Project Management in NASA: 1980 and Today

by Donald P. Hearth

NASA's public image has been damaged during the past year by a growing public perception that "NASA doesn't manage complicated space projects very well — certainly not as well as they used to." The experiences with the Hubble mirror, the hydrogen leaks in the Shuttle, and the continuing cost and management changes in the Space Station Freedom Program suggest that the public perception has some justification. This situation was, probably, a major factor in the creation of the Augustine Commission which is examining the future U.S. space program as this article is being written.

We should recognize that the problems noted above are isolated ones and that there have been many recent successes; for example, Voyager and Magellan. Moreover, the "good old days" weren't always "good"; we also had technical, cost and management problems in the "old days." Perhaps, one could argue, NASA is being held to a more rigorous standard of project management performance than during its first 30 years. This may very well be the case. Nevertheless, I believe that NASA occasionally deviates from some of its established principles of sound program and project management, and the such deviation may contribute to some of today's problems.

In 1980, I had the privilege to lead a team that examined NASA project management experience since the early 1960s and the problems in the management of then current NASA projects. This study resulted in the identification of factors that encouraged cost growth and schedule slips as well as factors that contributed to successful project management. The findings of the 1980 study are summarized in this article along with a personal set of "Project Management Principles."

The 1980 Study

In the late 1970s, NASA experienced major costs overruns and schedule slips with projects such as Shuttle, Hubble, and IRAS (the infrared astronomical explorer). The NASA Administrator established a study to examine NASA project management and to make recommendations on how to improve the agency's performance.

The team we assembled included individuals with extensive management experience in NASA Headquarters and the NASA Centers, as well as experience with unmanned and manned projects. The team was first rate, including individuals such as Jack Lee (Spacelab Project Manager and current MSFC Director), "Gus" Guastaferro (Director of Planetary Programs in OSSA and currently a Vice President at Lockheed), Charlie Hall (former Pioneer Project Manager), and Tommy Campbell (current NASA Comptroller).

We worked closely with the Administrator's Office, the Headquarters Program Offices, the NASA Centers, NASA contractors, former NASA employees, and congressional committees. As far as we know, no information was denied us, and all of the people interviewed in government and industry were extremely open and candid

The study was conducted over a four-month time period in the three phases outlined in Table 1. The major Conclusions and Recommendations are listed in Tables 2 and 3. Many of the findings relate to actions taken before formal project approval.

Project Management Principles

Most individuals who have been associated with the management of technical projects have their own principles of project management. The 1980 study and the NASA experience have resulted, in my opinion, in the principles noted later. They include activities that occur before a project is approved, since these establish the baseline for implementation of the project. (Many of these principles are included in a memorandum from the NASA Administrator on February 6, 1985, and NASA Management Instruction 7120, approved on the same date.)

Table 1 - The Process Used in the 1980 Study of NASA Project Management

Phase 1

- Cost and schedule data were collected for all NASA projects (spaceflight, aeronautical and large construction) since 1958. The data collected included initial estimates, at the time of "commitment" to the OMB and Congress, and final (or current) figures. In addition, information on all NASA competitive procurements was examined.
- Discussions were held with NASA personnel at various management levels in order to develop a list of potential factors that they felt contributed to cost and schedule growth of NASA projects. Factors identified included contractor "buy in," turnover of NASA project managers, inflation, inadequate NASA travel money, technical complexity, etc.

Phase 2

- The study team selected a group of projects for detailed examination. The 13 projects selected included some that met initial cost/schedule estimates and some that overran initial estimates, as well as projects that were implemented by various NASA Headquarters Program Offices and NASA Centers, some that were implemented in-house and under contract, and some that were implemented at various times in NASA's history. In other words, we attempted to select a representative cross section of NASA projects for intensive study.
- The study team divided itself into two-person teams; each team examined two of the selected projects. Project documentation was examined, interviews were conducted with past and present managers in NASA Headquarters and the Centers, and interviews were conducted with industry personnel that were involved in the preparation of the company's proposal and/or with NASA or the industrial firm. Each team identified, to their satisfaction, the reasons for the cost and schedule performance of each project.
- The study team examined the experience of other government agencies in the management of projects with advanced technology; particular attention was given to development projects in the U.S. Air Force.

Phase 3

- The results of the first two phases were analyzed to identify "generic" factors.
- The study team prepared a final report comprised of a set of briefing charts and a written statement on its conclusions and recommendations.
- Results of the study were reviewed with NASA management, a representative group of NASA project managers, industry, and the Congress.

My principles for the successful management of NASA space flight projects are as follows:

1. NASA should be realistic and honest with itself, with the Executive Branch, with the Congress and the public in terms of the goals, capabilities, costs, schedule, and technical risks of a new project when it is under consideration for approval to proceed into design and development. NASA should not overstate goals and not be deluded into a success-oriented cost and schedule in order to obtain project approval.

