Strategic Plan for Knowledge Management," which addressed GAO's recommendations to strengthen the Agency's lessons learned processes and systems. The Team's plan stated that knowledge management applications are the key to helping bring the right information to the right people at the right time. The focus of the redesign was an attempt to deliver key information to project members at the time they are making a critical decision. However, this draft strategic plan was not finalized or published.

Current Lessons Learned Policy

In March 2005, NASA Procedural Requirements (NPR) 7120.6 established the requirements for the collection, validation, assessment, and codification of lessons learned submitted by individuals, NASA Mission Directorates, programs and projects,

[15] NASA, "Enhancing Mission Success – A Framework for the Future," December 21, 2000, http://history.nasa.gov/niat.pdf (accessed March 5, 2012).

[16] GAO, "Survey of NASA's Lessons Learned Process" (GAO-01-1015R, September 5, 2001). Available at http://www.gao.gov/new.items/d011015r.pdf (accessed March 5, 2012).

[17] GAO, "NASA: Better Mechanisms Needed for Sharing Lessons Learned" (GAO-02-195, January 30, 2002). Available at http://www.gao.gov/new.items/d02195.pdf (accessed March 5, 2012).

and any supporting organizations and personnel. The NPR assigns to the Office of the Chief Engineer primary oversight of the NASA lessons learned process, to include developing and maintaining LLIS. In addition, the NPR requires the establishment of Lessons Learned Committees at both the Headquarters and Center level, a Curator who uploads approved lessons learned to LLIS, and "closed-loop infusion of lessons learned recommendations into Center and HQ [Headquarters] documentation and training."

The Center-level Lessons Learned Committees are headed by Center Data Managers (Center Managers) and are expected to administer the lessons learned process at each Center as well as support the Headquarters-level Lessons Learned Steering Committee. The Center-level Committees are the primary mechanism for collecting, assessing, validating, and documenting lessons learned into Center-level documentation and training. The Committees are responsible for maintaining the Center-specific lessons learned process; administering and overseeing the process of transforming a lesson into a complete formatted lesson for Headquarters review and input to LLIS; coordinating the transfer of lessons learned into the Center's corrective action system; and promoting the use of lessons learned during the life cycle of program or projects at their Centers.

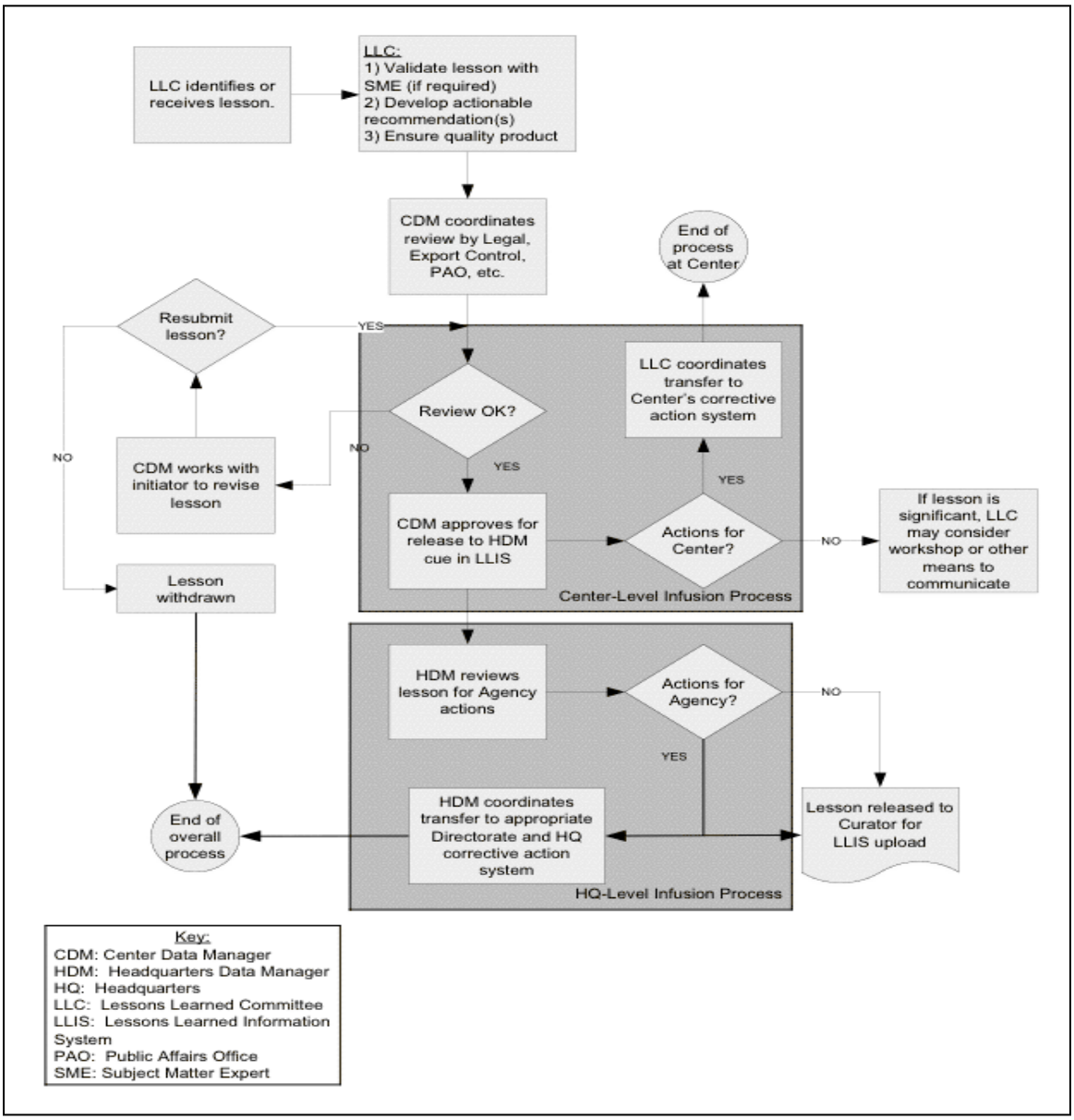
The Center-level Committees either identify lessons learned on their own or receive them from a submitter or from the NEN website. The Committees validate the lesson with a subject matter expert if required, develop a recommendation, and refine the knowledge captured into a lesson for Headquarters review. Prior to submitting the lesson to Headquarters, Center Managers coordinate export control, patent, legal, and public affairs clearance of the information.

