FACILITY FORM 602
N70-31745
(ACCESSION NUMBER)
(THRU)
(PAGES)
(CODE)
(NASA CR OR TMX OR AD NUMBER)
(CATEGORY)

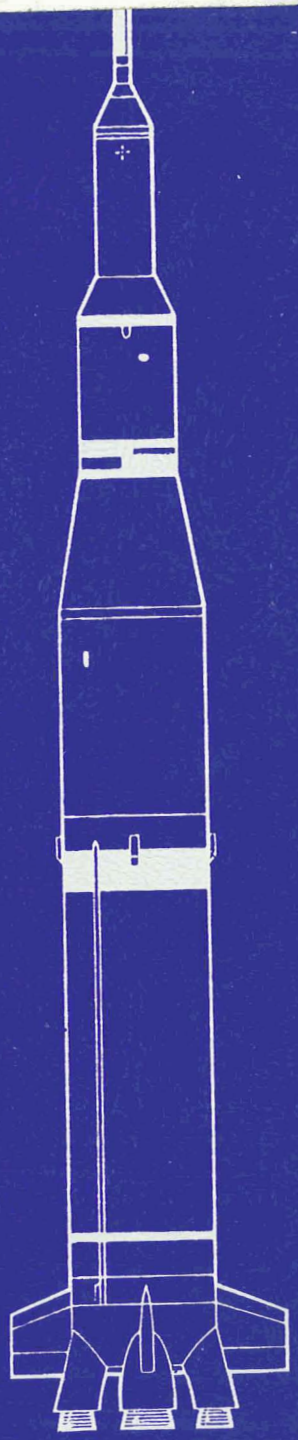
N70-31745

PROJECT MANAGEMENT IN THE

APOLLO PROGRAM

Interim Report 6223-R-1

SYRACUSE/NASA PROGRAM



NASA

National Aeronautics and Space Administration

Syracuse University

N70-31745

PROJECT MANAGEMENT IN THE APOLLO PROGRAM

Interim Report 6223-R-1

A Presentation at NASA HQ

29 June, 1970

by

Project Management Group: E. E. Drucker
W. Pooler
D. L. Wilemon
B. D. Wood

Syracuse/NASA Program

NASA Research Grant No. NGL 33-022-090

Syracuse University

April 1970

CASE FILE COPY

INTRODUCTION

Eugene E. Drucker

I would like to start this presentation with a few words concerning our origin, makeup and objectives. Our program was conceived as a result of NASA's desire to make itself available to the Universities as a learning laboratory. The Syracuse University effort was begun under the Sustaining University Program as the first part of a planned long range association between Syracuse and NASA. The purpose of our particular study was partly to update the University in the methods of modern project management, and partly to study NASA from a more objective, broader point of view and with greater articulation than might be possible within NASA itself.

The complexity of NASA's total task required us to concentrate on a small piece of the whole picture, which, by mutual interest, focused in on the role of the project manager in the Apollo Program. We are talking about managers of projects like LM, CSM, S-I-C, S-II, S-IVB, etc.

For about 2 years we have been studying the anatomy of project management in Apollo, and we have found that the study of the project manager, the person, is inextricably entangled in the study of project management as an organization.

The makeup of our research team was guided by the requirements of the task, and the team is now a close knit group from engineering, business administration, sociology and political science. We have learned to work together extraordinarily well as an interdisciplinary team.

Our information was gathered from a large number of lengthy interviews mostly taped, with NASA personnel at several levels at the three major field centers and headquarters, with engineers and managers at the plants of five prime contractors, with NASA resident people, and with Congressmen and

Congressional committee staffs. Also, NASA documents, contractor documents and Congressional committee reports were used. Finally, we held a 3 day conference with our own project team and representative NASA personnel to test some of our preliminary hypotheses and conclusions.

From these sources we have formed a comprehensive picture of the various interactions of a project manager with the elements of his working environment. We would like to proceed with a series of very compact summaries of our research findings, with the hope that you can suggest places in NASA where our type of work could fit in.

We'll start with our sociologist, Bill Pooler.

APOLLO AND GENERAL ORGANIZATIONAL CONSIDERATIONS

William Pooler

The aim of this presentation is to discuss some of the potential general organizational properties of the Apollo project effort. An implicit assumption is that an intensive study of the maturation of the NASA - Apollo organization can substantially contribute to the extension and modification of current organization and management theory.

