Using TSP With a Multi-Disciplined Project Management System

Timothy A. Chick
Naval Air Warfare Center

The Team Software Process℠ (TSP℠) provides an extraordinary amount of data, including project planning and tracking data in terms of task hours and earned value, but it does not provide a mechanism for incorporating the plans of multiple teams, which do not all use TSP. In today's world of large and complex systems, the project must consist of multiple disciplines such as software engineers, system engineers, hardware engineers, domain experts, test engineers, and other support personnel. To plan and track a multi-discipline project, a consolidated plan must be created and tracked. Not all disciplines are able or willing to use TSP, so traditional project planning and tracking methods must be used for the overall project.

Standard Team Software Process℠ (TSP℠) for a single project is designed for software teams of between three and 15 software engineers. TSP does not address other disciplines or how to integrate the plans and schedules of the many individuals needed to develop, build, or maintain a large complex system. Because it does not address how to integrate the plans and schedules of a large system, it also does not address how to manage or track such a large project.

This is the dilemma I found myself in a few years ago when my organization decided to begin using TSP for its software work. In addition to software engineering, a typical project for my group includes systems engineering, independent verification and validation, domain expertise, flight testing, and multiple support functions such as configuration management and quality assurance. Of all these disciplines, only the software engineering group was able or willing to use TSP, so traditional project planning and tracking methods were needed for the overall project.

Why Have a Consolidated Plan?

A consolidated plan forces the many disciplines' practitioners to think through their approach and make decisions about how to proceed. It forces the disciplines' practitioners to think outside their proverbial bubbles and consider how the work they perform impacts other groups. Network-based schedules can then be created to identify the interdependencies of activities and the impacts of late or early starts.

Once the schedule is developed, a critical path can be identified and *what if* exercises can be performed. In addition, resources – including facilities, equipment, and personnel – can be identified and tracked. The earned value (EV) method for each task should be determined during the development of the plan. The consolidated plan will provide a vehicle to facilitate executive and customer review. The process of developing a consolidated plan will often identify missing work in the individual team's plans, thereby identifying potential problems early.

A consolidated project plan should define how, when, by whom, and for how much. It should adequately reflect contract milestones, establish meaningful indicators to measure work progress, and allow for the identification of specific activities and events that contribute to schedule variances. Without addressing the interdependencies of the many disciplines, you cannot adequately address these questions.

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TSP Versus Traditional Project Planning and Tracking

TSP encapsulates many of the elements of traditional project planning and tracking such as work breakdown structure (WBS) or size summary (SUMS), which is a deliverable-oriented, hierarchical decomposition of the work to be executed [1]. TSP also addresses things like tasks and resource allocation at a much more detailed level than most common project plans. However, TSP does not fully encapsulate other concepts of traditional project planning and tracking such as (1) resource dictionaries, which include labor category, rate (cost/staff hour), and resource availability; (2) tasks with associated logic; (3) Gantt/Pert graphs; and (4) critical path analysis. This article will only scratch the surface of some of these concepts; for more details refer to [1].

After many years of experimenting and using different techniques for project planning and tracking, my organization has developed the following guidelines to consider when developing a consolidated plan:

- WBS – develop to two or three levels:
  - Determine EV method.
    - TSP tasks use percent complete as defined in the section "Converting TSP EV Into EVMS EV" (see page 6).
    - Non-TSP tasks use 50/50 as the preferred method; 0/100 is only used for tasks less than or equal to a one-month duration or reporting period.
    - Work activities are not to exceed two-month durations or two reporting period durations.
  - Tasks should be discrete, resulting in a product or measurable result.
  - Resources should be assigned with budgeted hours or expense.
- Limit level-of-effort (LOE) activities to less than 10 percent of total effort.

Earned Value Management

EV is the budgeted value for an element of work that has been completed, with that value determined from what had initially been planned for accomplishing that element of work. EV techniques have been developed to provide multiple ways to measure accomplishment that best fits

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the work being accomplished [2]. TSP uses the EV technique 0/100, which allows no credit of a given task until the task is completed. No value is earned for starting a task or for partially completing a task.

This planning technique should be limited to tasks that are planned to start and complete within the same reporting period. This method works well using TSP because TSP breaks the work task down to such granularity that a task is completed every week, which is the reporting period of a TSP team. A TSP team meets weekly to discuss individual status and how it impacts the team's commitments.