The Headquarters-level Steering Committee is chaired by the Headquarters Data Manager (HQ Manager) and is composed of a group of Headquarters and Center representatives, including the Center Managers, who provide guidance and develop policies related to sharing and using NASA's lessons learned. The Steering Committee is expected to facilitate sharing of lessons learned activities across Centers. The HQ Manager reviews lessons learned submitted by Center Managers and Headquarters personnel and is responsible for processing lessons learned submitted by the Centers; coordinating the transfer of the lessons learned recommendations requiring Headquarters action to the Headquarters corrective action system; coordinating trend analysis of lessons learned; and maintaining lessons learned process metrics.

The Curator uploads lessons approved by the HQ Manager to LLIS. In addition, the Curator is responsible for ensuring LLIS is maintained in accordance with Federal records and Agency policy; providing usage metrics information to the Center-level Committees and the Steering Committee; providing helpdesk functions for the LLIS website; and providing a final quality assurance function on lessons released by the HQ Manager.

The figure below illustrates how information flows into LLIS at NASA.

Lessons Learned Input Process



Source: NPR 7120.6.

Additional Policies Governing Lessons Learned

NASA Policy Directive 7120.4D, "NASA Engineering and Program/Project Management Policy," March 16, 2010, states that it is NASA's policy to collect, validate, and disseminate lessons to improve outcomes and prevent recurrence of known problems. It also states that lessons learned will be incorporated into Agency directives, standards, and

rules. Furthermore, it makes the Chief Engineer responsible for facilitating, promoting, and implementing the use of lessons learned and charges program and project managers with collecting, documenting, and submitting lessons learned in accordance with NPR 7120.6.

NPR 7120.5D, "NASA Space Flight Program and Project Management Requirements," March 6, 2007, requires program and project managers to document how they will conduct operations using lessons learned and how they plan to capture lessons learned in accordance with NPR 7120.6.[18] The policy also states that the project manager and project team shall complete their analysis and archiving of lessons learned at the end of each project's mission. However, the NPR contains no description of how managers are to implement the lessons learned process.

NPR 7123.1A, "NASA Systems Engineering Processes and Requirements," March 26, 2007, established Agency-wide requirements for performing, supporting, and evaluating systems engineering. The processes described in this document were to build upon and apply best practices and lessons learned from NASA, other Government agencies, and industry. However, the NPR does not provide instructions regarding how to disposition lessons learned and contains no reference to LLIS and the process described in NPR 7120.6.

In February 2009, the Chief Engineer and the Chief of Safety and Mission Assurance issued a letter to all Centers and Mission Directorates describing LLIS enhancements and requesting active participation by NASA's workforce to institutionalize lessons learned and share them across the Agency (see Appendix B). This informal policy guidance stated that at the conclusion of every significant development, when projects, instruments, subsystems, and other elements are completed, team leadership should convene a workshop to reflect on and capture lessons learned. The guidance further states that the effort to capture lessons learned should not wait until after a launch or closeout, but rather should take place immediately after a team has finished its major effort while memories are still fresh.

Observations and Recommendations of the Aerospace Safety Advisory Panel

The Aerospace Safety Advisory Panel, established in 1968 to evaluate NASA's safety performance and advise the Agency on ways to improve that performance, has consistently emphasized the importance of knowledge sharing and capturing lessons learned. In its two most recent annual reports, the Panel highlighted the value of quickly capturing lessons learned in a format that is easily accessible, enables storage for

[18] NASA Memorandum 7120-81, "NASA Space Flight Program and Project Management Requirements," was issued on September 22, 2009, as an interim directive while NPR 7120.5D was being revised. Requirements of NPR 7120.5D discussed in this report were retained in the interim directive.

long-term retrievability, and is searchable by personnel inside and outside the Agency.[19] It also pointed out that while individual Center and programmatic efforts were excellent, more needed to be done to establish an Agency-wide process or tool to enable easy access to information resources. Consequently, in its Annual Report for 2010, the Panel recommended that NASA capture and document the lessons learned from the Constellation Program.[20] In response, NASA documented those lessons learned in a two-volume submission to LLIS. Furthermore, in its Annual Report for 2011, issued on January 25, 2012, the Panel recommended that NASA establish a Chief Knowledge Officer to integrate the capturing of lessons learned Agency-wide and consider creating Chief Knowledge Officer positions at the Centers and within the Mission Directorates. NASA is in the process of developing a course of action to address these recommendations.

Objectives

The objective of our audit was to examine NASA's use of LLIS and how the system fits within NASA's overall knowledge management strategy. We also reviewed internal controls related to the objective. See Appendix A for details of the audit's scope and methodology, our review of internal controls, and a list of prior coverage.