The Apollo project dominated the host organization, NASA, which housed it. Men and dollar resources tended to flow to NASA through and because of Apollo. Over time as fervor dimmed and resources became scarcer, the binding of Apollo to the rest of NASA and the attendant readjustment became problematic. No doubt the quasi-autonomy and high priority Apollo enjoyed contributed largely to the success of the venture. But since it was a project with a precisely defined goal, the future of the total organization, was threatened once the task was completed. Future undertakings will have to be organized such that organization and project concerns, as well as their inter-relations are balanced. Somehow projects must be dominated by the more enduring host organization, no matter what their size or scope. At the same time, because of the uncertainties involved in Research and Development work and the life-cycle nature of projects, organizational flexibility and receptivity to change must be maintained.

In complex technologically oriented organizations, there are three general dimensions which must be coordinated and made harmonious. They are; the technical and/or scientific, the overall internal organization,

and the social, economic, and political environment. I do not think it is accidental that the Apollo project proceeded relatively smoothly when the top leadership of NASA consisted of the triad of Webb looking outward, Seamens acting as a general manager, and Dryden over-seeing the scientific and technical considerations. No doubt functional equivalents to this kind of leadership exist. One alternative would be the creation of the Office of Organization and Management coupled with similar emphases on coordinating scientific and technical expertise and extra-NASA organizational relationships. Whatever the arrangement, these three dimensions appear to require constant monitoring for the continued functioning of complex organizations.

The strong in-house technical and scientific capability of NASA contributed to the success of Apollo. But as the character of the program changed, and as design and development decisions were made which acted to constrain the future direction of the program, coordination and organizational control concerns assumed greater importance. Thus, managerial competence also played an important part in the Apollo success. And finally, as national priorities changed, the skill of Webb and others in dealing with the Executive and the Congress and in restructuring NASA and Apollo such that it could adapt to diminished resources was also important.

Current models of organization are too static. NASA and the Apollo program have changed drastically since their inception. We have to create new models which capture the change processes as well as the important enduring structural considerations.

Parenthetically, I might make some additional remarks. A knowledge of past history, for example, the tie between Houston and the older NACA

organization and between Huntsville personnel and their past booster and engine experience, is crucial to an understanding of Apollo. Also, as much as social scientists might abhor the idea, individuals do affect organizational functioning. Somehow newer theories will have to accomodate both organizational considerations and the predilections and capabilities of individuals who make up the organization. Finally, future typologies of organizations will have to specify more precisely the similarities and differences among Research and Development and more routine activities.

Two characteristics of the Apollo organization appear to have general relevance for future undertakings involving technological complexity. The first characteristic involves the apparent purposeful use of conflict. On the one hand, conflict tended to promote control by the top levels of the NASA-Apollo organization. On the other hand it tended to maintain sub-unit integrity as well as created conditions which facilitated personal contacts. The routinizing of conflict was accomplished in NASA by partitioning responsibility in one of two ways. Responsibility tended to exceed the scope of authority associated with it as was the case with project managers particularly at Huntsville, or there was overlapping responsibility and/or authority for particular tasks. An example of this would be a functional manager and an institutional manager attempting to carry out their respective responsibilities. Where disagreement coincided with the scope of activities at lower levels of the organization, it tended to be "settled" by personalized exchanges and trade-offs. Also, through continued interaction better definition of the responsibilities and capabilities of the various sub-units was achieved. Where the conflict

was of a wider scope, such as competing solutions to a problem which affected a significant portion of the total project, it would be carried to higher levels of the organization where responsibility and scope of conflict were better matched.

The second characteristic involves the nature of the upward flow of conflicts coupled with the necessity of information feedback. The change panels, while ostensibly created as a configuration management device can also be conceptualized as a general organizational mechanism for necessary hierarchical evaluation and control. This is true especially within organizations which comprise a series of relatively insulated levels and within these levels a series of relatively insulated sub-units. As problems arise that cannot be solved by the sub-units, a single level change panel is initiated. Either the problem is solved or its dimensions are brought into clearer focus. If it cannot be handled at this level, members of the sub-units, now representing the variety of interests at a particular level initiate a change panel at the next highest level. As the problem goes to the next higher level of the organization the views and interests of the sub-units of the lower levels of the organization are represented and as well greater definition of the problem is achieved. Each conflict or problem represents a substantive instance of the change panel system in operation, with the formal structure enduring as a mechanism to insure feedback and conflict resolution. An important aspect of this process is the assumption that many problems are routine and can be handled at lower levels of the organization. To encourage necessary upward information flows, problem resolution proceeds inductively with the interests and perspectives of concerned members of all levels of

the organization being voiced in a determination of a problem solution.