I have found, however, that this method usually does not work very well for a large complex project, which uses traditional project planning and tracking because developing such a detailed plan at the project level is usually not realistic. It is very difficult to break tasks down to extremely small elements and still be able to accurately apply duration and logic while still accounting for any interdependencies with other disciplines.

For example, many projects report EV monthly. In this case, 0/100 would be a good method of EV for tasks that are less than one month in duration. If you used 0/100 for tasks that had duration longer than the reporting period, then you would have spikes in your EV. This makes it very difficult to determine if the project is progressing as planned or if corrective action is required.

Other EV methods not used by TSP are 50/50, percent complete, and LOE. The 50/50 technique is typically used when the task begins in one reporting period and completes in the next. The 50/50 technique credits 50 percent of the EV when a task is started and 50 percent of the EV when the task is completed. By receiving EV for starting and completing the task, this method allows a project to show progress during both reporting periods.

The least desirable of the discrete EV techniques is the percent-complete method. Percent complete allows an estimated percent completed to be assigned for a given reporting period. Unlike 0/100 and 50/50, this method can be extremely subjective. For example, if the estimated percent completed is based on opinion rather than on an objective evaluation of the work completed and the work remaining, then the EV assigned to the task may be grossly inaccurate.

Certain tasks are difficult to quantify in terms of work accomplished; these tasks are referred to as LOE. Because the EV will always equal the budget, there will never be any schedule variance. This method should only be used for tasks in which no tangible product is developed such as project management, clerical support, etc. This method would be used for many of the off-task items identified in TSP such as meetings, phone calls, or anything else not directly related to the immediate activity.

In my experience, groups that are new to EV try to use this method the most because it is the easiest to define and track. The problem is that it does not usually give an accurate picture of how the project is progressing. In fact, when LOE is greater than 10 percent of total effort, the EV becomes skewed to the point that it is very difficult to determine if the project is on schedule or on cost, and if the project will be able to make its commitments.

Developing a Project's EV Management System With TSP as an Input

Now that I have gone over why a consolidated plan is needed and some of the differences between TSP and traditional project planning and tracking, how do you make the leap from a TSP launch to a consolidated project EV management system (EVMS)?

The TSP launch provides most of the core data elements needed as input into a consolidated EVMS. It provides estimates, tasks to be performed, durations, sequential logic and milestones, and assigns resources to tasks. The data hours found in TSP are the *task hours* that resources will actually work to complete the task identified in TSP. The EVMS system captures *staff hours*, which are all of the hours the resources work in each period. Therefore, a conversion of the data is necessary. The EVMS system also needs to capture interdependencies in more detail than identified using TSP.

As stated previously, TSP breaks its major tasks down into granular tasks that can be completed within a one-week period. This can be considered too much detail to maintain in a consolidated project plan. So translation between a TSP task and an EVMS activity is done by translating SUMS assembly items to activities in EVMS. The resources are then assigned to the EVMS activities by determining the resources assigned to the corresponding TSP tasks.

The task hours planned for the SUMS assembly items must be converted into staff hours. When we first made this conversion, we did what any good planner does when he or she has no historical data: We estimated based on personal experience. We knew the average task hours per week the TSP team used for estimation, and we knew the average hours per week an engineer worked, thus giving us a starting ratio for task hours to staff hours. Once we collected some historical data, we determined that based on the type of work being performed, the task hour to staff hour ratio varies between 2.0 and 2.62. That is, it takes between 2.0 and 2.62 staff hours for every TSP task hour performed. Knowing this, we accurately converted task hours planned during a TSP launch to staff hours for EVMS purposes. Once the estimated staff hours were determined, we used the resource hourly rates to develop cost estimates.

The duration of EVMS activities can be determined by using the start and completion date of the first and last phase mapped to the TSP assembly. EVMS milestones are updated based on any milestones identified during the TSP launch, along with milestones identified from other project entities.

Using the task log in Table 1 (see next page) as an example, one of the activities in EVMS is called *Widget A*. Jack, John, and Jill are assigned resources for Widget A. According to the task log, Jack is assigned 200 planned task hours, and John and Jill are both assigned 44 planned task hours. Using the TSP task hour to staff hour ratio of 2.62, Jack would be assigned 524 (200*2.62) staff hours, and John and Jill would be assigned 115 (44*2.62) staff hours in EVMS for Widget A. The duration for Widget A in the EVMS would be 95 days because the planned start week and completion date is week 5 and week 24, respectively ((24 weeks minus 5 weeks)*5 days/week = 95 days). The predecessor of Widget A would be Widget B, and the successor of Widget A would be Widget C because of the order established during the TSP launch.