[19] The Aerospace Safety Advisory Panel annual reports can be found at http://oiir.hq.nasa.gov/asap/ (accessed March 5, 2012).

[20] The Constellation Program was to develop the transportation and infrastructure necessary to enable a sustained and affordable human program to explore the Moon in preparation for further deep space exploration missions. The Program was canceled in February 2010.

THE LESSONS LEARNED INFORMATION SYSTEM IS UNDERUTILIZED

We found that NASA project managers do not routinely use LLIS to search for lessons identified by other programs and projects or contribute information to LLIS. Project managers we surveyed said the system is not user friendly and that the information it contains is outdated and generally unhelpful. We also found that Agency policy requirements regarding when and how to input information into LLIS have been relaxed over time, policy direction has been inconsistent, LLIS-related funding was disparate across the Centers, and monitoring of the essential Center-level LLIS process was lacking. In addition, we found that the Chief Engineer's strategy for knowledge management, lessons learned, and LLIS is not well defined and that his goal for LLIS was not well understood across the Centers and Mission Directorates. Consequently, LLIS has been marginalized in favor of other knowledge sharing initiatives.

Managers Are Not Consistently Using or Contributing to LLIS

We found that NASA program and project managers did not use or contribute to LLIS in accordance with established requirements and guidance. In fact, LLIS input by most Centers has been minimal for the past several years. Specifically, from 2005 through 2010 only JPL consistently contributed information to LLIS (see Table 1).

Table 1. LLIS Input (by Facility and Year)							
Facility	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**Total**
ARC	0	0	0	3	0	34	**37**
DFRC	0	0	0	0	1	20	**21**
GRC	0	2	3	0	1	0	**6**
GSFC	0	1	1	0	0	5	**7**
HQ	0	1	1	2	0	0	**4**
JPL	10	15	10	12	10	14	**71**
JSC	0	1	0	0	5	0	**6**
KSC	80[a]	2	1	1	0	1	**85**
LaRC	0	1	0	0	2	8	**11**
MSFC	3	0	4	3	1	4	**15**
SSC	1	0	0	0	0	1	**2**
Total	**94**	**23**	**20**	**21**	**20**	**87**	**265**

[a] 78 of the 80 lessons learned submitted by Kennedy in 2010 related to the Space Shuttle Program.

ARC: Ames Research Center
DFRC: Dryden Flight Research Center
GRC: Glenn Research Center
GSFC: Goddard Space Flight Center
HQ: NASA Headquarters
JPL: Jet Propulsion Laboratory
JSC: Johnson Space Center
KSC: Kennedy Space Center
LaRC: Langley Research Center
MSFC: Marshall Space Flight Center
SCC: Stennis Space Center

We surveyed 28 managers of space and science projects launched between January 2005 and May 2011 to determine the extent to which they used LLIS. We found that many of these managers did not routinely search LLIS for lessons that could potentially reduce or limit risk to their projects. We also found that many managers did not contribute information to the system.

Contributions to LLIS. The managers we spoke with provided a variety of reasons for not contributing information to LLIS.

- "The lessons learned during the development and launch . . . were applied to the next satellite in the series, which is how the project routinely operated. Since these were specific items that only applied to . . . satellites developed by the project and would not be useful for any other project, they were not entered into LLIS."

- "We did not contribute lessons learned to LLIS during the project life cycle, primarily because we delivered unique one-of-a-kind technology and components

> for the . . . missions. Rather, the process and maturation efforts for the delivered hardware were documented in publications and technical reports available from the NASA Scientific and Technical Information System."

- "Not to the LLIS, but [we] did through participation on the PM [Project Management] Challenge, multiple Road to Mission Success presentations, and the . . . Masters Forum. The main reason for not entering data directly into the NASA system is that it is just not an effective tool."

In addition, managers were generally unaware of NASA's policy requirements for contributing to LLIS. Of the 28 project managers we surveyed, only 10 were familiar with the requirement in NPR 7120.5D to contribute lessons to LLIS.[21] Moreover, of these 10, some said they simply had not complied with the policy.

The project managers provided varying reasons for their noncompliance with NASA's lessons learned policy, including

- no explicit statement in NPR 7120.5D requiring them to capture lessons learned by inputting information into LLIS;
- NPR 7120.5D requires periodic reviews and additional scrutiny from various external review boards that meet the intent of the lessons learned policy;
- inadequate resources necessary to implement the requirements; and
- lessons learned reporting is a low priority, time-consuming process.

One project manager offered the following observation about the roles and responsibilities of project managers in regard to contributing information to LLIS:

> No, it was not clear what the Project's specific obligations were beyond ensuring the previous lessons learned were taken into account and the general obligation to capture them in some way at completion. The primary reason that lessons learned are not formally well captured is that during the execution of a flight project, capturing and documenting lessons learned is essentially unfunded scope for an effort that is almost always cost- and schedule-challenged already. Once a mission is launched, it is quickly disbanded both for budgetary reasons, as well as to reassign critical human resources to ongoing Projects.

Use of LLIS. Twelve of the project managers we surveyed said they did not use LLIS as a project management tool at all. Of the 16 project managers who stated they had used LLIS, the extent of use varied widely by project. Moreover, these managers provided a range of opinions about the value of LLIS, with only 6 describing LLIS as useful. These 6 managers reported that they periodically searched LLIS for relevant lessons and

[21] The 11 JPL managers we surveyed were focused primarily on JPL's internal lessons learned process, which applies to all JPL projects.

incorporated lessons into their project management and engineering practices. The other 10 managers said LLIS did not contribute to their projects' success or provide any information that assisted in managing their projects.

