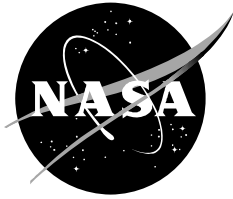# Best Practices for Researching and Documenting Lessons Learned

John L. Goodman

United Space Alliance
Houston, Texas

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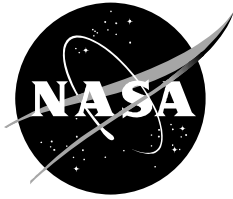- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.

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Houston, Texas

Contents

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Introduction

Identification, resolution, and avoidance of technical and programmatic issues are important for ensuring safe and successful space missions.[1,2] Although the importance of applying lessons learned to reduce risk is frequently stressed, there is little material available to help technical and management personnel research and document lessons learned. Collecting, researching, identifying, and documenting lessons learned that will be useful to current and future management and engineering personnel is not always a straightforward task.[3] This white paper presents lessons learned and best practices concerning the research and documentation of technical and organizational lessons learned. It is intended to enable organizations to initiate or improve lessons learned research and documentation efforts.

The content of this white paper is based on four technical lessons learned projects conducted by the United Space Alliance (USA) Flight Design and Dynamics Department, in support of the NASA/Johnson Space Center (JSC) Flight Design and Dynamics Division. Each project published a report, titled as follows:

GPS Lessons Learned From the ISS, Space Shuttle and X-38 [4]
Lessons Learned From Seven Space Shuttle Missions [5]
Space Shuttle Rendezvous and Proximity Operations Experience Report [6]
Navigation Technical History with Lessons Learned [7]

The four projects were different in availability of subject matter experts and primary source material, subject scope, and the level of effort required to produce the final report. However, generic lessons can be drawn from all of them. The best practices will be discussed by the phases of report research and development:

Defining Report Requirements, Project Organization, and Schedule
Collection and Analysis of Source Material
Writing and Integrating the Report
Review and Revision of the Report

Defining Report Requirements, Project Organization, and Schedule

The scope of the report must be defined before research and writing can begin. Report scope will be dependent on customer requirements, schedule, budget, source documentation, subject matter experts, and personnel who will conduct the research and writing tasks. A project leader who has final authority to make editorial decisions should be appointed. Personnel who are qualified and available to conduct research and writing should be identified. Input from professional technical writers and editors, along with publications personnel, should be included in the planning process.

Personnel assigned to lessons learned tasks must have an aptitude for research, writing, and creating documents that engage the reader. Contributors should be subject matter experts with a recognized and demonstrated proficiency for research and writing. If contributors do not possess these skills, a significant amount of project time may be spent resolving report quality issues. Furthermore, subject matter experts who lack research and writing skills may not make sufficient progress, posing a risk to cost and schedule as well as risk of not meeting requirements for report content. If a subject matter expert must be used whose research and writing ability is not known, a short research and writing assignment could be given to identify any potential research and writing issues. Examples of good lessons learned research and writing could be provided to aid in skill development. Review of draft text early in the project by a technical writer or professional editor may also promote skill development.

Define report audience, scope, outline, and format requirements before writing begins. The needs of current and future engineers and managers should be considered when defining the scope and format of the report. When deciding on format and content, determine who the audience is, and how the document should be written to effectively communicate. Different subject matter experts will have different views on experiences, lessons learned, and factors underlying success or failure. Report authors should consider placing raw data in an appendix so that readers may examine the evidence and form their own opinions, independent of the report authors. If report format and organization issues are not defined early in the project, too much time may be spent resolving them late in the project, when time is needed to resolve issues with content, style, or to perform additional research. A professional writer and editor can provide useful advice early in a project when defining report format and organization.

Conduct preliminary research on the topic to help determine report scope. Authors should have some familiarity with technical and programmatic history to assist the customer in defining report scope and to effectively assess the value of source documentation and interviews later in the project. In addition to communicating with the report customer, meetings with subject matter experts are helpful in defining scope, format, and locating sources of documents and other subject matter experts. Seeking advice from external subject matter experts before research and writing begins establishes a relationship that will include them in the research, development, and subsequent review process.

A lessons learned report is not a requirements document. Some subject matter experts may be apprehensive about document content due to the impact it could have on future programmatic decisions. It is important to state that the document is for informational purposes and that it is not a set of requirements for current or future flight programs.

