

NASA LANGLEY RESEARCH CENTER

SOFTWARE PROCESS IMPROVEMENT INITIATIVE

CORNERSTONE REPORT

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INTRODUCTION

This report summarizes the CornerStone phase of the Software Process Improvement Initiative (SPII) at Langley Research Center (LaRC) which began in July 1997. The report takes the reader through the events and activities which have transpired in the development of the initial *Software Process Improvement Initiative Implementation Plan* (http://sw-eng.larc.nasa.gov/resources/SPI_plan_U.pdf) for LaRC and poses several lessons learned. The reader is encouraged to examine the *Software Process Improvement Initiative Implementation Plan* for additional information which is introduced in this report.

Background

Software development represents a vital part of systems used by industry and Government to accomplish their respective missions. In recent years, it has become evident that software development costs are steadily increasing. According to a report entitled *Profile of Software at National Aeronautics and Space Administration* (NASA-RPT-004-95), software products and services comprise more than 10 percent of the civil service and contractor workforce and more than \$1 billion of the FY93 budget. In the light of shrinking budgets and staff we must increase productivity and quality of our software development. Software process improvement is a sound investment. Using the Software Engineering Institute's Capability Maturity Model as a basis for improvements, the typical return on investment realized is from 5:1 to 8:1.

This was the main theme of a presentation given to the LaRC Associate Director, Chief Information Officer, and Information Systems and Services Division on July 8, 1997. (The presentation, *LaRC Software Process Improvement Initiative Sponsors Briefing*, can be viewed at: <http://sw-eng.larc.nasa.gov/resources/brfng4/ppframe.htm>) The presentation, given by members of SASPG, OSEMA, and IOG, outlined a plan to kick off a long term software process improvement initiative by first assessing and documenting the current state of the software practice, reporting improvement opportunities and best practices, and developing a long range plan to implement those improvements. The kick off phase, called "CornerStone," would be the foundation for the initiative's improvement efforts. At the conclusion of the briefing, the plan was approved and an additional sponsor, the LaRC ISO 9000 Project Manager, was appointed by the Associate Director. Further, it was agreed that a group of hand-picked, experienced software practitioners from RTG, IOG, SASPG, and OSEMA would be requested to unite on the CornerStone Team in order to address software process improvements issues.

CORNERSTONE ACTIVITIES

CornerStone Goals

The leader of the CornerStone Team arranged for a consultant to facilitate the team's efforts. The CornerStone Team, including the consultant, held its first meeting on July 29, 1997. Early on, the team identified the long-range goals of the software improvement initiative at LaRC and the specific goals of the CornerStone phase of the initiative, as well as the roles and responsibilities of the CornerStone Team. These goals are stated below.

Long-range SPI Initiative Goals

- 1) To develop sustainable mechanisms for continuous improvement in the productivity and quality of software developed across LaRC
- 2) To increase customer satisfaction with LaRC software products
- 3) To improve the work environment for LaRC's software community, leading to higher morale and increased productivity

CornerStone Goals

- 1) To develop a plan to improve LaRC's software development practices
 - Identify current state of software development at LaRC
See the ***Software Process Improvement Initiative Findings Presentation*** at: <http://sw-eng.larc.nasa.gov/resources/FindingsBrfg.html>.
 - Identify current best practices used in software development at LaRC
See the ***Software Process Improvement Initiative Findings Presentation*** at: <http://sw-eng.larc.nasa.gov/resources/FindingsBrfg.html>.
 - Develop a High Performance Model for LaRC's software development activities which incorporates the appropriate elements of the Capability Maturity Model, ISO 9000, Strategic and Quality Framework, and Baldrige Award Criteria
See Appendix A of the initial ***Software Process Improvement Initiative Implementation Plan*** at: http://sw-eng.larc.nasa.gov/resources/SPI_plan_U.pdf.
- 2) To obtain management support, complete with resources, to implement a LaRC Software Process Improvement Plan

CornerStone Approach

To determine the current state of the software development at LaRC and the best practices, the team planned to conduct a series of “workshops” or interview sessions with developers, customers, and managers representing a cross-section of different software domains at the Center. This was agreed as a more effective means of gathering needed information than a Center-wide survey or mass workshop. There were ten separate domains or areas of product concentration that were identified and a separate workshop was scheduled for each. The information obtained from the workshops would become the basis on which improvements would be planned and implemented.

