Planning and Scheduling Training For Working Project Teams at NASA

by F. G. Patterson Jr.

In 1988 the National Aeronautics and Space Administration began its Program/Project Management Initiative (PPMI), a curriculum of Agencywide training in systems engineering and systems engineering management. Since its inception, many courses have been offered. Sixteen courses are now offered on a regular basis, shown in Figure 1. Between 1988 and May 1996, PPMI conducted 294 courses and trained 6,368 people.

Each of the courses has been designed and prepared for an Agencywide audience and addresses specific issues that confront NASA management. One of the most basic project management skills is *planning and scheduling*. In even the most rudimentary performance, a manager must prepare an ordered list of tasks, allocate resources to each task, and prepare a schedule that is realistic enough to convince higher level management that proper controls are in place. Because of its importance, planning and scheduling is included as part of several PPMI courses. These courses present a methodology for planning and scheduling to a diverse NASA-wide audience of both civil servants and contract personnel.

Problems with Traditional Methods of Project Planning and Scheduling

Planning and scheduling is an activity that has much in common with the definition of product requirements, and although the similarities may be recognized, the activities are usually conducted much differently. In the generation of product requirements, the engineering community is increasingly alert to the need of working with a group of stakeholders that is thought to be representative of all active interests in the development of the product. Representing what he refers to as the viewpoint of the sociologist, M. Jackson (1995) describes the definition of a system as something that "has to be continually renegotiated subjectively between the various stakeholders, who all have their own agendas and perspectives." In most NASA projects, the efficiency of the requirements team approach is preferred to a canvassing approach. Thus, a requirements team of stakeholders is carefully picked, and a process of requirements engineering is carried out (Patterson, 1997). The result of the team approach is a specification that reflects the needs of all the members of the team.

APM	Advanced Project Management
CoF	Construction of Facilities Management
CBP	Construction of Facilities Best Practices
IPM	International Project Management
MPM	Multi-Project Management
PM	Project Management
PPS	Project Planning and Scheduling
PROGM	Program Management
REQ	System Requirements
SAM	Software Acquisition Management
SE	Systems Engineering
SPI	Software Process Improvement
TM	Task Management
TPM	Topics in Project Management
TSPM	Topics in Software Project Management
TTC	Technology Transfer & Commercialization

Figure 1. A current offering of PPMI courses.

Most planning and scheduling activities, on the other hand, are done by the project manager, who often has the "help" of a support contractor, sometimes referred to as a *planner*. The conscientious project managers who compose their own plan and schedule have the benefit of adjudicating every decision,

negotiating every tradeoff, and, indeed, of participating in every word and symbol in the documentation, thus taking ownership of the documentation and its contents. Now, while the dedication of such a project manager is commendable, this process limits the scope of the task to the best efforts of a single person.

There is no one right person or group who, to the exclusion of the others, can do an adequate job of planning and scheduling. We have seen again and again that the program or project manager cannot know, or even analyze the quantity and level of detailed data necessary to synthesize a comprehensive plan. Task managers, while collectively representing a broader scope that a single individual, do not speak for or understand the issues of other stakeholders, such as the user community. Scientists are primary customers at NASA, but they are focused on the problem rather than the solution. Engineers have the opposite bias and address the solution rather than the problem.

When plans and schedules are written by a single person or group, and in cases in which contractor planning and scheduling personnel are used, the community of stakeholders is sometimes asked to "review and approve" the work. However, such methods do not often get the investment, understanding, or adequate attention of stakeholders who may be overwhelmed by—or, indeed, may not even recognize their own inputs in—the technical and symbolic language that is commonly in use. Thus, in such cases, there can be little sense of *ownership* of the plans by the stakeholder community.

A more fundamental problem is that a systems engineering approach (Sage, 1992) to planning and scheduling requires attention to project variables in three dimensions (Figure 2):

1. Structure,
2. Function, and
3. Purpose.

While the best efforts of project management may bring structure and process to a project, without stakeholder involvement the purpose dimension is likely to be underrepresented. The result is inevitably reflected in faulty planning.