Project managers provided a variety of reasons for not using LLIS, including a lack of clear policy criteria requiring they do so and their belief that the system is outdated, is not user friendly, and does not contain information relevant to their projects. Some managers said that most of the information in the system did not apply to their projects because their projects were unique or the information was drawn from projects "vastly different" from their own. Others reported they found it difficult to find information in the system relevant to the specific issues they faced. One project manager stated, "[We] didn't find anything useful, but we were able to say that we had checked this box."

Other Factors Contributing to the Marginalization of LLIS

Changes to NASA's program and project management policies over time, inconsistent policy direction relating to the capture of lessons learned, uneven funding, and a lack of monitoring and oversight have contributed to the underutilization and marginalization of LLIS. Specifically, the relevant policies have become less specific regarding LLIS over time; funding provided to most of the Centers by Headquarters for their lessons learned processes has been minimal; and the Center-based process for recommending and reviewing potential lessons learned has not been adequately monitored.

Historical Changes to Lessons Learned Requirements. Over time, NASA policy regarding when managers should capture and contribute lessons learned to LLIS has changed. Specifically, the program and project management policies issued in 2002 and 2005 required project managers to capture and contribute lessons learned to LLIS throughout a project's life cycle. However, the current policy only requires these actions at project closeout.

2002 Policy. NPR 7120.5B stated that "at each major milestone" program and project managers shall report the extent to which they applied lessons learned. It also stated that the managers shall contribute to the body of knowledge all significant lessons learned at the end of formulation and implementation and as deemed appropriate. The policy also required that program and project managers report the extent to which they contributed lessons learned. Moreover, each program and project manager was required to apply significant lessons learned from past experiences at the beginning and during the conduct of each subprocess.

2005 Policy. NPR 7120.5C also stated that the project manager shall provide the Office of the Chief Engineer with input to LLIS in the form of captured experiences and lessons learned by the project team "throughout the project lifecycle, for example, at major milestones." It also required that the program manager evaluate lessons learned

from existing and previously executed programs and projects to identify applicable lessons for use in program planning and execution.

Current Policy. In contrast to earlier policy requirements, NPR 7120.5D, issued March 6, 2007, provides no requirement that project managers use LLIS throughout a project's life cycle.[22] Instead, it states that the project manager and project team shall complete analysis and archiving of lessons learned "during project decommissioning, or closeout." Because most projects are executed over many years and may go through a number of management changes, this change diminishes the timeliness, usefulness, and number of documented lessons that are likely to be captured in LLIS. For example, if the original project manager failed to capture lessons learned from the project's formulation phase, it is unlikely that a new project manager at closeout will identify those lessons, much less be able to capture the information for submission to LLIS.

Inconsistent Policy Direction and Implementation. In contrast to the formal policy embodied in NPR 7120.5D, NASA's Chief Engineer has urged managers to document lessons learned throughout a project's life cycle. In his 2009 joint letter with the Chief of Safety and Mission Assurance (see Appendix B) he stated:

> At the conclusion of every significant development under your leadership – when projects, instruments, subsystems, elements completes its work – the team involved should convene a sharing workshop to reflect on and capture its lessons learned. This shouldn't wait until after launch or closeout; it should take place immediately after the team has finished its major effort, while teams are still assembled and while memories are still fresh.

However, the Chief Engineer acknowledged that this letter did not result in a measureable improvement of the Centers' use of the LLIS process to institutionalize lessons learned.

In addition, we also found that implementation of lessons learned process requirements across the Centers was inconsistent. We surveyed the lessons learned representatives at each NASA Center and found that only two, the Glenn Research Center and JPL, have fully complied with NASA policy in the implementation of their respective lessons learned processes. Specifically, when we examined the respective Centers' processes against the requirements of NPR 7120.6, we found significant deficiencies. Per the NPR, Center-level Committees are the primary mechanism for collecting, assessing, validating, and documenting lessons into Center-level documentation and training. However, we found that 5 of the 10 NASA Centers did not use a Center-level Committee to develop potential lessons learned for Headquarters review and input to LLIS; 5 of 10 Centers did not use a Center-level Committee to coordinate transfer of lessons to the their Center's corrective action system; 6 of 10 Centers did not use a Center-level Committee to promote the use of lessons learned throughout program and project life cycles; and 6 of 10 Centers did not cross-reference lessons to their engineering standards. Collectively,

[22] NASA Memorandum 7120-81, "NASA Space Flight Program and Project Management Requirements," was issued on September 22, 2009, as an interim directive while NPR 7120.5D was being revised. Requirements of NPR 7120.5D discussed in this report were retained in the interim directive.

these process deficiencies limit the potential for new lessons learned to improve current and future NASA programs and projects. Table 2 shows the process deficiencies by Center.