The Key Process Areas (KPAs) defined in the Software Engineering Institute's Capability Maturity Model were reviewed and ten were selected by the CornerStone Team as the critical software processes for achieving a High Performance Organization. These ten were chosen because of their fundamental importance in maturing an organization's software development

processes and because of their strong mapping to ISO. The team members selected the KPAs which were the focus of each specific workshop. The focus KPAs were chosen based on team member's knowledge of those areas having the most potential for improvement for the particular workshop domain and for capturing the particular domains known best practices.

Organize Workshops

The CornerStone Team developed a generic list of questions for each KPA. The questions were designed to foster open discussions, surface sensitive or frustrating issues, and expose strong and weak development practices with respect to the subject KPAs. KPAs were divided into primary and secondary categories for each workshop in order to assess the subject domain as fully as possible within the time constraints. A list of primary KPA questions were covered fully, while secondary KPA questions were covered partially.

A point of contact (POC) who had experience or familiarity with the subject software domain was appointed for each workshop. The domain POCs developed a list of participants and notified participants of the purpose, time, and location of the workshop. Additionally, some of the POCs customized the generic questions for specific workshops using their domain knowledge.

In order to maintain focus during workshops, the CornerStone Team developed a master script which was customized for each workshop. The script provided a sequence for conducting the workshop which included items such as opening the workshop, introductions, orienting the participants, alerting participants on confidentiality of information discussed in the workshops, asking questions which were common to all of the workshops, asking questions for each KPA that was selected for coverage at that workshop, and closing the workshop.

The CornerStone Team received orientation training before conducting the workshops. At a CornerStone Team meeting prior to the first workshop, the consultant and the CornerStone Team leader role-played a mock workshop. This also allowed the team members to critique the script and make adjustments.

Conduct Workshops

The consultant led the first workshop in August 1997. At this workshop, the domain POC served as recorder and another team member was a participant. Several team members were present as observers. By the time all workshops were completed in September 1997, all team members were afforded the opportunity to lead, participate, or observe one or more workshops.

During each workshop the recorders captured the participants' comments in notebooks containing the previously prepared script and questions. In the absence of an automatic recording mechanism (due to the sensitivity of the information discussed in the interviews), it became painfully obvious during the first workshop that more than one recorder was needed. (After the first two workshops, the team held a lessons learned meeting at which time this and other workshop improvements surfaced. See "Lessons Learned" later in this report.)

Shortly after each workshop, the workshop team transferred the participants' comments to post-it notes in a prescribed format in order to classify the comments as strengths, weaknesses, or observations; identify the KPA to which they referred; tag the information with the workshop number; and record the transcriber's initials. In some cases questions triggered responses which related to different KPAs. Selected strengths were further categorized as best practices and a POC was recorded on the post-it note. During the transcribing process, comments were reviewed for accuracy, relevance, and appropriate wording to ensure clarity and anonymity.

In order to accommodate the availability of interviewees, the period for conducting the workshops was extended longer than anticipated. However, this was beneficial because team members needed to spend time documenting strengths and weaknesses between workshops. Additionally, subsequent workshop teams were able to sharpen their focus and explore themes which became evident after a few workshops.

The periods between workshops also provided an opportunity for participants to amplify earlier comments or independently express thoughts on matters that were inappropriate for the workshop format. Between workshops, team members were also able to collect artifacts or obtain additional information pertaining to best practices and conduct follow-on interviews. One of the immediate benefits of the workshops was the cross fertilization of ideas among workshop participants in different LaRC organizations. On several occasions participants expressed that they were unaware that another organization was performing similar work using the same, similar, or better tools and methods. This observation clearly indicates a need for improved intergroup coordination. One mechanism for improvement would be a web page where developers and managers could locate information about methods and tools that are used by others. The need for improved intergroup coordination strongly suggests the establishment of an organization (formal or informal) which provides education on software engineering concepts, fosters the exchange of best practices, and promotes software process improvements.

