



AV-8B's Experience Using the TSP to Accelerate SW-CMM Adoption

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The Personal Software ProcessSM/Team Software ProcessSM (PSPSM/TSPSM) provides a framework for disciplined software engineers to successfully execute software development projects. This article describes synergies identified in a TSP implementation that have accelerated organizational software process improvement – resulting in attaining a Capability Maturity Model[®] for Software Level 2 over more than 40 percent faster than the average duration reported by the Software Engineering Institute (SEI).

This article describes an organization's experience successfully applying both the Software Capability Maturity Model[®] (SW-CMM[®]) and Personal Software ProcessSM/Team Software ProcessSM (PSPSM/TSPSM). While work at the Software Engineering Institute (SEI) has shown

how the TSP relates to the SW-CMM [1, 2], this article describes results from a CMM-based Appraisal for Internal Process Improvement (CBA-IPI) in a software development and maintenance organization.

These results show how the use of the

TSP has accelerated the SW-CMM adoption. Feedback from engineers and the Systems/Software Engineering Process Group (SSEPG) on these results provide additional insight, and the current status of the TSP project is described. Continuous learning is also addressed as an organization applies its TSP experience to the rest of the organization as well as to improving the TSP, itself.

The organization in this success story is the AV-8B Joint System Support Activity (JSSA), located at China Lake, Calif. This Naval Air Systems Command (NAVAIR) team provides software support for the AV-8B Harrier aircraft for the United States Marine Corps and its allies, Spain and Italy. The AV-8B JSSA is a progressive organization in terms of ongoing process improvement initiatives. These efforts paid off when the combined benefits of the PSP, the TSP, and a robust Earned Value Management System (EVMS) were aimed at demonstrating a SW-CMM Level 2 process maturity.

While all of these factors were equally important, this article focuses on how the PSP/TSP successfully prepared the AV-8B JSSA for that Level 2 appraisal in an accelerated 14 months. This accelerated pace supports an earlier report by Boeing that showed that the PSP/TSP helped them reduce their time advancing from SW-CMM Level 3 to Level 4 by 33 percent [3], and is significantly shorter than the average time to move to Level 2 reported by the SEI [4].

Getting the PSP and the TSP in Place

The AV-8B JSSA's TSP project team consisted of seven software engineers, three systems engineers, and one test engineer. Before the appraisal, the project received PSP training during the fall of 2000. This

Maturity Level 2 Impacts of TSP Realized

Requirements Management Key Process Area (KPA)

- The Team Software ProcessSM (TSPSM) scripts (processes) direct software engineers to review allocated requirements provided by project system engineers before incorporating them into software activities.
- The TSP launch scripts supported software engineers in using allocated requirements as a basis for software planning, work products, and activities.

Software Project Planning KPA

- The Personal Software ProcessSM (PSPSM)/TSP PROxy-Based Estimation (PROBE) method was used to estimate the size of software work products by combining guidance from the TSP scripts, historical data, and professional judgment.
- Software planning data were recorded in the TSP notebooks for project tracking and future planning. This included size, time, resource, and quality estimates, both individually and for the project team.
- The TSP launch processes and checklists made project planning more robust by incorporating the project's software development plan, quality assurance plan, configuration management plan, and the organization's earned value management system requirements.
- The TSP launch processes required the team to identify and assess programmatic and technical risks, and to create a risk mitigation plan.
- The TSP processes helped to facilitate more effective communication between the software, systems, and test integration teams in performing project planning throughout the build process.

Software Project Tracking and Oversight KPA

- The actual size of work products was recorded and tracked against estimates in the PSP/TSP workbooks.
- Project's effort, cost and technical activities were tracked in the TSP weekly team meetings through rollup of individual workbooks.
- The TSP re-launches provided additional periodic reviews of the project.
- The TSP data enabled corrective actions to be taken as necessary, based upon cost, effort, size, risks, and task assignments.
- The TSP team workbook clearly showed task assignments for all work products and activities.

Software Quality Assurance KPA

- Representatives from the Quality Assurance (QA) group had started to attend some of the weekly reviews to increase their understanding of the TSP processes.
- The QA group's organizational role in weekly management meetings expanded to report on the TSP project's use of their newly acquired processes.