Once the conversion of TSP launch data to EVMS data is done, additional analysis needs to be made of the project's consolidated plan before it is considered complete. TSP off-task activities need to be identified and budgeted in the EVMS system. This includes TSP roles such as planning manager, test manager, design manager, and team lead. These tasks should be as specific as possible so that the correct method of EV can be assigned, trying to avoid LOE activities as much as possible so that project LOE does not exceed 10 percent of the total effort.

Dependencies between the TSP team's activities and other disciplines should be identified and linked in the EVMS. This allows for the establishment of the project's critical path. The dependencies should also be analyzed to determine the impact to the other disciplines' plans, and to determine any resource allocations such as facilities' needs to be changed. Once this additional analysis is completed, the consolidated plan is ready to be baselined. The baseline is the basis in which the project's performance is measured against using EV.

At this point, you may be thinking it is a lot of work to baseline a consolidated project plan – and you would be correct. In fact, most large projects only rebaseline once or twice a year and only if the projects' overall performance against the baseline varies so much that the plan no longer reflects reality sufficiently to manage the project. So how do you take into account that TSP teams usually relaunch every three to four months?

This method required that the TSP team plan the entire effort up front, even if the effort is over a year in duration. When TSP teams relaunch, the current plan in the EVMS is updated but not the baseline. The only time the EVMS baseline will be updated with a team's relaunch data is when the entire project undergoes a project rebaseline.

During the period that the EVMS baseline does not reflect the TSP team's relaunch, the TSP relaunch data will be used as the basis for any EVMS action plans developed due to a deviation outside the project's defined acceptable variance, usually plus or minus 10 percent cost and schedule. In other words, a relaunch is simply a mechanism for developing a detailed action plan for correcting inaccurate plans developed during a TSP team's initial launch.

It is important to note that even though the overall team plan may extend for several years, the TSP's detailed plans extend for only a few months [3]. Thus, it should be expected that once the TSP team goes beyond the first few months following the TSP launch, the team will begin to vary beyond the EVMS baseline due to the fact that TSP launches and relaunches are not designed to develop a detailed plan beyond a three- to four-month period.

For example, Figure 1 represents the consolidated EV for a multi-disciplined project that consists of four TSP teams – system engineers, hardware engineers, domain experts, test engineers – and other support personnel. Figure 1 shows that both the cost and schedule are within a 10 percent variance, thus the project is performing within expected parameters.

Figure 2 is an EVMS report generated at the TSP Team A level of the multi-disciplined WBS. It shows that TSP Team A is behind schedule by 11 percent and over budget by 49 percent when comparing the team's current status against its baseline plan. Because this team is outside the 10 percent cost and schedule thresholds, the team is required to develop an action plan on how it will address these variances. One way for the team to address these variances is to conduct a relaunch, which would provide very detailed plans. Both the TSP team and project management can then use these detailed plans to mediate the impact to the overall project. Because the project is performing well, based on Figure 1, TSP Team A's performance would not justify the expense or effort needed to rebaseline the entire multi-discipline project. Thus, for EVMS purposes, TSP Team A would be tracked against its action plan.

Converting TSP EV Into EVMS EV

TSP teams can use a modified percent-complete method when converting TSP EV into EVMS EV. I mentioned earlier that percent complete could be subjective due to the lack of unbiased judgment. In this case, because TSP tasks are at a more granular level than the EVMS activities, the TSP tasks become the unbiased element used to determine percent complete.

One way of updating the completion of a TSP task is using the percent-complete method, which is assigned to the EVMS activity proportionally to the total number of unique TSP tasks mapped to the TSP assembly. For example, if five unique tasks are mapped to Assembly A and two of the tasks have been completed, then Activity A, in the EVMS, would be 40 percent complete. Some TSP tools such as Process Dashboard automatically calculate the percent complete at a given assembly level, in which case the number would be the percent complete in the EVMS for the corresponding activity.