Data Analysis

After the team posted all of the comments from all workshops on the wall of the "war" room, the analysis phase began. One by one, the post-it notes for each KPA were read and organized by common threads. As the post-its were read, the team made notes, held discussions, and reached consensus on what should be recorded relative to the particular KPA findings. The team electronically recorded each finding using a laptop computer connected to a projection display screen. This mechanism also facilitated consensus building (see Lessons Learned). The findings were categorized as best practices and improvement opportunities with associated consequences. It was decided to use the term "improvement opportunity" instead of "weakness" in documenting the findings. The findings briefing became the official published record of the data analysis and associated results.

During data analysis the team also rated each KPA activity using a color encoding scheme as follows:

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| Red | There was no evidence to support this practice or this practice does not exist at this time. |
| Yellow | The practice is performed on some projects, but in an inconsistent, ineffective manner. This may be an isolated best |

	practice.
Green	The practice is performed on most projects, most of the time.
Double Green	The practice is performed on all projects, all of the time.

Findings Briefing

On October 27, 1997, as promised, a findings briefing was given to workshop participants at the Pearl Young Theater. Each member of the CornerStone Team spoke for 10-15 minutes. For brevity, the speakers presented only the top three or four most significant improvement opportunities, consequences, and best practices listed under each KPA explored during the workshops although an extensive list was included in the viewgraphs. The team took the opportunity to educate the audience on the purpose and description of each KPA and its relationship to the Software Engineering Institute's Capability Maturity Model. In addition, team members presented introductory material concerning the SPII and near-term plans. The briefing was well received and audience feedback indicated that it was very accurate.

Several days later, on November 3, 1997, the briefing was repeated for the benefit of management stakeholders (sponsors and division chiefs of team members). The briefing was again well received with concerns noted regarding resources and relevance to ISO 9000 certification. Throughout the briefing, various managers cited the team's findings as accurate and applicable not only to software but to LaRC projects in general. The team was requested to include resource estimates and establish a strong relationship to the Center's ISO 9000 certification effort in its improvement plan.

Following the briefing, the team spent several minutes strategizing with the ISO 9000 Project Manager to promote means to include software processes within the LaRC ISO scope. The team has also briefed each Group Chief as their individual calendars have permitted.

Prioritizing Improvement Activities

Prior to embarking on the development of a long-range software improvement plan, the team retreated to further clarify and analyze the data from the workshops. The team organized and captured all the data from the workshops in an electronic file for future reference. This file was arranged by KPAs and general workshop questions to ensure that all data was preserved. During this effort, the team observed several common trends among the KPAs, such as the needs for training in certain software process areas, newer tools (with training), and better intergroup coordination. Each team member agreed to meet with their respective Division sponsor to obtain their input on which were the top three highest priority KPAs.

After this input was obtained, the team met and totaled the division votes for each KPA. Each team member also voted on their top three priority KPAs. For the top five KPAs, individual improvement activities were identified and documented. The team then conducted a vote to determine which of the recommended activities should be implemented under the initial plan. To do this, the team prepared a set of criteria and defined a 30-point voting scheme. The criteria included return on investment, schedule length, alignment with ISO, resource requirements, range of applicability, likelihood of success, suitability for pilot demonstration, and the logical order of implementation. The 30-point voting scheme allowed points to be cast however desired (in whole number units) for the improvement activities. Thus, a member could assign all points

to the same improvement activity, or spread points among several activities. The succession of lists used in the prioritization process can be found in the appendices of the initial ***Software Process Improvement Initiative Implementation Plan***.

At the next team meeting, votes were cast by each team member for the improvement activities. Upon tabulating the results, the improvement activities corresponding to four KPAs (or composites) emerged. These are Requirements Management, Software Configuration Management, Software Project Management (Software Project Planning combined with Software Project Tracking and Oversight), and Software Subcontract Management.