Software Configuration Management KPA

- The project's Configuration Management (CM) plan was prepared in accordance with the TSP and the organization's CM and data management processes.
- The TSP scripts provided guidance on CM activities for the software engineers.
- Software work products placed under CM were identified in the CM plan and the TSP scripts, and the TSP process was used to track changes and problem reports.

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Maturity Level 3 Impacts of TSP Realized

Organization Process Definition and Organization Process Focus

Key Process Areas (KPA)

- Software engineering and other related groups received orientation on process improvement activities and their roles and responsibilities in the Personal Software ProcessSM and Team Software ProcessSM (PSPSM/TSPSM).
- Needed project processes were identified with the TSP process inventory launch step and process performance data was beginning to be collected.
- The organization's approved life cycles had started to incorporate the PSP/TSP.
- A process improvement proposal repository was being created and the project was conducting post-mortem sessions at the end of each build cycle.

Training Program KPA

- The project's training plan included the PSP/TSP.
- The TSP launch training provided an orientation to the applicable roles required to both launch the project and operate on a weekly basis.

Integrated Software Management KPA

- The TSP launch scripts required the team create a process inventory that identify any weak or missing processes needed to deliver their product.
- The project was managed according to the TSP scripts and used the TSP data (metrics) for software planning and estimating.
- Project cost and effort was managed in the organization's Earned Value Management System (EVMS) according to the TSP launch/re-launch handbooks. Detailed TSP data from the individual engineer level clearly fed into the EVMS system and provided insight to better understand EVMS data.
- Software risks (programmatic and technical) were identified, assessed, and tracked according to TSP risk scripts.

Software Product Engineering KPA

- The TSP software engineering tasks were clearly understood, integrated, consistently performed, and measured.
- Project TSP plan workbooks were used by all project personnel to plan and track their work efforts.
- Tools such as object oriented analysis and object oriented design, the PSP/TSP scripts and checklists, and EVMS were integrated into the project's process.
- Defects were collected by each member of the project team during every phase of development and then analyzed by the team at post-mortem.
- The TSP performance measures collected were then used to determine status on project phases and to improve the process for the future project plans.
- The TSP processes helped the software, systems, test integration and project management teams work more closely together on project planning throughout the software life cycle.

Peer Review KPA

- Peer reviews were planned and documented in each engineer's TSP project plan workbook.
- Peer reviews were performed in accordance with the TSP scripts and the organization's peer review process.
- Engineers, in both individual and peer reviews, used the TSP scripts and the launch workshop notebook to collect defect data throughout the project.

training consisted of an executive workshop (one day), management and support staff training (two days each), and software engineer training (14 days).

A TSP launch was then conducted in January 2001 where the project was defined to have five build cycles. As a result, the launch has been followed by supporting re-launches in April 2001, December 2001, February 2002, and most recently June 2002.

The Appraisal

The CBA-IPI appraisal of the AV-8B JSSA organization took place in May 2001. Two AV-8B JSSA software projects were examined during this appraisal – the TSP project and a non-TSP project of similar size. The appraisal focused primarily on

SW-CMM Level 2 and Level 3 goals. To better understand the impact of the TSP, a decision was made by the appraisal team to also *listen* for Level 4 and Level 5 evidence as it related to TSP. These observations would help determine which SW-CMM Key Process Areas (KPA) were influenced by the use of the TSP on the project and to what extent.

The Maturity Level 2 Impacts of TSP Realized sidebar (see page 5) and Maturity Level 3 Impacts of TSP Realized sidebar (above) outline the TSP-related observations for SW-CMM Level 2 and Level 3 KPAs, as noted during a CBA-IPI appraisal of the AV-8B JSSA.

These TSP observations represent a solid process foundation upon which other capabilities can be effectively built.

In addition to the Level 2 and Level 3 evidence, the appraisal team also noted a number of higher-maturity observations at Maturity Levels 4 and 5. These are shown in the sidebar, High Maturity Impacts of TSP Noted During the Appraisal.

Feedback from the Engineers

The TSP-trained software engineers at the AV-8B JSSA enthusiastically admit that TSP improves the way the organization plans, schedules, and tracks work, and also provides a strong emphasis on higher quality software. This statement is even true of those who initially doubted the TSP as just another management fad.