Table 2. NPR 7120.6 Process Deficiencies by Center

Center	Center Committee Does Not Administer and Oversee Lessons Learned Process	Center Committee Does Not Coordinate between LLIS and Center's Corrective Action System	Center Committee Does Not Promote Use of Lessons Learned throughout Project's Life Cycle	Lessons Learned and Engineering Standards Not Cross-Referenced
ARC				X
DFRC	X	X	X	X
GRC				
GSFC	X	X	X	
JPL				
JSC	X		X	
KSC				X
LaRC	X	X	X	X
MSFC		X	X	X
SSC	X	X	X	X

ARC: Ames Research Center
DFRC: Dryden Flight Research Center
GRC: Glenn Research Center
GSFC: Goddard Space Flight Center
JPL: Jet Propulsion Laboratory
JSC: Johnson Space Center
KSC: Kennedy Space Center
LaRC: Langley Research Center
MSFC: Marshall Space Flight Center
SSC: Stennis Space Center

Disparate Funding for LLIS Support. The Chief Engineer's Office provides most of the funding to support the LLIS process at each of the Centers.[23] Total LLIS funding for fiscal year (FY) 2011 was $782,000, with funding per Center ranging from $21,785 at the Ames Research Center to $305,095 at the Kennedy Space Center. However, we found little correlation between the funding levels and the number of lessons learned contributed to LLIS. For example, JPL received a total of $70,000 for FYs 2008 through 2010 while Glenn received approximately $470,000 for LLIS activities.[24] Over that 3-year period, JPL contributed 35 lessons learned compared to Glenn's 5 contributions. Table 3 shows the funding provided by Headquarters for the LLIS process at each NASA Center from FY 2006 through FY 2011.

[23] Only the Dryden Research Center and JPL provided supplemental funding to support their LLIS process.

[24] The Chief Engineer's Advanced Planning and Analysis Division Manager stated that the funds provided to Kennedy also support the HQ Manager function and funding to Glenn supports Agency-wide knowledge sharing activities in addition to the Center Manager function.

Table 3. LLIS Funding by Center						
Center	**FY 2011**	**FY 2010**	**FY 2009**	**FY 2008**	**FY 2007**	**FY 2006**
ARC	$ 21,785	$ 38,622	$ 28,066	$ 48,693	$ 54,854	$ 67,153
GRC	169,493	184,673	156,036	129,510	24,546	24,077
LaRC	38,780	15,952	34,818	36,342	27,747	23,194
DFRC	63,000	56,861	24,932	2,550	4,682	15,720
GSFC	42,331	52,453	18,372	3,784	57,405	357,564
JPL	34,000	30,000	20,000	20,000	35,000	35,000
MSFC	34,000	34,000	14,588	3,631	46,854	24,563
SSC	23,000	16,726	18,731	49,699	38,076	48,306
JSC	50,516	51,858	51,596	48,843	39,904	1,879
KSC	305,095	210,349	143,944	145,534	217,000	39,027
Total	**$782,000**	**$691,494**	**$511,083**	**$488,586**	**$546,068**	**$636,483**

ARC: Ames Research Center
DFRC: Dryden Flight Research Center
GRC: Glenn Research Center
GSFC: Goddard Space Flight Center
JPL: Jet Propulsion Laboratory
JSC: Johnson Space Center
KSC: Kennedy Space Center
LaRC: Langley Research Center
MSFC: Marshall Space Flight Center
SSC: Stennis Space Center

Lack of Monitoring. The NASA lessons learned process implemented in March 2005 requires periodic reviews to assess compliance with NPR 7120.6. However, since 2005, the Chief Engineer has completed only one such Agency-wide assessment, in 2010, which we found inadequate. Specifically, the review failed to assess and evaluate all of the essential elements of the lessons learned process such as whether the Center-level Lessons Learned Committees administered and oversaw the lessons learned process and whether the Committees promoted use of lessons learned throughout project's life cycle (see Table 2 on page 13 for essential elements).

In our judgment, the inconsistent policy directives and the disparate amounts provided to the Centers to support the LLIS process, combined with the Centers' inconsistent implementation of policy requirements, has contributed to the reduced number of lessons learned added to LLIS, undercuts NASA's commitment to building a robust lessons learned system, and reduces the use and significance of LLIS in favor of other components of knowledge sharing, such as the annual Project Management Challenge seminar and *Ask Magazine*.

Lack of a Formal Strategy for Knowledge Management

NASA's overall strategy for knowledge management, lessons learned, and how LLIS fits in is not well defined. We asked the Chief Engineer about the Agency's 2002 draft

"Strategic Plan for Knowledge Management." He conceded that the draft plan was never formalized. He also acknowledged that the lessons learned process and LLIS have not received the attention needed to enable them to function as originally designed and that his efforts to energize the NASA workforce in this effort, including the joint letter in 2009 and the 2010 assessment, have resulted in little measureable improvement in the Centers' use of the process or system. Finally, although he indicated that the NEN website will be a key element of any future strategic knowledge management plan, he conceded that how LLIS will fit into this overall strategy has not been determined.

Conclusion

Following the failures of the Mars Climate Orbiter and Mars Polar Lander in the late 1990s, the Office of the Chief Engineer was tasked with developing a plan for implementing the resulting mishap investigation boards' recommendations. The Office's report, released in 2000, made the following observations relating to lessons learned.[25]

> The continuous capture and application of project knowledge and lessons learned must become a core business process within the Agency's program and project management environment. Regular input into NASA's knowledge bases, such as the lessons learned database, should be emphasized. Programs and projects should implement a "document-as-you-go" philosophy, promoting continuous knowledge capture for the benefit of current and future missions. More importantly, program and project managers must regularly utilize the knowledge management tools to apply previous lessons learned to their own projects. The Agency can provide help for individuals to understand, learn from, and apply the lessons of others to their own work as part of a daily routine.

As of January 2012, the Agency has not met those goals. In fact, NASA's Aerospace Safety Advisory Panel recently stated in its 2011 Annual Report that in spite of excellent examples of individual and specific programmatic efforts to facilitate knowledge sharing, these efforts do not ensure the identification and capture of critical knowledge or provide for an Agency-wide single process or tool for locating and accessing all information resources.