Plan Development

The improvement activities were incorporated into an agreed upon plan format. The team then outlined an implementation approach and defined the roles and responsibilities of those who would implement the plan. Several decisions were made:

- Improvement opportunities would be implemented through pilot projects which would be managed by technical working groups (TWGs), comprised of members from different organizations in order to promulgate the benefits.
- Improvement opportunities would be performed on a voluntary basis, rather than mandated.
- Proponents (i.e. developers and managers) would be established by demonstrating the usefulness of processes utilized.
- Support and resources would be sought from the highest levels to promote success.
- Alignment with the LaRC ISO 9000 certification effort would be critical to the success of the software improvement initiative.

The improvement activities, roles and responsibilities of the SPI Initiative Sponsors, Senior Management Steering Committee, Management Steering Group, SPI Manager, Software Engineering Process Group (SEPG), and Technical Working Groups are discussed in the initial ***Software Process Improvement Initiative Implementation Plan***.

The team drafted the ***Software Process Improvement Initiative Implementation Plan*** over several iterations between November 1997 and January 1998. With each revision, the details of the approach, roles, and responsibilities became more complete and better organized. Prior to approving the plan, the MSG Leader directed the team to begin implementation of specific activities in the plan concurrently with finalizing the document, so that neither time nor momentum would be lost.

The plan was given to the MSG Leader for review and comments were incorporated. Then the plan was approved by the LaRC ISO 9000 Project Manager who was one of the CornerStone sponsors. This was done to assure the remaining members of the MSG that there was strong alignment between the plan and the Center ISO 9000 certification activity. The plan was then released to the MSG. As of this writing, the plan has been signed by all MSG representatives and SPI sponsors.

Three important aspects of the plan have been implemented. First, improvement activities have been initiated. Second, the Software Engineering Process Group (SEPG) and associated

Management Steering Group (MSG) have been formed. Third, the SEPG is supporting the ISO 9000 Project Office in developing the ISO software engineering process for LaRC.

CONCLUSION

The CornerStone Team has accomplished its primary objective to develop a long-range software improvement plan for LaRC.

The team has baselined the state of software practice at LaRC and identified areas which are most beneficial to start implementing improvements. The team observed needs for better requirements management; better planning, managing, and tracking of software projects; better configuration management; and better contract management. In addition, the team recognized the need for training in these software processes and better tools to support them. The team has endeavored to understand the baseline and interpret it such that existing best practices and planned improvement activities will benefit the LaRC software community most advantageously.

The broad range of domains and depth of experience with software at LaRC represented on the team, combined with successful teamwork practices, led to a synergy among its members which was invaluable in arriving at a baseline and a viable plan. This synergy has been transferred to the SEPG which is primarily comprised of members of the CornerStone Team.

Lessons Learned

1. At a workshop where recording devices are not used in order to promote confidentiality, the interviewer should be supported by two persons dedicated to taking notes. The interviewer concentrates on the flow of the discussion between participants and the recorders focus on recording the rapid fire of answers to the posed questions.
2. Associate a person's name with a best practice. Otherwise you must go back and poll participants one by one to identify the contact person in order to get more information and artifacts.
3. The "war" room was invaluable for many reasons, but suffice it to say that continuity from meeting to meeting was significantly enhanced. This was particularly important during the data analysis phase.
4. When documenting information in team meetings, the computer projection capability was very valuable for coming to consensus. On the down side, this made it easier to digress into "wordsmithing" text entries.
5. Record interview notes electronically from the start. Transcribing the interview notes first onto post-it notes was a waste of time since they had to be captured on electronic media eventually.
6. Remember to employ effective configuration management practices - keep backups of the data in case of disk crash.

7. Keep a master list of workshop participants to make it easier to notify them of briefings and other events. Remember to maintain confidentiality.
8. Allocate sufficient time during the workshop phase of the schedule to accommodate 1) participants' project schedules, 2) to transfer the interview notes, and 3) to adjust the content of the remaining workshops to augment areas where limited data has been obtained.

An electronic version of this report can be found at the following http://sw-eng.larc.nasa.gov/resources/CS_RPT11.pdf.