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Project Planning: Getting it Right the First Time [1,2]

Jeffery Webster
Jet Propulsion Laboratory, California Institute of Technology
Pasadena, California, USA
818-393-3269
Jeffery.N.Webster@jpl.nasa.gov

Abstract—As the number of space flight projects being conducted concurrently at the Jet Propulsion Laboratory (JPL) has increased, so has the need for institutional support for the projects. One area of particular importance to Flight Project success is support during the early project planning/formulation phase. Numerous studies have identified front-end project planning as a key element of project success. This paper describes JPL's Project Formulation Support Team (PFST), which plays a central role in providing the institutional support tools and services for projects during their early formulation phases and ensure they get off to the right start. Finally, potential future trends in project formulation are discussed, including the increasing application of information networks to meet flight project needs, the effects of competition in the selection process for new flight projects, and the increasing use of multi-national flight project teams.

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1. INTRODUCTION

In the past JPL planned and conducted three to five large flight projects at the same time. During that time JPL's institutional management and support systems provided oversight and support for the flight projects. However, during the 1990s, and continuing through the present, the number of flight projects being planned and conducted by JPL has increased dramatically. Over the last few years JPL been simultaneously planning and conducting 40 to 50 flight projects at a time.

As the number of flight projects being planned and conducted by JPL increased, so did the need for institutional oversight and support to the projects. JPL's institutional management and support systems have expanded in response to the increased number of flight projects underway. JPL's institutional support systems continue to evolve as new and better tools and services are developed to manage and support the large number of concurrent flight projects underway at JPL.

While the growing number of flight projects underway at JPL has created the need for more institutional support of many types, it is in the area of project planning that the need for improved support assumes particularly high importance. It is during the project planning process that decisions are made which have far-reaching effects on the flight project's ability to achieve successfully its cost, schedule, and performance objectives.

2. PROJECT PLANNING: LAYING THE FOUNDATION FOR SUCCESS

Many fundamental characteristics of a flight project are established during the early formulation phase of the project, during which many project planning activities are implemented. For example, the Project's overall cost, schedule, and technical performance parameters are defined; top-level requirements are established; critical constraints are identified; initial mission and system trade options are outlined, and their associated costs and benefits; and preliminary technology assessments and technology development and infusion requirements are made.

The flight project planning process at JPL occurs mainly during Phase A, Advanced Studies, and Phase B, Mission and Systems Definition, as shown in the JPL Flight Project Life Cycle in Figure 1 below. The JPL project life cycle is contained in the pink field in the chart. The corresponding NASA project life cycle is shown in the blue field at the top of the chart, while the major project reviews and major project milestones events are shown in the yellow field.

[1] 0-7803-8155-6/04/$17.00 ©2004 IEEE.
[2] IEEEAC paper #1354.