2. Advancing the national technology base is an important purpose of the space program. Thus, NASA should not reduce the technical challenges of NASA projects simply to reduce the possibility of cost growth and schedule slips. NASA must, however, consider the project's technical risks during the pre-approval phase and in designing the implementation phase as well as the project organization. NASA, OMB and the Congress should expect up to a 30 percent cost growth even if the project is well managed and there are no **major** technical surprises.

3. A NASA project should be well understood before it is approved for design and development. A through definition of the technical aspects, management (including the roles of the NASA Centers), cost and schedule is required to estimate potential risks to NASA management, the Executive Branch, and the Congress as they contemplate approval. Up to 5 to 10 percent of the runout cost of a project should be expended during the definition phase. NASA managers must not assume that approval of definition funds automatically means approval and funding of the project itself.

4. When a project is approved by NASA management, the OMB, and the Congress for implementation, the project's technical goals, schedule, runout cost, annual funding, organization, etc., are established. If the project stays within the agreed upon boundaries, the OMB and the Congress should ensure continued funding during future annual budget cycles and allow NASA to manage the project.

5. Both the NASA Headquarters Program Offices and the NASA Centers have important management roles during project formulation and implementation. The Headquarters Program Offices have the lead during project formulation and are supported by the Centers. **Except in very rare cases**, project management should be delegated to a NASA Center during formal project definition and during project implementation. Headquarters should then perform the oversight function and "represent" the project in Washington. Delegation to a Center is necessary in order to ensure that the project management organization has direct access to NASA's technical expertise so as to staff the project and have the technical resources available to deal with the technical problems that will inevitably arise in the project. In those cases where the project management role is retained in Headquarters, NASA must provide a workable mechanism that will ensure the same availability of the technical expertise of the NASA Centers to the Headquarters project management organization as if project management were at a Center.

6. The line of management responsibility, authority, and accountability for project management should be from the Administrator to the Program Associate Administrator to the Center Director and then to

the Project Manager. A Headquarters "Program Director"/"Program Manager" will normally represent the Associate Administrator and interface directly with the Project Manager in the Center. Thus, the Project Manager reports directly to Headquarters as well as to the Center Director. It is critical that the Center Director retain a portion of project accountability to ensure that the full technical capability of the Center is applied to the project as required.

7. NASA should minimize the management and technical interfaces within its projects. The number of NASA Centers assigned management responsibilities on a particular project should be minimized. If it is necessary to have two or more Centers assigned to a project, one Center should be designated as the Project Management Center and be assigned overall project authority (including the allocation of funding to the supporting Centers). In addition, the management and technical interfaces between the Centers should be defined and documented prior to the approval of the project to proceed with implementation.

8. The individual who is most critical to the success of a project is the Project Manager. That person must be provided the appropriate authority, responsibility, resources (including access to NASA internal technical expertise), and access to NASA management. The Project Manager is then held accountable for the performance of the project. Project reserves (i.e., contingencies) should be managed by the Project Manager and be used to deal with technical and schedule problems; not with budget cuts. Project management in NASA should be viewed as a desirable and long-term career path for NASA employees.

9. NASA and selected industrial contractors should form a working team to implement the project. There should not be an adversarial relationship between NASA and a contractor. The selection of a contractor during the acquisition process should be based primarily on technical considerations, the bidder's management capabilities, implementation plans, and the bidder's past performance. Contracts on tasks that have a high technical uncertainty should be cost plus, not fixed price.

10. The Project Manager should implement a technical and management information system which will enhance close communication among all project elements in government, industry and other participating organizations. The Project Manager must maintain a day-to-day understanding of the status and problems of work being performed so that technical problems can be anticipated and dealt with in a timely manner. This will require project reviews, in-plant representation, person to person contacts, etc., in addition to a formal Management Information System.

11. NASA management should minimize the extent of project elements outside of the authority of the Project Manager which are also in development. NASA must be realistic in recognizing and providing in its project plan for those supporting elements that are not fully operational.

None of the above are meaningful without the most important ingredient to successful project management in NASA — capable and committed people within the NASA project organization as well as in those parts of NASA Headquarters and the Centers that support the project during both normal times and during project emergencies.

In light of NASA's current problems and the relatively low public perception of the agency, what should be done about NASA? This is a question that the Augustine Commission is, no doubt, considering as it ponders the nation's future in space.

A major restructuring of NASA would be a mistake. I believe that following the project management principles proven by NASA experience will result in improved NASA performance in the management of flight projects and increased public confidence in the space program.

In addition, the roles and missions of the NASA Centers need to be clarified since they have become blurred in recent years, thereby contributing to some of NASA's current project problems. The Research Centers (ARC, LaRC, LeRC) should concentrate on aerospace research, technology (R&T) and support to the industry, other government agencies, and projects managed by the NASA Development Centers. The project management roles of the Research Centers should be restricted to those small flight projects which are vital elements of their R & T programs.