A study of NASA also makes clear that the character of specific tasks and early intra-organizational relationships are necessary for an adequate understanding of complex organization. The three field centers of the Apollo effort are quite differently organized. To understand how and why they are different it is necessary to analyze specific relationships within each of the centers. For example, some of the differences between the field centers can be attributed to the well developed relationships between mission control, the astronauts, the scientists, and the engineers at Houston in comparison to the very close historical ties between the laboratory directors and the top Apollo and field center leadership at Huntsville. Other differences relate to the development of particularistic inter-field center relationships such as those between Kennedy and the other two centers as a consequence of the configuring and launching responsibilities located at Kennedy. Finally, the very nature of their activities further accounts for the differences within the centers and their different institutional and project organizations. An interesting theoretical problem has to do with separating out generic from situationally specific organizational considerations. And it can only be resolved by long term organizational studies of the activities of complex organizations such as NASA.

This discussion suggests that what has been accomplished by NASA has implications for generic organization and management theory. I would also like to suggest that the NASA-Apollo model can be utilized as a guide for future inter-disciplinary tasks whether they be of a technical or social nature. Essentially, Apollo involved managing and coordinating diverse

groups and tasks within and outside the organization. This was accomplished by a core of highly competent technical and management personnel who controlled resources and who formulated an overall design that was modified and extended through time. There is every expectation that similar core organizations can be created to work on new problems facing NASA as well as existing problems of human society such as population, housing and public transportation.

The strength and feasibility of the model lies in creating a strong in-house technical and managerial capability to dimension, design, and control the overall effort and as well to "manage" diverse groups in a relatively insular fashion. The interdisciplinary focus is achieved not by bringing all the relevant discipline personnel together in one organization, but rather by letting each of the discipline groups work on their aspect of the effort with direction from the smaller core organization comprised of experts from all the disciplines. This core group would have the responsibility for evaluating and bringing together the output from the separate activities they were managing. In essence, this appears to represent an informed interdisciplinary perspective coupled with a research and development orientation necessary to deal with the complex human problems that face man. In spirit it is the model developed out of the NASA-Apollo experience.

THE ROLE AND PROBLEMS OF THE PROJECT MANAGER

David L. Wilemon

My objective in the research program has been to investigate the interpersonal relationships existing within the Apollo project groups. More specifically, I have been investigating how project managers influence the technical specialists over whom they have no direct authority, but on whom they are dependent for information and support. In other words, what levers can a project manager "pull" to accomplish the cost, schedule, and performance, objectives of his project? In discussing the lack of authority over support personnel, one Apollo P.M. (project manager) noted:

> I think it makes it more difficult to get the job done when you have to rely on support people over whom you have no real authority.

To identify how P.M.'s get support for the projects without formal authority I shall analyze some of the influence techniques employed by Apollo project managers. These influence techniques are most apparent and most easily understood when we view the project manager's relationship with those in the research and development laboratories and those within the various functional areas of NASA. These influence or power techniques are also used in the project manager's relationships with his contractor. However, in this case he additionally has financial leverage via the contract.

We found that expert power, reward and punishment power, and referent power are the three primary influence techniques used by project managers. Expert power, for example, refers to the ability of the project manager to get his interfaces to do what he wants them to do because they attribute

greater knowledge to him or believe he is more "qualified" to evaluate the consequences of certain project actions than they are. Expert power can come from a project manager's managerial expertise or from his technical competence. In the area of managerial expertise the project manager may have abilities associated with the management of the project which enables him to build an influence base over others. For example, the project manager is in a critical position that can allow him to have a systemic view of the total activities of the project. He knows what inputs and/or changes will affect the business side of the project. His management abilities are frequently demonstrated by his grasp of the complicated cost, schedule, and information systems attached to the project organization as well as his human relations skills.

In some cases it appears that it is difficult for the project manager to exert influence based on technical ability alone. However, this may be overcome if the project manager can view the project from a mixed technical/managerial perspective. It may also be overcome by his demonstrated abilities and track-record in making sound project decisions.

The ability to reward and punish direct or indirectly is another means by which project managers build an influence base. Although it appears that the project managers within the Apollo program cannot use reward power as freely as their counterparts in industry, in matters such as promotions and salary increases, they can reward project participants by:

1. Giving recognition--both formally and informally.
2. Providing greater visibility.
3. Giving stimulating work assignments.
4. Delegate authority and responsibility to his interfaces.