Specifically, we found that LLIS is underutilized and has been marginalized in favor of other knowledge management tools such as *Ask Magazine* and the annual Project Management Challenge seminar. Users told us they found LLIS outdated, not user friendly, and generally unhelpful, and the Chief Engineer acknowledged that the system is not operating as originally designed. Although we believe that capturing and making available lessons learned is an important component of any knowledge management system, we found that, as currently structured, LLIS is not an effective tool for doing so. Consequently, we question whether the three quarters of a million dollars NASA spends annually on LLIS activities constitutes a prudent investment.

[25] NASA, "Enhancing Mission Success – A Framework for the Future," December 21, 2000, http://history.nasa.gov/niat.pdf (accessed March 5, 2012).

Recommendations, Management's Response, and Evaluation of Management's Response

Given the importance of knowledge management and sharing and to align the mechanisms used to capture and share lessons learned with available resources, we made the following recommendations.

Recommendation 1. We recommended that the Chief Engineer develop and implement a comprehensive strategy for institutional knowledge management that includes collection and dissemination of lessons learned.

Management's Response. The Chief Engineer concurred, stating that in accordance with a recommendation from the Aerospace Safety Advisory Panel, a staff member from the Office of Chief Engineer will be assigned the role of Agency Chief Knowledge Officer and will be responsible for developing and implementing a comprehensive strategy for institutional knowledge management that will include collection and dissemination of lessons learned. The anticipated completion date is March 2013.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the proposed actions.

Recommendation 2. We recommended that the Chief Engineer determine if LLIS is worth the cost of continued operation, support, and sustainment.

Management's Response. The Chief Engineer concurred, stating that although it is difficult to quantify the actual benefits of capturing and broadly sharing lessons learned, NASA recognizes the value of the process. He further stated that based on monthly LLIS utilization metrics, he believes the $750,000 his office spends on LLIS activities is a worthwhile investment.

Evaluation of Management's Response. We consider management's actions responsive to the intent of the recommendation, and the recommendation is therefore resolved. Nevertheless, in light of our findings regarding the utilization level of LLIS by project managers, we remain skeptical about the value of continuing to invest in LLIS in the absence of significant actions to improve the current system. Accordingly, we urge the Chief Engineer to further consider LLIS's role in NASA's larger knowledge management system as part of the implementation of the Agency's proposed corrective actions to our other recommendations. We will keep this recommendation open until the Chief Engineer and the Chief Knowledge Officer have had the opportunity to make this assessment and implement corrective actions.

Recommendation 3. We recommended that the Chief Engineer revise NPR 7120.5D to establish program and project management requirements that align with NASA's strategic vision for institutional knowledge management and sharing.

Management's Response. The Chief Engineer concurred, stating that when revisions to NPR 7120.6 are complete his office will consider whether changes are required in other engineering and program and project management requirements documents.

Evaluation of Management's Response. Management's proposed actions are responsive to the intent of the recommendation; therefore, the recommendation is resolved and will be closed upon completion and verification of the proposed actions.

Recommendation 4. We recommended that the Chief Engineer revise NPR 7120.6 to align Center and program/project management practices and improve the collection and dissemination of lessons learned Agency-wide by establishing requirements that can be supported by available resources.

Management's Response. The Chief Engineer concurred, stating that his office hosted a Knowledge Services Retreat on February 26–29, 2012, with a focus on developing a strategy to change NPR 7120.6 by March 2013.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the proposed actions.

APPENDIX A

Scope and Methodology

We performed this audit from March 2011 through January 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We reviewed lessons learned requirements contained in several NASA policy documents, including the following:

- NPR 7120.5D, "NASA Space Flight Program and Project Management Requirements," March 6, 2007, and NASA Memorandum 7120-81, "NASA Space Flight Program and Project Management Requirements," September 22, 2009, which was issued as an interim directive while NPR 7120.5D was being revised.
- NPR 7120.6, "Lessons Learned Process," March 22, 2005.
- NPR 7120.7, "NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements," November 3, 2008.
- NPR 7120.8, "NASA Research and Technology Program and Project Management Requirements (w/change 1 dated 11/24/10)."
- NPR 7123.1A, "NASA Systems Engineering Processes and Requirements w/Change 1 (11/04/09)."
- NPR 7150.2A, "NASA Software Engineering Requirements," November 19, 2009.
- NPR 8621.1, "NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping w/Change 5 (03/15/2010)."

To determine whether NASA had established processes for oversight, support, and facilitation of LLIS and whether those processes were functioning in accordance with the applicable NASA policies, we interviewed NASA and contractor personnel responsible for the collection, validation, assessment, and codification of lessons learned submitted by individuals, Mission Directorates, and programs and projects. Additionally, we surveyed the lessons learned process representatives at each Center for compliance with

NPR 7120.6. Further, we reviewed all lessons inputted to LLIS during the period of review to determine the timeliness of the Headquarters review process.

To determine use of and contributions to LLIS, we surveyed all 32 NASA flight projects launched from January 2005 to May 2011. We received and reviewed responses from 28 flight project managers for 26 Science Mission Directorate projects and 2 Space Operations Mission Directorate projects. We did not receive responses from four projects: two were small-scale technology demonstration projects; the responsibility for the development of one project was with another agency; and the project manager for the fourth project was no longer with NASA.

To determine whether NASA had taken appropriate actions in response to GAO's 2002 report, we interviewed personnel responsible for addressing GAO's recommendations who were still with the Agency and reviewed source documents to verify that corrective actions were taken.