Actual cost and actual staff hours expended on an activity in the EVMS should be recorded using a timecard sys-

Table 1: *TSP Task Log*

Assembly	Phase	Task	Resources	Estimated Size	Size Measure	Rate (per hour)	Estimated Hours	Engineers	Plan Hours	Plan Date	Plan Week
Widget B	PM	Widget B - Post-mortem	Jack	3	LOC	8.3	0.4	1.0	0.4	7/19/2004	5
Widget A	PLAN	Widget A - Research and Planning	Jack	2,000	LOC	200.0	10.0	1.0	10.0	7/19/2004	5
Widget A	DLD	Widget A - Detailed Design	Jack	2,000	LOC	47.6	42.0	1.0	42.0	8/23/2004	10
Widget A	TD	Widget A - Test Development	Jack	2,000	LOC	200.0	10.0	1.0	10.0	9/6/2004	12
Widget A	DLDR	Widget A - DLD Review	Jack	2,000	LOC	125.0	16.0	1.0	16.0	9/13/2004	13
Widget A	DLDINSP	Widget A - DLD Inspection	Jack, John, Jill	2,000	LOC	90.9	22.0	1.0	22.0	9/27/2004	15
Widget A	CODE	Widget A - Code	Jack	2,000	LOC	47.6	42.0	1.0	42.0	10/25/2004	19
Widget A	CR	Widget A - Code Review	Jack	2,000,	LOC	153.8	13.0	1.0	13.0	11/1/2004	20
Widget A	COMPILE	Widget A - Compile	Jack	2,000	LOC	400.0	5.0	1.0	5.0	11/1/2004	20
Widget A	CODEINSP	Widget A - Code Inspection	Jack, John, Jill	2,000,	LOC	90.9	22.0	1.0	22.0	11/15/2004	22
Widget A	UT	Widget A - Unit Test	Jack	2,000	LOC	125.0	16.0	1.0	16.0	11/29/2004	24
Widget A	PM	Widget A - Post-mortem	Jack	2,000	LOC	1000.0	2.0	1.0	2.0	11/29/2004	24
Widget C	PLAN	Widget C - Research and Planning	Jack	400	LOC	200.0	2.0	1.0	2.0	11/29/2004	24

Note: For DLDINSP and CODEINSP, the number of engineers is listed as 1.0. This is due to the replication of task that occurs using the Software Engineering Institute's TSP tool. This is only one of many equally valid methods used to address the replication of tasks to multiple individual workbooks when multiple engineers are assigned as a resource.

tem or other mechanism and not by using the task hour to staff hour ratio. This conversion should only be used for planning purposes. Both TSP and non-TSP teams need to collect these actual staff hours expended in the same manner to maintain consistency and validity of EVMS data.

Conclusion

TSP allows software teams to consistently meet commitments [4]. TSP provides an extraordinary amount of data that can be used for project planning and tracking. This data can be effectively incorporated into a consolidated multi-disciplined project plan. By incorporating the TSP data into an EVMS that tracks the entire project and not just the software development effort, the project is able to consider how work performance by one group impacts other groups within the project.

TSP encapsulates many traditional project planning and tracking elements such as WBS, tasks, and resource allocation. TSP does not fully encapsulate other concepts of traditional project planning and tracking such as critical path and dependencies.

TSP uses the 0/100 method of EV. Other EV methods not used by TSP include 50/50, percent complete, and LOE. It is important to select the appropriate method of EV to accurately measure the performance of an activity. When selecting an EV method for a project, duration and type of activity are the primary considerations.

Most of the information required to develop an EVMS project plan can be obtained from a TSP launch. In addition to this data, you must consider TSP off-task activities (LOE), dependencies between the TSP team's activities and other disciplines, and the project's critical path.

For project tracking purposes, once the TSP data has been incorporated into the EVMS project baseline, a TSP team can use a modified percent-complete method when converting TSP EV into EVMS EV. Because TSP tasks are at a more granular level then the EVMS activities, the TSP tasks become an unbiased element used to determine percent complete.

Most large projects only rebaseline the project plan once or twice a year, or when the project's overall performance against the baseline varies so much that the plan no longer reflects reality. Including the entire software effort in the EVMS baseline requires that the TSP team launch the entire effort – not just the next three- to four-month effort. For EVMS, a TSP relaunch is used simply as a mechanism for developing a detailed action plan for correcting inaccurate plans developed during a TSP team's initial launch or during the initial EVMS baseline.