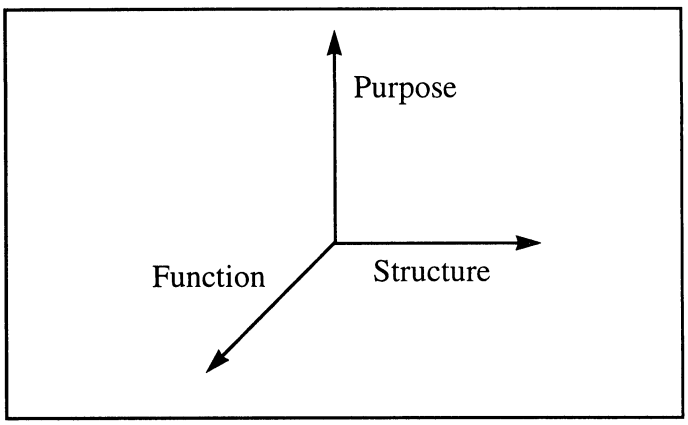

Figure 2. Three dimensions of planning and scheduling.

Problems with Traditional Methods of Project Planning and Scheduling Training

Traditional methods of planning and scheduling training use a "slide, lecture, demonstration, and exercise" format that does not engage the student adequately. In the best cases, fascinating case studies may be presented, in which important classes of problems are brilliantly analyzed and interpreted with the participation of the student. However, without the realism, and the attendant urgency offered by a project in progress, such exercises are little more than toys. In the worst case, students may be passive viewers of a "spectator sport." There is little investment and no urgency about the critical path or other results.

Moreover, the traditional "slide, lecture, demonstration, and exercise" format by its nature even in the best case fails to emphasize the most important aspects of planning:

- *Realistic negotiations among stakeholders* is unlikely. Planning, and replanning as a result of scheduling or other resource studies, is a process of "give and take" that loses effectiveness when it is merely "role playing" in a simulated negotiation in a traditional class setting.

- *The critical role of project manager cannot be realistically simulated*, except perhaps by a well prepared instructor who has thoughtfully studied the script (thus denying the students the opportunity to play the project manager role). There is no real basis for the project manager to decide among alternatives, since there is no reality to use for a reference.

- *Training may be unduly focused on automation*, since, of all the elements of the classroom exercise, the computer-driven process is the most realistic and most transferable to the participant's own project domain.

- *Inadequate training for identifying tasks and dependencies among tasks* is arguably the most elementary and important challenge of all.

NASA Project Planning and Scheduling (PPS) Training

Based in planning theory, NASA PPS training addresses fundamental needs that embody structure, function, and purpose:

- The need to allocate and structure resources (the *structure* dimension):
  - division of labor, positions;
  - structuring of time;
  - phasing of cost.

- The need to implement and to support an orderly process (the *function* dimension):
  - performance of tasks;
  - interrelationships among tasks;
  - roles of people and groups.

- The need to define, develop, and deploy a product that satisfies stakeholders in the project (the *purpose* dimension):
  - continual involvement of stakeholders;
  - availability of appropriate management controls;
  - attention to quality.

NASA PPS training focuses on the structuring of time and cost. As preliminary coursework (for which the Project Manager is responsible before the course meeting convenes), a work breakdown structure (WBS) is developed that will permit the identification of responsibility for the development of subsystems, including civil servants, contractor personnel, and their sub-contractors. Thus, the division of labor and the identification of positions in the project have been accomplished in advance, allowing the PPS training to address the division of time and cost.

During a PPS course, a team of stakeholders is assembled that includes the project manager and staff, subsystem managers and other task managers, customers (in NASA's case, these are often scientists), and experts in other areas whose contribution is essential to the success of the course. For example, an expert on project documentation is usually required. Depending upon the size of the project, the team size may vary greatly.

The basic task for the PPS participants is to determine and write down the tasks that need to be done, to create a partial ordering of the tasks that leads to successful completion of the project, to identify dependencies among tasks, to identify the person responsible for each task, and to estimate the resources required for each task. To accomplish the work of planning and scheduling, the representation of the tasks, their interrelationships, and their resource requirements is an important factor. We have two methods of representation that are currently in use for PPS training, depending upon the size of the project. For smaller projects, we use a Cards-on-the-Wall format that creates a network of resource-loaded tasks using cards to represent tasks and colored string between cards to represent dependencies. Each stakeholder sub-team has its own color for cards. This "life size" representation and color coding of the network allows stakeholders to navigate the walls, inspecting paths of special importance, bringing events of the future into the present where they may be purposefully influenced. For larger projects, we use the "one-pager" (Schoenfelder, 1995) representation.