The NASA Development Centers should concentrate on development projects that closely match their technical expertise and experience. For example, GSFC should concentrate on unmanned science projects in Earth orbit, JSC on manned space system projects, JPL on science projects in deep space, and MSFC on rocket propulsion and launch vehicle projects.

Other steps may also be needed. For example, new mechanisms may be necessary to continue to attract and retain high quality, motivated people in NASA. NASA's in-house technical capability has been the key to its success over the past 32 years and sets it apart from many government agencies. It is vital to the nation's future in space that this unique characteristic of NASA not be lost.

Table 2 - Major Conclusions of the 1980 Study

1. There were four major reasons for cost/schedule growth in several NASA projects:
   a. Technical risk. NASA projects generally include high levels of technical complexity.
   b. Inadequate definition of technical and management aspects of a project (including the specific project to be implemented) prior to seeking approval to proceed from OMB and the Congress. This problem is exacerbated in that, in many cases, only advocates of the project review its readiness and the adequacy of cost/schedule estimates prior to submittal of the proposed project to the NASA Administrator for approval. Inadequate definition was judged to be the most significant contributor to cost/schedule overruns.
   c. Industry's recognition of NASA's tendency to select the low bidder in the competitive acquisition process. (When the study results were reviewed with NASA senior management, they were surprised that NASA tends to select the low bidder.) This has an adverse effect on project performance when artificially low bids are accepted by NASA and used to rationalize low project costs.
   d. Poor tracking of contractor accomplishments against approved plans in a timely fashion, leading to late identification of problems.

2. The following have been significant contributors to good cost and schedule performance:
   a. The function of the NASA Project Manager who is provided the appropriate authority, responsibility, and resources (including access to internal NASA technical expertise) and who is held accountable for the performance of the project.
   b. Adequate definition of the project to be implemented prior to commitment of its cost and schedule to OMB and the Congress.
   c. Proper planning and management of project contingencies.

d. Early understanding between NASA and the implementing contractor(s) of the project's scope, implementation plans, and interfaces.

3. Some NASA space projects have experienced cost growth in the development of their ground segments. This has been due to a lack of understanding of the design complexity and inadequate definition of the ground segment. This situation has been particularly evident in high data volume projects.

4. In some cases, the management of technically complex projects has been assigned to multiple NASA Centers without sufficient and timely consideration of the management relationships between the Centers and the technical interfaces between the project elements assigned to the various NASA Centers. The resulting project management complexities have contributed to cost growth and schedule slips.

5. A project will experience increased technical, schedule, and cost risk when it is dependent on the parallel development of critical supporting elements that are outside the Project Manager's control. An example is the dependence of the Hubble managers on the Shuttle.

Table 3 - Major Recommendations of the 1980 Study

1. The technical challenges of NASA projects should not be reduced in order to minimize the possibility of cost growth and schedule slips. Rather, NASA should allow for the technical risks in the extent and type of the pre-approval work performed, the estimate, annual funding plan and the project schedule. NASA, OMB, and the Congress should expect up to a 30 percent cost growth even if the project is well managed and there are no ***major*** technical surprises.

2. The NASA Administrator should require a complete definition of technical and management aspects of all new projects prior to submittal for new start approval; this should include the specific project proposed for implementation. Five to 10 percent of the funds required for the complete project should be expended during definition. If a budget "line item" is required for project definition, NASA should update its estimate of cost and schedule to OMB and the Congress after definition is completed. This update should be viewed by all parties as the NASA commitment (subject to Recommendation 5). Finally, Program Associate Administrators should organize a review of all proposed projects by a group of "non-advocates" who have project management experience and understand the technologies associated with the proposed project.

3. Selection of contractors should be based primarily on technical considerations and the bidder's management capabilities, implementation plans, and past performance.

4. NASA projects should have adequate visibility of each contractor's technical performance and utilization of resources. NASA Project Managers should have access to the technical capabilities of the NASA Centers in order to monitor the contractors, oversee the government's technical work, and examine contingencies and work-around plans that will be required by technical problems. NASA Center Directors should be accountable to ensure that their Project Managers receive the technical resources required and that their Centers support, where appropriate, projects at other Centers.

5. After the implementing contractor is selected, the first months of the contract activity should be devoted to developing an early NASA/contractor understanding of the project scope and interfaces. The project's commitment to OMB and the Congress should be updated after this "early understanding" period.

6. All NASA projects should have adequate financial reserves (i.e., contingencies). These reserves should be under the control of the Project Manager and be used to deal with technical problems; they should not be used to deal with budget cuts by NASA management, OMB, and/or the Congress.

7. NASA should minimize the management and technical interfaces within its projects. The number of NASA Centers assigned management responsibilities on a particular project should be minimized. If it is necessary to have two or more Centers assigned to a project, one Center should be designated as the Project Management Center and be assigned overall project authority (including the allocation of funding to the supporting Centers). In addition, the management and technical interfaces between the Centers should be defined and documented prior to approval of the project.