These statements summarize their TSP sentiments:

- The TSP tracks the quality of what we are producing, not just the time we produce it in.
- You can look at what you did previously.
- You really see how good a product is.
- It is easy to track all the information.
- Once the PSP/TSP becomes your process, it is relatively effortless.

Comments from select TSP project team members are worth repeating. "It is the future, I am sold on it," adds the software team lead. The software lead goes on to explain how TSP benefits both the organization and the individual. "People with TSP/PSP training can go from project to project. They are much more versatile. When the organization as a whole does better work, you don't need a superstar to pull it along."

The TSP project's lead software design engineer has become one of the organization's strongest advocates of PSP/TSP. "PSP really sells you on finding defects early in the process. It really does make a difference at the end. We thought it wasn't going to work. But we all became converts by producing valuable data all along the way. We also significantly improved productivity. I worried because I have seen too many people more interested in the process than in the product. But TSP keeps you focused entirely on the project as you finish smaller products at regular intervals."

He also talked about the importance of software design in the PSP/TSP. "You have got to have good design to get good code. One advantage of doing design in TSP is the design review process. These reviews help you find and fix potentially costly defects much sooner."

Another project software lead views PSP/TSP like this: "The whole idea of keeping historical data is to make the

product cost less ... to make better estimates for future work. A big benefit of PSP/TSP is that you can document what changes will cost."

The leads of both the TSP and non-TSP projects shared the same viewpoint. "In the end, what this is really about is people. No matter what you invest in terms of training and overhead, what you are really investing in is people. And the important thing is that we improve what we are doing."

Feedback from the SSEPG

"Including a TSP and non-TSP project in the same appraisal was very insightful," said the lead of the AV-8B JSSA's SSEPG. "While both projects had the necessary process evidence, finding and understanding the TSP project evidence was effortless. Three-quarters of the SW-CMM requirements for Level 2 were automatically satisfied simply by the project following TSP." This SSEPG lead is another TSP convert at AV-8B, along with her appraisal teammates.

TSP Project Evolution

The second build cycle delivered a testable product with some functionality. At their last re-launch, this seven-person TSP project had completed a 41-week development effort in 45 weeks, or within 10 percent of their original estimate. The defect density of the product at system integration test was 2.1 defects/thousand lines of code. Perhaps the most significant quality-related observations have come from the systems and test engineers. They are astounded by the robustness of the application and its 100 percent up time. For them, this is a first.

After that the project continued with planning their work and working their plans with the TSP. After the May 2001 appraisal, the project conducted two additional re-launches associated with the third build cycle of their product.

The first of these was in December 2001; it planned the project through to the following June 2002. Of particular interest was the fact that during this re-launch another mini re-launch was planned. This was because the team felt a mid-course correction would be needed due to the fact that new work with no historical basis for planning was starting up. This meant that it would be in their best interest to stop and re-plan. This re-launch was conducted in February 2002 and was very effective in quickly allowing the team to apply recently gathered metrics and re-plan accordingly for the rest of the third build cycle.

The project is now underway after its most recent launch, conducted in June 2002, that planned the fourth build cycle.

Filling in the Organizational Gaps and Overlaps

The TSP and the SW-CMM are complementary by design. However, since the TSP concentrates on project issues, it does not address the broader organizational aspects of the SW-CMM. Even if all teams in an organization were using the TSP, there is still the need for an additional thin layer of organizational support. That organizational support is more obvious at SW-CMM Level 3, where projects are expected to use a common set of documented and approved management and engineering processes. In addition to the gaps, there are also overlaps between the TSP and the SW-CMM to consider.

Both the gaps and the overlaps have challenged the AV-8B JSSA. Filling the biggest gap meant creating a developmental change control board, which the TSP assumes is in place organizationally. For many lower-maturity organizations, creating this board may be a TSP project effort that the organization can then adopt as a standard approach. That was the case at AV-8B.

The second challenge was an overlap between the TSP project roles and organizational roles. Both the TSP project and the organization have duplicate roles that are responsible for processes, configuration management, and quality assurance. Negotiating the roles, responsibilities, and functional touch-points for these duplicate sets of roles takes time, effort, and patience.