Method for Smaller Projects

Our PPS course was developed by the Center for Systems Management in Cupertino, California. The course follows the following basic steps:

1. Identification of stakeholders.
2. Commitment to 4-day, 96-hour, off-site meeting with a single goal.
3. Using a WBS, identifications and ordering of project tasks by functional teams.
4. Identification of dependencies among project tasks.
5. Cards-on-the-Wall technique for displaying ordered tasks and dependencies.
6. Approval of network by project manager.
7. Capture of network into automated project management system.
8. Computation and analysis of critical path.
9. Tradeoffs of resources and goals.
10. Repetition of process to create a successful plan and schedule.

PPS training is different from a simple "facilitated meeting" in which a facilitator captures ideas and tries to assist in forming consensus among group members. PPS training uses a format in which the project manager *presides* over the process, but in which the leader *conducts* the process. It has proven to be essential to keep these roles distinct. That is, the project manager must not conduct, and the PPS process leader must not preside. The project manager is responsible for the correctness of the planning, for all assignments of responsibility, and for all other decisions about the *project*. The leader, on the other hand, is an expert on the PPS process and brings efficiency, objectivity, and closure to the meeting, but may know very little about the technical domain of the project being planned. The choice of a leader who can conduct and control the meeting is essential to its success. At NASA this separation of roles has been used very effectively.

Method for Larger Projects

To date, NASA PPMI has had only one experience with a large group of more than 200 people. Our approach used the "one pager" representation format, as previously mentioned. While the "cards on the wall" process undoubtedly scales up for use in larger groups, project managers may wish to use other representation formats for capturing information. For large projects, a recursive system of systems approach is used, in which parallel project planning and scheduling efforts are carried out for the smaller systems.

Beneficial Side-effects of PPS Training

Based upon surveys, participation, and personal observation, there is no doubt that each of the student participants in a PPS training session leaves with a new definition of *planning and scheduling*; a deep appreciation of the basic tools, including GANTT charts, PERT charts, logic networks, critical path analysis, project resource estimation, and automated tools; a personal success story that serves as a model for future planning activities; and an appreciation of the need for and the benefits of good planning. From the viewpoint of the NASA Office of Training and Development, these factors alone justify the use of the intact team approach as a training vehicle.

Moreover, at least four predictable side-effects are extremely beneficial to projects and have made PPS training very popular among knowledgeable project managers. They are:

1. **Team building.** Without exception, every PPS class has reported strongly effective team-building activity, recognition of the needs of other stakeholders, and improved understanding of and appreciation for product requirements.
2. **Identification of high-risk project plan elements.** Teams are compelled to recognize neglected or hard-to-face areas (often software),

understand interactions among tasks, and perceive relationships to critical paths. For example, in one project in which software had been largely ignored, the entire software documentation list was defined, planned, and scheduled during the training, an activity that resulted in identifying software development as the critical path.

3. **Reprogramming of inefficiently used resources.** Each of the most critical resources of a project—time, money, and people—is the object of careful scrutiny by a group of stakeholders, whose interests in the project (the purpose dimension) are at the forefront of their attention.

4. **Recognition and resolution of potential future problems.** By structuring a project plan that extends well into the future to the point of project completion, many errors and omissions may be corrected in the present, eliminating a future cost impact to the project.

Project Planning and Scheduling training with intact teams has been beneficial for students, projects, and the Agency. The intact team format has been used very successfully for more than a dozen smaller projects (25 or fewer participants) over a period of 18 months. It has also been used extremely successfully for one larger project (more than 200 participants).

Because of the PPMI's success with PPS training techniques, training with intact teams is being investigated for use in other program and project management needs. In particular, there are two candidate training programs whose team orientation suggests the intact team approach. They are requirements definition and software process self-assessment.

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