To determine how NASA's system and process compare with other significant entities' approaches to obtaining, documenting, and using lessons, we contacted and interviewed representatives of several entities from the public and private sectors.

Use of Computer-Processed Data. We obtained computer-processed data from LLIS during the performance of this audit. We verified data obtained with corroborating testimony from NASA personnel and source documentation and found no reason to doubt the reliability and validity of LLIS data.

Review of Internal Controls

We evaluated the Chief Engineer's internal monitoring controls for compliance with the NPR 7120.6 process. We interviewed Government personnel at NASA Headquarters with oversight responsibilities specified in the NASA policy. We interviewed Government and contractor personnel located at the Centers with functional responsibilities defined in NASA policy. We conducted a compliance survey focused on the implementation of the lessons learned process at each Center. In our opinion, the combination of the Steering Committee meetings, NEN-generated process statistics, and "OCE [Office of the Chief Engineer] Requirement Compliance Surveys of Centers" appear collectively to be an adequate process-monitoring control for Headquarters and the Centers.

Prior Coverage

No reports concerning LLIS have been issued by the NASA Office of Inspector General or GAO during the last 5 years. The following GAO reports, however, are of particular relevance to the subject of this report. Unrestricted reports can be accessed over the Internet http://www.gao.gov.

"NASA: Better Mechanisms Needed for Sharing Lessons Learned" (GAO-02-195, January 30, 2002)

"Survey of NASA's Lessons Learned Process" (GAO-01-1015R, September 5, 2001)

LESSONS LEARNED / KNOWLEDGE SHARING LETTER

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

February 19, 2009

Reply to Attn of: Office of the Chief Engineer

TO: Distribution

FROM: Chief Safety and Mission Assurance
Chief Engineer

SUBJECT: Lessons Learned/Knowledge Sharing Letter

We are writing to request your active participation in addressing an issue of critical importance to the long-term health of NASA. NASA makes significant investments in the intellectual capability of our workforce, but all too often we do not make time available to capitalize on these investments. Our technical workforce possesses a depth and diversity of expertise that is second to none in the world, yet we leverage only a fraction of our capacity to share our knowledge and lessons learned with each other. At the senior leadership level, we trust that grassroots efforts will take care of this, but we do not expend enough personal effort supporting these activities from the top.
This is not a new concern. In 2003, the Columbia Accident Investigation Board concluded that, "NASA's current organization…has not demonstrated the characteristics of a learning organization."[1] Many high-reliability organizations wrestle with this issue. The recent news about the "Spirit of Kansas" B-2 stealth bomber crash,[2] where a technique learned by some flight and maintenance crews but not others probably would have prevented the accident, is a dramatic reminder that knowledge sharing is not "nice to do" – it is "must do."

For many of our hardest learned lessons, we have gone to great lengths to institutionalize knowledge in design principles and flight rules, such as the GSFC GOLD rules,[3] JPL Design, Verification/Validation & Ops Principles for Flight Systems,[4] and JSC Design and Procedural Standards.[5] We also have conducted extensive outreach across our community to ensure that agency-wide procedures such as NPR 7120.5D and NPR 7123.1A reflect state-of-the-art practices in project management and systems

[1] http://anon.nasa-global.speedera.net/anon.nasa-global/CAIB/CAIB_lowres_intro.pdf
[2] http://www.cnn.com/2008/US/06/06/crash.ap/index.html#cnnSTCVideo
[3] http://gsfcrules.gsfc.nasa.gov
[4] http://nen.nasa.gov/syseng/43913-Design-Principles.pdf
[5] http://server-mpo.arc.nasa.gov/Services/CDMSDocs/Centers/JSC/Dirs/JPR/JPR8080.5A.pdf

engineering.[6] We need to be vigilant in continuing to improve and grow these efforts to institutionalize our lessons and share these capabilities across the agency.

Our efforts to record knowledge and lessons at an institutional level in our processes and procedures are necessary but not sufficient. Within the context of NASA, learning has to take place on three levels. It has to reach our *individual practitioners*, through job assignments, formal training, knowledge sharing workshops, and membership in communities of practice. It also has to take place among our *teams*, through either sharing workshops or one-on-one mentoring and coaching. Finally, learning has to occur at the *organization* level. With our field centers spread around the country, there are very few built-in opportunities for cross-pollination among the technical workforce, so we have to employ through cross-agency knowledge sharing initiatives such as case study workshops, forums, publications, and communities of practice to build a broader learning organization.

NASA continues to implement new and innovative ways for our workforce to share their knowledge as part of their normal everyday work. It is critical that we support the capability to document and store our rich history in the form of lessons and knowledge in searchable and discoverable formats. We must ensure that we use technology so that it is a complement to (and not a substitute for) our face-to-face activities. The NASA Engineering Network[7] offers easy methods to search for lessons and knowledge across the agency, and serves as a central portal for communities of practice in specific technical disciplines. With the addition of an open format lesson submission to NASA's Lessons Learned Information System (LLIS),[8] our workforce can easily save daily work products containing valuable lessons and related contextual information with a few simple key strokes.

Examples of other key agency-wide resources include:

- Process Based Mission Assurance Knowledge Management System video nuggets and case studies[9]
- NASA Safety Center's Cases of Interest[10]
- Courses, forums (captured in a video library), case studies, and publications such as ASK Magazine and ASK the Academy offered by APPEL[11]

Use of agency-wide resources help to advance and increase knowledge sharing across our workforce.