The good news is that the AV-8B JSSA is a stronger, more effective organization for filling the gaps and eliminating the overlaps. NAVAIR's lead TSP coach will also be able to further leverage this experience by sharing AV-8B's lessons learned with other NAVAIR TSP projects.

Conclusions

The TSP launches and executes projects

with individuals trained in the PSP. These teams follow standards contained in a disciplined, automated process framework. It is important to understand that the PSP and TSP frameworks are flexible and should be evolved based on the team and organization's needs. The primary vehicle for this evolution is the process improvement proposal – a fundamental element of the TSP.

The AV-B JSSA is on its own unique evolutionary TSP path. It is plowing new ground by integrating its TSP tools with its EVMS, which is one of only two EVMS systems in NAVAIR currently certified. It is also reshaping the TSP for application to its maintenance software projects. With strong support for the TSP coming from all levels of the organization and results that speak for themselves, the AV-8B JSSA feels their process improvement initiatives will continue on an accelerated course. ♦

References

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2. Davis, N., and J. McHale. Relating the Team Software Process to the Capability Maturity Model for Software (CMU/SEI-2002-TR-008). Pittsburgh: Software Engineering Institute, Carnegie Mellon University, 2002.
3. Vu, J.D. "Process Improvement Journey (From Level 1 to Level 5)." European Software Engineering Process Group, 2001.
4. Software Engineering Institute. Process Maturity Profile of the Software Community – 2001 Year End Update. Pittsburgh: Software Engineering Institute, Carnegie Mellon University, 2002.

Additional Reading

1. Humphrey, Watts S. Introduction to the Team Software ProcessSM. Boston: Addison-Wesley, 1999.

High Maturity Impacts of TSP Noted During the Appraisal

Maturity Level 4 and 5 Key Process Areas

- The Team Software ProcessSM (TSPSM) is beginning to provide the organization a foundation for software quality management activities.
- Quality goals are being established using TSP launch scripts and defects are being tracked using the Personal Software ProcessSM and the TSP.
- The TSP is helping to establish organizational defect prevention activities.
- The TSP collects and consolidates defect data for current and future use, which supports awareness by this project, and use of defect data by other projects.
- Data to support continuous process improvement are becoming available through TSP by capturing and acting on process improvement proposals. TSP post-mortems are scheduled and held to identify improvement opportunities.

About the Authors



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WEB SITES

Team Software Process: Software Engineering Institute

www.sei.cmu.edu/tsp

To have a high-performance software organization you must have high-performance teams, staffed with high-performance software engineers. The Personal Software ProcessSM (PSPSM) and the Team Software ProcessSM (TSPSM) provide a road map for organizations and individuals to follow on the road to high performance. The TSP provides specific guidance about how PSP-trained engineers can work as effective team members on a high-performance team. The PSP provides specific guidance on how individual engineers can continually improve their performance.

Software Productivity Consortium

www.software.org

The Software Productivity Consortium provides reduced-to-practice technology for the development of systems and software, and is a vehicle for members and affiliates to adopt, implement, and improve their processes, methods, and technologies for developing software-intensive systems. Its structure as a consortium fosters a collaboration to leverage pooled resources among members, share lessons-learned, and develop targeted technologies that meet fundamental and common needs of all members, and are experienced with a multitude of process and framework models.

Earned Value Basics

www.acq.osd.mil/pm/evbasics.htm

Earned value is a management technique that relates resource planning to schedules and to technical cost and schedule requirements. All work is planned, budgeted, and scheduled in time-phased "planned value" increments constituting a cost and schedule measurement baseline. There are two major objectives of an earned value system: to encourage contractors to use effective internal cost and schedule management control systems, and to permit the customer to be able to rely on timely data produced by those systems for determining product-oriented contract status. The benefits to project management of the earned value approach come from the disciplined planning conducted and the availability of metrics, which show real variances from plan in order to generate necessary corrective actions.

Software Technology Support Center

www.stsc.hill.af.mil

The Software Technology Support Center is an Air Force organization established to help other U.S. government organizations identify, evaluate, and adopt technologies to improve the quality of their software products, efficiency in producing them, and their ability to accurately predict the cost and schedule of their delivery.