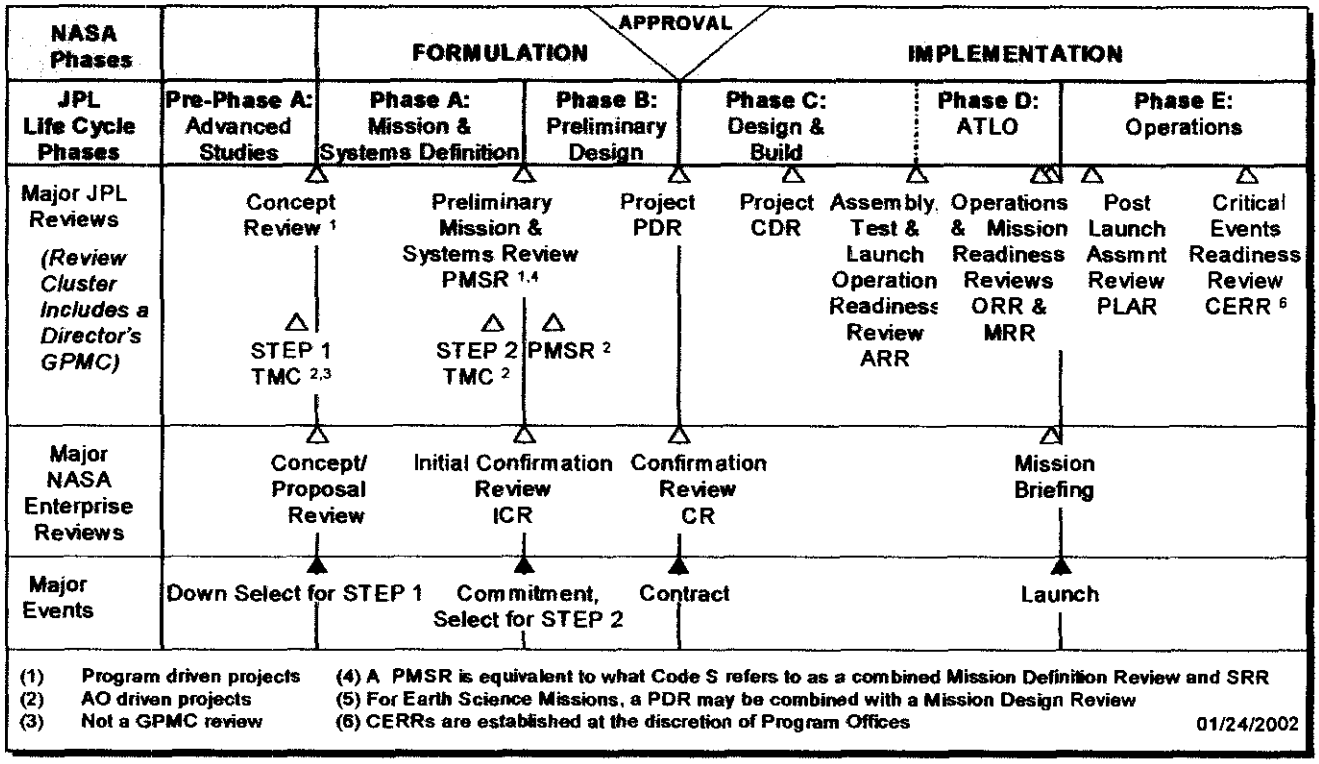

Figure 1: The JPL Project Life cycle

Project Planning is a Key Element of Project Success

As noted in journal articles, engineering guides, and review reports, robust flight project planning is a key element of project success. Abbreviated or under funded Flight Project planning efforts often create the conditions for later problems, or even failures, in development projects and space missions. For example, an analysis by the NASA Comptroller, cited in the NASA Systems Engineering Handbook, states, "Overruns are very likely if (project) Phases A and B are under-funded."[3]

This is a frequently recurring theme. In the October 2003 publication of *ASK Magazine*, the journal of NASA's Academy of Program and Project Leadership, the first lesson learned cited in the article describes the criticality of project planning, as follows: "The seed of problems are laid down early . . . review of most failed projects or of project problems indicates that the disasters were well planned to happen from the start."[4]

In a report on cost growth on NASA missions, the United States General Accounting Office (GAO) cited insufficient definition studies as a reason for cost growth and schedule slips on NASA projects.[5] The GAO report cited two internal NASA studies and comments by NASA officials which specified the need for thorough project definition studies, referred to in this paper as project planning.

In recognition of the importance of project planning, JPL has dedicated significant resources to develop and deploy institutional tools and services to assist flight projects during their early planning stages. A partial list of the tools and services provided by various JPL institutional organizations includes:

[3] "NASA Systems Engineering Handbook, SP-610S," June 1995, pp. 29.

[4] Jerry Madden, "Lessons From the Dark Side," *ASK Magazine*, October 2003, 32-40.

[5] "NASA PROGRAM COSTS: Space Missions Require Substantially More Funding Than Initially Estimated," United States General Accounting Office, pp. 2, 11, December 1992.

- dedicated Proposal Team rooms;
- collaborative engineering facilities and technical expertise, for example JPL's well-known Team X advanced mission design facility;
- the Flight Hardware Logistics Program, which provides hardware from various sources for use by new projects;
- Project Configuration Management and Project Information Management tools and services;
- Launch Approval / Launch Services tools and services; and
- Project Costing tools and services.

3. THE PROJECT FORMULATION SUPPORT TEAM

JPL's Project Formulation Support Team (PFST) is a key element of the Laboratory's institutional infrastructure which provides support to flight projects. The PFST, like several of the other JPL institutional support systems for flight projects which were described above, is part of JPL's Project Support Office. The Project Support Office reports to the JPL Assistant Director for Flight Projects.

At this time the PFST is comprised of 26 members, each with expertise in a discipline or subject area relevant to the Flight Project planning process. The number of members fluctuates over time as people rotate onto or off of the PFST in response to institutional and flight project priorities.

How the PFST Works

New flight projects entering Phase A are candidates for PFST support. The PFST Manager briefs the proposal or project managers on the PFST's role, and the tools and services which are available.