There are specific steps you can take to improve NASA's performance as a learning organization. At the conclusion of every significant development under your

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[6] http://nodis3.gsfc.nasa.gov/lib_docs.cfm?range=7

[7] http://nen.nasa.gov/

[8] http://nen.nasa.gov/portal/site/llis/LL/

[9] http://pbma.nasa.gov/videolibrary_main

[10] http://nsc.nasa.gov/Services/Knowledge-Management/coi.php

[11] http://appel.nasa.gov/node/32

leadership—when projects, instruments, subsystems, elements completes its work—the team involved should convene a sharing workshop to reflect on and capture its lessons learned. This shouldn't wait until after launch or closeout; it should take place immediately after the team has finished its major effort, while teams are still assembled and while memories are still fresh.

As a leader, you can play a critical role by modeling behaviors conducive to learning at the highest level of your organization. By holding your own internal sharing workshops and attending open-door knowledge sharing forums, you can send a powerful signal about the importance of making time for these activities. Your example can also encourage participation in activities that foster individual reflection about lessons learned, such as writing articles for practitioner-focused publications.

We must not forget the risk that we accept if we do not take the time to encourage our workforce to engage in sharing NASA's lessons and knowledge. We cannot afford to lose sight of the importance of continuing to improve our performance as a learning organization. Thank you for taking the time to help us institutionalize the sharing of knowledge and lessons learned from the top down. Your leadership in this area will make a real difference.

Bryan O'Connor

Dr. Michael G. Ryschkewitsch

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MANAGEMENT COMMENTS

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

FEB 27 2012

Reply to Attn of: Office of the Chief Engineer

TO: Assistant Inspector General for Audits

FROM: Chief Engineer

SUBJECT: Response to OIG Draft Audit Report, "Review of NASA's Lessons Learned Information System" (Assignment No. A-11-010-00)

The Office of the Chief Engineer (OCE) appreciates the opportunity to review your draft audit report entitled "Review of NASA's Lessons Learned Information System" (LLIS) (Assignment No. A-11-010-00).

In the draft report, the Office of the Inspector General (OIG) outlines several findings and communicates four recommendations. NASA's response to the recommendations, including planned corrective actions, follows:

Recommendation 1: Develop and implement a comprehensive strategy for institutional knowledge management that includes collection and dissemination of lessons learned.

Management's Response: NASA concurs with the intent of this recommendation.

To fulfill our existing responsibility for technical excellence and training of the engineering competencies outlined in NPD 1000.3, OCE is already engaged in knowledge capture and sharing activities. The Aerospace Safety and Advisory Panel (ASAP) in its 2011 Annual Report recommended that NASA establish a Chief Knowledge Officer within the Agency as a single focal point to develop the policy and requirements necessary to integrate knowledge capture across programs, projects, and Centers, and further, to consider establishing Chief Knowledge Officer positions at all NASA Centers and in all Mission Directorates to ensure standardization of program and lessons learned. The OCE will assume the Agency Chief Knowledge Officer role in this context. The individual assigned this role will be responsible for developing and implementing a comprehensive strategy for institutional knowledge management that includes collection and dissemination of lessons learned. It is OCE's intent to complete this action by March 2013.

Recommendation 2: Determine if LLIS is worth the cost of continued operation, support and sustainment.

Management's Response: Concur. NASA recognizes the value of including lessons learned in the overall institutional knowledge strategy. In their annual report to Congress, the ASAP stated that one of the overarching and fundamental purposes of NASA is to create knowledge. The ASAP further stated that ensuring that this knowledge is captured and available to future generations is more than an obligation; it is a sacred trust. LLIS is one tool that NASA operates and sustains to capture knowledge. OCE will spend $750K on lessons learned activities in FY 2012, representing 0.04 percent of the Agency's total budget. Based on the LLIS utilization metrics collected each month, this investment is providing a tremendous return on investment.

In a recent NASA's budget activity, the Agency considered how to assess the cost savings resulting from the efforts of the software professionals at the NASA Independent Verification and Validation (IV&V) Facility. After considerable effort to identify metrics or assessment algorithms used by commercial software developers, the Agency concluded that it is not possible to estimate the cost avoidance associated with IV&V's work. NASA sees it equally challenging to estimate the costs avoided by capturing and broadly sharing engineering lessons learned.

Recommendation 3: Revise NPR 7120.5D to establish program and project management requirements that align with NASA's strategic vision for institutional knowledge management and sharing.

Management's Response: NASA concurs; when the revision to NPR 7120.6 (see the response to Recommendation 4) has been completed, OCE will consider changes that may be required in other OCE engineering program/project management requirements documents.

The action to respond to this recommendation will depend on completion of the revision of NPR 7120.6 (see Recommendation 4).

Recommendation 4: Revise NPR 7120.6 to align Center and program/project management practices and improve the collection and dissemination of lessons learned Agency-wide by establishing requirements that can be supported by available resources.

Management's Response: NASA concurs. OCE is hosting a Knowledge Services Retreat on February 26-29, 2012, that will focus on a strategy to change NPR 7120.6, the Agency's Lessons Learned Process.

Depending on the outcomes of the Knowledge Services Retreat, OCE intends to have changes to NPR 7120.6 incorporated into the Agency's online directives review process with an estimated completion date of March 2013.

Thank you for providing the opportunity to review and comment on the subject draft audit report. If you have further questions or require additional information on the NASA response to the draft report, please contact Maureen Moore at 202-358-1822.

Michael G. Ryschkewitsch

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House Committee on Science, Space, and Technology
Subcommittee on Investigations and Oversight
Subcommittee on Space and Aeronautics

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