Document lessons learned from projects that successfully mitigated technical and programmatic risk. Lessons learned efforts are most often motivated by challenging projects, systems performance issues, or mishaps. In such projects, lessons learned may be a frequent topic of discussion among personnel working in projects that have encountered technical and organizational challenges, making the task of collecting potential lessons learned straightforward. However, much can also be learned from projects that meet or exceed initial expectations. Investigators should seek the reasons behind project success.

Define multiple lessons learned efforts, each having a narrow scope. Projects with a smaller scope require fewer contributors and are easier to lead and coordinate than large projects. A well-defined research and documentation project with a narrow scope will pose less risk to cost and schedule than a project with a broad scope. It is easier to get subject matter experts to review a small document than a large one.

Consider researching and documenting lessons learned in a task that is separate from the research and documentation of technical history or process description. Technical history and process description is useful, but may require more work than lessons learned. There is also additional risk of a gradual increase in project scope. A document of lessons learned versus a historical document may require a different approach to research and writing. Reports with a broad scope will require multiple authors. This can result in differing levels of detail in research and writing styles during development. Resolving issues with differences in style and content can lead to late and extensive changes, further compressing project schedule.

Whenever possible, assign only one author and researcher to a report section. Assigning multiple personnel to one section can result in diffusion of responsibility, prose that does not flow, organizational conflicts within a section, and redundant material. If a large section of a report must be assigned to multiple individuals, one person should be identified who has editorial control over that section. Other contributors assigned to that section should act in a supporting role. Clearly defined tasks should be assigned to supporting contributors. Each writer should read through the whole section to understand it before working with an editor. This is particularly important if more than one author has worked on a section.

Develop a realistic schedule for editorial reviews and feedback from external subject matter experts. Reviews by editors and subject matter experts who are outside the project are critical to ensure accuracy and adequate coverage of the subject matter. However, such reviews take time. Project planning should reflect the possibility that reviewers have multiple tasks to perform that have higher priorities than the review. A reviewer may not be able to devote full attention to a review to meet an overly optimistic schedule. Turnaround on reviews of draft reports can be lengthy, and adequate time must be scheduled for proper consideration. However, the review phase should not be longer than 2 or 3 months. Longer time periods, or an open-ended schedule, may prompt subject matter experts to give the review a low priority, increasing the risk that feedback will not be provided. Some reviewers may want more time, as reviews can be difficult to conduct due to frequent interruptions in the work environment. The review phase should be scheduled well ahead of time to permit subject matter experts to adjust their schedules. This helps ensure participation by an appropriate cross section of personnel. The review process should start early in the project, and the review phase should end about 4 weeks before the final version is due for publication. This allows for enough time to perform additional changes as well as quality checks on format, grammar, spelling, and content accuracy.

Track budgeted versus actual hours of all personnel and organizations supporting the project and ensure that the level of work required can be accomplished with the available budget. The impact of gradual increases in project scope on available remaining budget and schedule may not always be obvious to contributors and project leadership. Continuous tracking of hours worked and correlation of worked hours with task content can help the project leader avoid budget and schedule surprises. Such situational awareness can enable project leadership to take early action to re-scope the project, or assign priorities to research tasks and issue resolution to ensure that document requirements are met within available schedule and budget. The project leader should be familiar with the level of work that is driven by the report scope, suggested improvements, and formatting to avoid negative impacts on employee work load, cost, and schedule.

Determine what software will be used and identify potential compatibility issues. Differing versions of word processing software, equation editors, and portable document software can lead to a variety of unique technical and format problems that will introduce delays into a

schedule. These issues may also require special expertise and attention from professional editors and information technology specialists.

Collection and Analysis of Source Material

Collecting and examining historical documentation is critical to the accuracy and content of the report, as much knowledge is forgotten over time. The scope, accuracy, and applicability of historical documentation vary greatly. Interviews with subject matter experts can help identify critical documents and avenues of exploration that will help in prioritizing topics and making efficient use of time. Source material should be organized in a fashion that facilitates easy retrieval in the future. More material may be collected than authors have time to examine.

Useful source documentation may be found just about anywhere. The most valuable and time time-saving source documentation are reports written in complete sentences and paragraphs that were created when the lessons were learned. These documents and others of lesser value, such as presentation charts, may be in filing cabinets, informal and formal libraries, internal electronic databases, and even on the internet. Subject matter experts who have participated in investigations of anomalous system performance may have accumulated large amounts of primary source material. This material may include white papers, informal memos, and presentations representing the technical expertise and observations of many team members. Large bodies of primary source material may already have been collected by other individuals and projects. Use of such material will save a considerable amount of time. Publicly available program histories can also provide useful background information and may reference useful source material that could be obtained. Primary source documents may be placed on compact disks and delivered to the report customer along with the final report. This will permit future researchers access to original source documents in a timely manner.