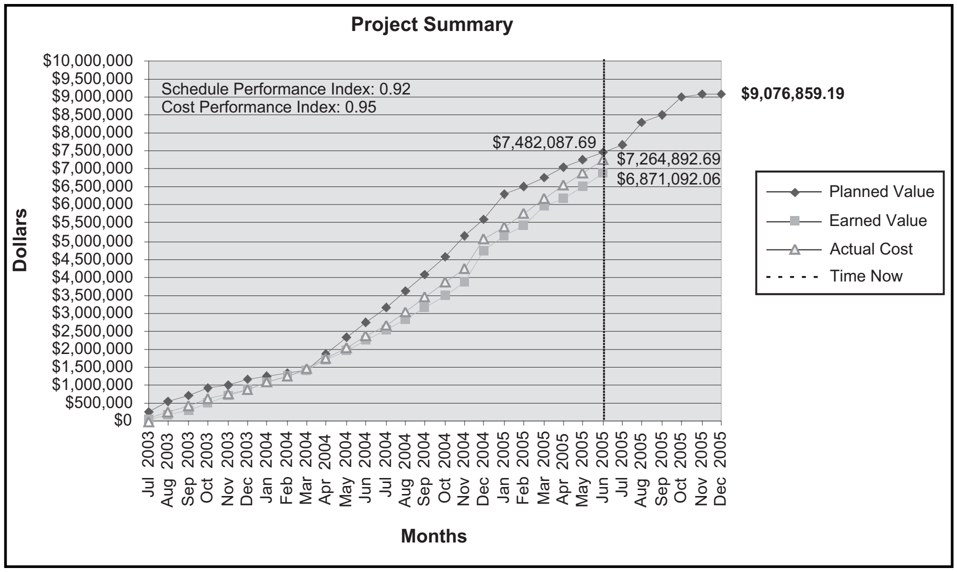

Figure 1: *Project Summary EVMS Report*

TSP does not eliminate the need for developing a consolidated project plan and tracking progress against the plan, especially in the world of very large and complex systems that consist of personnel from multiple disciplines such as software engineering, system engineering, hardware engineering, domain expertise, test engineering, and other support personnel.

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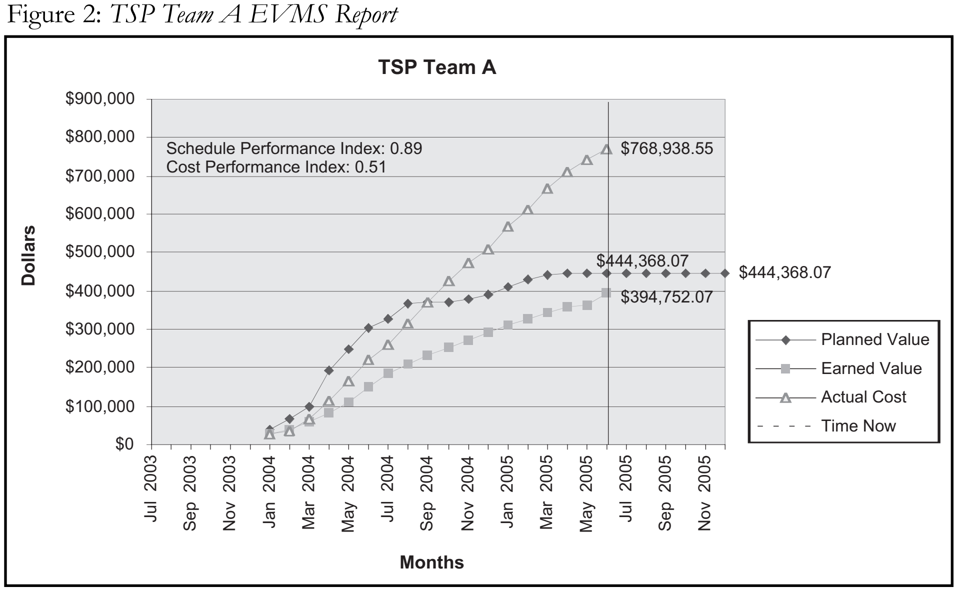
Figure 2: *TSP Team A EVMS Report*



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About the Author

Timothy A. Chick is the software manager for the Hawkeye: Navy Airborne Warning and Control System Aircraft (E-2C HE2K) Software Support Activity for the Naval Air Warfare Center (NAVAIR), a division of the Department of the Navy at Patuxent River, Md. He is also the Software Engineering Process Group lead and a certified Personal Software Process[SM] instructor and trained Team Software Process[SM] coach. Chick has been with the E-2C program for more than six years. He has held several positions, including project team lead and software engineer. He has a Bachelor of Science in computer engineering from Clemson University and a Master of Science in computer science from Johns Hopkins University.

Naval Air Warfare Center – Aircraft Division
BLDG 2185 STE 1190-B2 4.1.4
22347 Cedar Point RD UNIT 6
Patuxent River, MD 20670
Phone: (301) 342-0489
Fax: (301) 757-3219
E-mail: timothy.chick@navy.mil

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