After the project manager decides on what PFST support is needed, the PFST Manager assigns a member of the PFST to serve as the PFST Representative for that project. PFST project planning support normally continues through the end of Phase B, but support activities taper off as the project's planning efforts are completed in preparation for the project's Preliminary Design Review (PDR) at the end of Phase B.

The PFST Representative assigned to the Project is responsible for coordinating all JPL institutional resources which can be used to help the flight project through the project formulation phase. These institutional resources include the Subject Matter Experts on the PFST, and many other non-PFST organizations at JPL such as technical experts from JPL's line organizations, the legal department, and the facilities management division. It is the PFST Representative's job to help the flight project define its project planning needs, and help identify and bring to bear the JPL resources available to meet the needs.

Funding Options for PFST Services

Some PFST-provided tools and services are funded by JPL's institutional accounts and are provided at no charge to the flight projects, as follows:

- Guidance and advice from PFST Discipline and Subject-matter experts on a consulting basis;
- Project Planning tools, such as the Planning Templates described above;
- Identification of institutional resources, such as the non-PFST Subject-matter Experts described above.

When a flight project needs more in-depth or long-duration support from a PFST Representative, the project funds the Representative's work. Examples of such work include:

- developing project requirements and requirements documentation;
- writing project planning documents;
- developing project cost estimates, budgets, or schedules
- implementing project acquisition plans;
- delivering project hardware or software; and
- developing or operating project information management systems.[6]

After the PFST Representative's scope of work has been defined, the Representative begins meeting with flight project personnel and other PFST Subject Matter Experts

PSFT Discipline and Subject-Matter Experts

The standing positions, or seats, on the PFST at this time include the following discipline and Subject Matter Experts:

- Systems Engineering;
- Software Engineering;
- JPL sponsor requirements;
- JPL institutional requirements;
- Mission Assurance;
- Flight Hardware Logistics Program;
- project Work Breakdown Structure;
- project planning;
- project resource planning;
- project scheduling;
- acquisition management;
- launch approval;

[6] Kevin Clark and Ken Van Amringe, "Introduction to Project Formulation Support Team Products and Services," pp 5, August 8, 2003.

- launch services;
- Configuration Management / project information systems engineering / project libraries & information management; and
- Project team development and roles.

The PFST obtains assistance from other Subject Matter Experts at JPL as needed, either to assist a flight project or to create or upgrade one of the PFST institutional support tools

4. PFST PRODUCTS: TOOLS AND SERVICES

The PFST provides two basic types of support for flight project planning efforts during project formulation phase: tools and services. It is important to note that, although JPL's flight projects are required to use some of the tools, such as document templates, which are provided by the PFST, the projects are not required to use PFST services. Rather, PFST services are offered to the flight projects, which then decide which services, if any, will be used.

One of the first things a PFST Representative does is brief the Project Manager on the many sponsor and JPL institutional requirements the project must meet during the project planning phase. From this conversation a more detailed work plan for the PFST Representative begins to emerge. The Project Manager, in consultation with the Representative, decides what specific products and service activities the Representative will perform.

PFST Tools

The project planning tools provided or supported by the PFST consist mainly of tailorable Planning Templates for the project planning products required by JPL or its primary sponsor, NASA. In cases where Templates are not available, examples of project planning documents from past projects are also provided, as appropriate for each project, to use as a guide. The following list shows the Planning Templates presently available for use by flight projects in project planning:

- Detailed Mission Requirements Document;
- JPL Design Principals Compliance Matrix;
- JPL Flight Project Practices Compliance Matrix;
- Project Plan;
- Project Implementation Plan;
- Project Work Breakdown Structure and Dictionary;
- Task Plan; and
- Test Plan[7]

[7] Charles J. Leising, "Project Plans and Activities During Formulation Phase," pp. 20, October 2003.

While Templates are not appropriate for all project planning activities, the application of Templates where appropriate can significantly reduce the time and expense, as well as improve the quality, of project planning activities. Other benefits include improved compliance with sponsor and JPL institutional requirements, and standardized project planning documents which enhance JPL institutional management's ability to review and approve flight project plans.

PFST Services

The assigned PFST Representative provides PFST services to projects. While providing support to the flight project, the Representative's role is that of an advisor to the Project; the Representative is not a reviewer or overseer. When assigned to a project, the Representative becomes a member of the project management team and therefore acts as an agent of the project.