Conduct interviews of subject matter experts. One-on-one interviews can be instrumental for locating source material, collecting observations, and gaining understanding of how organizational politics and personalities played a role in the outcome of a project. While oral history is important for identifying the key players and political climate within a project, key details can be forgotten and stories can change over time. Personnel who joined a project long after it was initiated may not be fully familiar with the rationale behind early programmatic decisions. This may have to be taken into account when evaluating their observations. While interviews are valuable, the optimal source of lessons learned is usually documentation created at the time the lessons were learned.

Explain to subject matter experts the goals, process, and value of the lessons learned research project. Creating a successful lessons learned report requires participation of subject matter experts (management and engineering) from various disciplines who may have busy schedules and have never before participated in such an activity. Some personnel may be eager to participate as they have learned the value of documenting experiences and lessons learned. Others may be uneasy about sharing their insight or knowledge. Projects that encountered difficulties can be a rich source of material, but some personnel may be reluctant to discuss past challenges, particularly if questions of human error or errors in judgment may arise. Collection, discussion, and preservation of experiences and lessons learned can be a controversial exercise. Understanding the purpose, goals, characteristics, and steps of the research project may help smooth relationships and encourage discussion amongst participants.

Ensure capture and preservation of lessons learned by clearly documenting them during a project and at project completion. Documentation and preservation of lessons learned and experiences should be conducted both during a project and immediately after completion. Memories fade, personnel change jobs, and detailed accounts of lessons and experiences are quickly forgotten if not written down. Documentation and preservation should be defined as steps in a project plan before a project is initiated. Early in a project, management and technical personnel are most motivated to preserve lessons learned and highlight factors behind successes and failures. As a program progresses, there may be less motivation to formally document lessons learned. This can complicate future historical research.

Writing and Integrating the Report

This phase involves analysis of source material, identification of lessons learned, best practices, and observations. Text is written and illustrations are obtained or created. Questions that arise during research and writing should be recorded for preservation and later research. Consultations with subject matter experts may be required to resolve some issues before the formal review process begins. Contributors or publications personnel integrate text and illustrations into a draft or modify an existing draft based on reviewer inputs.

Adhere to the facts. Evaluation of projects that encountered difficulties involves discussion of controversial and sensitive topics. Authors should be careful to adhere to the facts and avoid assigning culpability to individuals and organizations. Negative personal comments about people and organizations should be kept out of the report. There may be some valid lessons and experiences that are too sensitive to be widely distributed. An individual or a team that is researching and documenting lessons learned is not an independent mishap investigation board.

Strive to be objective. Report authors should be open-minded and consider all opinions and evidence provided by subject matter experts and documentation. When discussing problems, it is important to be balanced and fair. For example, the Global Positioning System (GPS) receiver on the shuttle was a combat-proven device, built by the thousands, that met the requirements of the original military customer. The source of GPS performance problems was not with a poor-quality product, but rather was the use of a software-intensive device in an application for which it was not originally designed. Furthermore, decisions concerning organization, schedule, requirements, level of testing, assumptions driving project requirements, etc., were made by the Space Shuttle Program and supporting contractors. The GPS receiver vendor was not responsible for these decisions. These points were made in the GPS lessons learned report.[4]

Clearly document lessons and experiences so that they will be easy to understand and apply. Some recorded lessons learned in historical documentation are written in such a technical fashion that they are difficult for someone years later to understand and apply. Even technical lessons have at their core a fundamental problem that is common across many technical disciplines, such as failure to communicate or follow proper procedures. Lessons and experiences should be written so that they can be universally understood and applied by both management and engineering personnel from various technical disciplines.

Include high-level background material to place lessons in context for the reader. Readers will not have the same knowledge of the topic as the subject matter experts and document authors. A factual history of the project is useful for helping the reader understand the lessons and experiences. Of particular importance is the rationale behind budget, schedule, policy, and organizational decisions that influenced the outcome of the project.

Avoid duplicating technique, process, or architecture details that already exist in other documents. The focus of a lessons learned report should be the lessons learned and experiences that are important to preserve. Some description of systems architecture, operational and algorithmic techniques, and processes may be necessary to give context to the lessons learned and experiences. However, too much effort expended on these topics distracts from researching and documenting lessons learned. Sources can be provided, either in bibliographic form or the source documents themselves, on a compact disk for the reader who is interested in more detail. An annotated bibliography can help a reader identify references of interest.

Report contributors should adhere to the customer's defined scope for the report, unless the scope is formally changed. Requirements creep can occur in report development as easily as it occurs in software development. Without specific requirements for what the report should address, the scope can increase as research progresses. This may lead to major formatting changes and significant addition of new material, all leading to compressed schedules and potential for missing project milestones, in addition to budget problems. Project leadership should discuss potential

changes in scope with the report customer and subject matter experts to determine whether the proposed changes add value to the report. A close relationship with the report customer permits frequent discussion of project status and timely resolution of requirements and scope issues.

Establish central file locations accessible to all contributors and clearly define content for each folder. Projects with more than one contributor will require close coordination. Written material and research notes will have to be shared and individual progress will have to be communicated regularly. The status and method of configuration control for the current working copies must be understood by all contributors. For folders or report sections that change often (i.e., references, document inventory), a list of items to be added is helpful to track what has and has not been incorporated. The contributors need to be informed of major changes by another person to their assigned sections to stay abreast of the current status of their work. This will avoid confusion when addressing editorial comments later in the project. This is particularly true in the event that one or more contributors are not available at critical times during the project.

If possible, provide original files to graphics and publications personnel. While clean and sharp graphics and illustrations add value to a lessons learned report a significant amount of time can be spent improving graphics and illustrations obtained from older internal documents through scanning and photocopying. Working with original files can speed up the process. In addition, providing graphics personnel with the original source of the illustration can be helpful. Using graphics already resident in current internal documents can save time as publications personnel may already have access to the original in electronic form.

Review and Revision of the Report

Review and revision is performed once a draft has been assembled. Multiple review and draft update cycles may occur, depending on the size of the report and the level of review needed. Feedback from subject matter experts can be obtained on an individual basis or in meetings held to discuss the draft. Written comments, with rationale for the comments explained using complete sentences, have been found to be the most helpful to report authors.

Conduct a review with subject matter experts who did not contribute to the writing of the report. Reviews by subject matter experts are critical to ensure accuracy, coverage of important topics, and to promote sharing of and critical thinking about the experiences. Quick, insightful, and accurate reviews of draft reports by external subject matter experts provide contributing authors more time to resolve issues and perform additional research. Reviewers may also provide feedback for improving legibility of a report. The first draft could be presented to two or three key personnel (management and technical) for initial review. After inputs are received and changes are made, a review process with a larger group of subject matter experts can be initiated. Tasks and reviews can be delegated to smaller groups of people with relevant experience. However, it is also good to have an outside opinion on lessons and observations produced by small sub-teams. It is important for reviewers to understand that a draft is not a final product and that all material in the draft is subject to change. While meetings to discuss a draft report were found to be useful, the most valuable input was obtained from redlined copies or emails containing comments on the drafts. Far more lessons and experiences were harvested in this fashion during the review process than from oral interviews during the initial research phase or from group review discussions. The authors should be open to everyone's input. Showing flexibility and a willingness to make necessary changes to the draft will encourage participants to contribute.

Use a draft as a means of getting subject matter experts to provide input. When asked to participate or provide examples of experiences and lessons learned, some subject matter experts may have difficulty providing input. The role of the primary author is to initiate momentum and glean information and history from subject matter experts. Distributing a draft lessons learned presentation or report for critique was found to be useful in provoking thought, analysis, and the sharing of experiences among management and technical personnel. A draft is also a vehicle for igniting creative thinking and discussion among subject matter experts of items that might not have surfaced during the original research phase. Reviews can help identify gaps in report coverage and lead authors to areas where more documentation needs to be collected and analyzed.

A review meeting is useful if the subject matter experts have reviewed the document before the meeting. Multiple document review meetings at a regular time and location can be held. There should be enough time between meetings to permit report authors to make necessary changes, acquire and study additional historical material, and review the new draft before distribution to subject matter experts for review. Reviews should consist of a small group of key subject matter experts (preferably fewer than 10). Small groups enable meeting attendees to reach a quick consensus and make it easier for all attendees to participate in the discussion.

Deliberation and consensus building is a process that takes time. While one person or a small group of people may serve as authors, in reality the quality of a report depends on the input from and deliberation among subject matter experts. Different people will view the project from different perspectives. Management and technical personnel may have different views on a project, and it may be beneficial to have varying views in the report. Some participants may have a more accurate picture of events and observed things that the authors did not detect in their original research. There may also be differences in interpretation of events among individuals. Not all observations and opinions may be suitable for preservation in a report. Subject matter experts may not agree on everything. Document authors should strive for a set of lessons learned and experiences that best represents the subject addressed in the report and that would be most useful to management and technical personnel working on future projects.