The PFST has members with expertise in the following subject areas:

- Requirements definition and documentation;
- Project Planning;
- Project Scheduling;
- Project Resource Management;
- JPL Standard Work Breakdown Structure Template tailoring;
- Project Information System, including Project library;
- Acquisitions;
- Flight Hardware Logistics Program;
- Launch Approval;
- Launch Services;
- Mission Assurance Planning;
- Technology development/infusion;
- Software management; and
- Team development and roles.[8]

In addition to the specific subjects listed above, PFST Reps provide advice to the flight project on a variety of broad subjects, including:

- the overall JPL project planning process and products;
- JPL sponsor and JPL institutional requirements;
- identification of non-PFST institutional Subject Matter Experts who can address project planning needs in areas such as compliance with

[8] Robert Aster, "Hat Write-up for a Project Representative from the Project Formulation Support Team," pp. 2, October 6, 2003.

environmental laws, security requirements, or export control requirements.

To manage the support process and help ensure success, PFST Representatives documents the commitments made to each flight project with which he or she is engaged. The Representative uses a PFST template to record the products and services he or she agrees to provide to the project, including specific product names or expected outcomes, and planned delivery dates.

5. FUTURE TRENDS

Some of the prominent trends in flight project design, development, and implementation will likely continue for at least the next five years, and will continue to impact the types and amounts of planning support the projects will need. Some of the more prominent trends are discussed briefly in the following paragraphs.

Use of competition to conceive and select new missions, such as those use by the National Aeronautics and Space Administrations' New Frontiers, and Discovery programs, is likely to continue, and perhaps increase. This will be a source of continuing or increasing demand for flight project planning tools and services, which can save time and improve the results of proposal team efforts. For example, the use of tailorable templates in preparing project planning products makes it easier for proposal teams to accurately capture and describe in the proposals the costs and risks the project will have to address during its implementation phase. Use of the planning document templates also helps ensure that sponsor and institutional requirements are included and properly addressed in the proposals.

Flight projects increasingly use information networks in most aspects of their management and engineering functions, including project planning. Many of the institutionally provided project planning tools and services have been created, or at least greatly enhanced, through the use of information networks. For example, information networks have enabled the evolution of collaborative engineering activities from teleconferences to videoconferences, to the integration of shared mission design engineering practiced by JPL's Team X.

Another changing aspect of flight project implementation is which has increased and will likely continue is the use of multi-national partners to plan and conduct the projects. Multi-national missions place special requirements on flight projects that need to be factored into project plans from the start. As discussed in the previous paragraph, flight projects increasingly use distributed information networks to enable and enhance engineering and management activities, both locally and over long distances. For projects with foreign partners, such information networks must comply with complex export-control regulations which dictate the conditions under which information can be shared with the project's non-US team members. Thus, the information network must be able to provide varying levels of access to project data, depending on each user's status. This requirement should be defined early in order to avoid time-consuming and expensive fixes later in the project.

6. REFERENCES

1. "NASA Systems Engineering Handbook (SP-610S)" June 1995, pp. 29.
2. Jerry Madden, "Lessons From the Dark Side," *ASK Magazine*, October 2003, 32-40.
3. "NASA POGRAM COSTS: Space Missions Require Substantially More Funding Than Initially Estimated," United States General Accounting Office, pp. 2, 11, December 1992.
4. Kevin Clark and Ken Van Amringe, "Introduction to Project Formulation Support Team Products and Services," pp. 5, August 8, 2003.
5. Charles J. Leising, "Project Plans and Activities During Formulation Phase," pp. 20, October 2003.
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7. BIOGRAPHY

Jeffery Webster *has a BA degree from the Pennsylvania State University and an MA degree from the University of Southern California. Mr. Webster was a Senior Analyst for the U.S. General Accounting Office for 21 years, and currently is a Staff Engineer in the Jet Propulsion Laboratory's Mission and Systems Architecture Section. At JPL he is a member of the Project Formulation Support Team, and the Proposal Team for a Venus lander mission. At the GAO Mr. Webster was responsible for planning and executing reviews of civilian and military space systems, and reporting the results to the U.S. Congress. Mr. Webster conducted reviews of numerous developmental and operational space programs, including most recently the space shuttle, space station, Cassini, X-33, and Mars programs. He also reviewed and reported on the National Aeronautics and Space Administration's (NASA's) technical and programmatic institutional functions including program and project management, mission assurance, quality assurance, aeronautic and space test facilities, information technology operations, and data management practices. Mr. Webster's work has been recognized by the GAO and JPL in numerous Meritorious Service, Outstanding Achievement, and Exceptional Performance awards, and by the U.S. Congress.*

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