Assign priorities to suggestions for expanded report scope. Reviews by editors and external subject matter experts may result in suggestions for additional topics to be covered. Such suggestions may enhance the value of the report. However, additional material may require a significant amount of time and effort to research and add to the report. Priorities should be assigned to potential scope expansions to ensure that workload, cost, and schedule are not negatively impacted. Once priorities and responsible contributors have been assigned, a list of additional work and research to be performed should be maintained and status should be tracked. This enables quick assessment of report progress by management.

Conclusion

Identification, resolution, and avoidance of technical and programmatic issues are important for reducing risk in spaceflight programs. Documented lessons learned, experiences, and best practices enable program personnel to mitigate recurring technical and programmatic issues that negatively impact cost, schedule, system performance, mission success, and safety. Such documentation plays a key role in preserving NASA's corporate knowledge for new and continuing programs. It is also a part of the career learning process and technical skill development of engineers and managers. All four of the identified lessons learned reports produced by the USA Flight Design and Dynamics Department provided timely lessons that have proven to be applicable to other projects and flight programs, both current and in development.

Research and documentation of lessons learned and experiences requires personnel with an aptitude for research and writing. In addition, contributing authors must possess technical expertise and an understanding of the programmatic aspects of space-flight projects and programs. Document scope and format requirements should be defined before written material is developed. Interviews with subject matter experts are useful when defining scope, as well as for researching lessons learned. Project schedule should provide enough time for editorial reviews and feedback from external subject matter experts and the production of interim drafts. Lessons and experiences should be clearly documented so that they will be easy to understand and apply. High-level background material is useful to place the lessons in context for the reader. Lessons learned are most efficiently and effectively captured during and at the end of a project, and should be a natural outcome of every project.

References

[1]Goodman, John L., and David P. Dannemiller, "Flight Safety Education For Current and Future Space Flight Programs," *Proceedings of the AIAA Space 2006 Conference*, AIAA, Reston, VA, 2006.

[2]Cheng, Paul, and Patrick Smith, "Learning from Other People's Mistakes," *Crosslink*, Aerospace Corporation, Vol. 8, No. 2, Fall 2007, pages 20-24.
See http://www.aero.org/publications/crosslink/fall2007/04.html (accessed March 14, 2008), or http://www.klabs.org/DEI/lessons_learned/aerospace_corp/lessons_from_mistakes.pdf (accessed March 14, 2008).

[3]Goodman, John L., *Knowledge Capture and Management for Space Flight Systems*, NASA Contractor Report NASA/CR-2005-213692, NASA Johnson Space Center, October 2005. See the NASA Technical Reports server at http://ntrs.nasa.gov/, or the Johnson Technical Reports server at http://ston.jsc.nasa.gov/collections/TRS/ (Accessed March 14, 2008).

[4]Goodman, John L., *GPS Lessons Learned From The ISS, Space Shuttle and X-38*, NASA Contractor Report NASA/CR-2005-213693, NASA Johnson Space Center, November 2005. See the NASA Technical Reports server at http://ntrs.nasa.gov/, or the Johnson Technical Reports server at http://ston.jsc.nasa.gov/collections/TRS/ (Accessed March 14, 2008).

[5]Goodman, John L., *Lessons Learned From Seven Space Shuttle Missions*, NASA Contractor Report NASA/CR-2007-213697, NASA Johnson Space Center, January 2007. See the NASA Technical Reports server at http://ntrs.nasa.gov/, or the Johnson Technical Reports server at http://ston.jsc.nasa.gov/collections/TRS/ (Accessed March 14, 2008).

[6]Goodman, John L., and Kelli S. Wiuff, *Space Shuttle Rendezvous and Proximity Operations Experience Report*, JSC-49626, Flight Design and Dynamics Division, Mission Operations Directorate, NASA Johnson Space Center, February 2003. Available from the NASA/JSC Scientific and Technical Information Center.

[7]Goodman, John L., et al., *Navigation Technical History with Lessons Learned*, JSC-63653, Flight Design and Dynamics Division, Mission Operations Directorate, NASA Johnson Space Center, April 2007. Available from the NASA/JSC Scientific and Technical Information Center.

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13. ABSTRACT *(Maximum 200 words)*

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