Project managers can "punish" those who do not perform adequately by:

1. Isolating them from the primary action of the project.
2. Giving negative comments to the individual's superior.
3. By formal means, i.e., documentating the individual's lack of compliance.
4. Exposing mistakes of their interfaces to their peer groups.

The last type of influence we found being used is referent power. It is based on the degree to which the project manager's interfaces 1) identify with and are committed to the objectives of the project; 2) identify with the organizational position of the project manager; and 3) identify and value their relationship with the project manager as an individual.

One project manager explained the value of referent power this way:

> I think I have the confidence of my support people. I'm able to call them and get a very quick response without any question. I think it's mutual confidence... that I'm able to get them to respond. I can pick up the phone and call any fellow in the support group and tell them we've got a problem at the Cape and you've got to catch a plane. He doesn't work for me, he doesn't owe me anything but he'll do it ....

A project manager also has the potential for influencing his support people if they can identify with him, or find a common basis for respecting him. As one manager stated, "There's a philosophy here that you aren't a good project manager unless you've come up through the bowels of engineering... Another P.M. agreed with his observations and put it this way:

> I guess I'm sort of lucky in that I came up with the support people so they don't resent me. I have no trouble in getting along with them.... It's been

> indicated that other managers who haven't come up through the ranks might have had more difficulty than I've had...

Another P.M., when asked how he knew who to ask for advice when he needed support replied: "Strictly personal friends that you've cultivated over the years ... and they may be anywhere within NASA."

What is the best "influence mix" for the project manager to employ?

> 1. If he has too much technical expertise it thwarts the contributions of his supporting team members. Full committment by them is weakened because it destroys their intrinsic motivations in problem-solving.
>
> 2. If he has too little technical expertise it slows down the decision-making process of the project. The P.M. would frequently need to check on the advice he receives from his support people. In the process, he might lose control over his project.
>
> 3. If the P.M. has too much referent power his support personnel may be afraid to tell him he's wrong. They may follow him blindly and not call a spade a spade.
>
> 4. If the P.M. has too much reward power, it may weaken the strengths inherent in NASA's skill centers. Good support people may want to gravitate to project work rather than build expertise in a functional work area. It may cause a "cheese-gap" or reward gap with the rest of the organization. Support personnel may be afraid to indulge in independent problem-solving if the P.M. has too much reward and punishment power.

We conclude that the most effective style for project managers appears to be one based on expert and referent power rather than one based on the P.M.'s reward and punishment power or the use of his limited degrees of

authority. The expert/referent style seems best to promote independent, professionally oriented problem-solving. It is a model where the participants respond to "colleague authority" rather than formal authority.

Special Problems Faced by Project Managers

Moving away from the influence techniques used by project managers, I would like to discuss some of the problems faced by project managers. They are:

1. Balancing his technical and managerial project functions.
2. Coping with Project and Professional Risk.
3. Surviving Organizational Restraints.
4. Managing Human Relationships.
5. Evaluating Information from Project team members.

A potential problem for the P.M. lies in over-stressing either his technical or his managerial responsibilities to the project. One supporting project team member emphasized the problem of an imbalance in the project manager's technical and managerial skills as follows:

> I've had experiences where the project manager tried to be too technical... that's what his project team is for...

Two types of risks P.M.'s face--project risk (failure of his project) and professional risk (engineering obsolescence).

Differences in the perception of project risk may be illustrated by these two responses from P.M.'s.

> If my hardware didn't work and failed it would be a catastrophic occurrence. I would completely expect to be replaced....

By contrast, another P.M. said:

> If you didn't want to accept the responsibility for the project, you don't have to, you just buck it up to the next manager, and if he doesn't want to make the decision he can buck it up to the program manager.

Engineering obsolescence, by contrast, refers to the possibility of losing one's technical competence as the result of concentration on management duties. One P.M. emphasized the point by stating:

> When my project terminates, I'll be an obsolete engineer... an untrained manager, and too old to go back to school.

It is important to point out, however, that for some P.M.'s professional risk is a trade-off. Project manager A, for example, may want to make his career in the management side and he sees that project management is a vehicle that can help him achieve his professional aspirations.

A number of the P.M.s interviewed indicated that certain parameters and restraints are placed on them over the life cycle of their projects. As projects mature various management reporting systems become attached to the projects and remain. As one P.M. noted:

> As a P.M. you get hit with directives, from the top and from every level. Many of these directives require comprehensive reporting. We've got a lot of people who think it would be real nice to have this or that report.

Civil Service Regulations also appear to be somewhat of a problem for the P.M.'s in building and maintaining their project team. As one P.M. said:

> I've got three people I could do completely without. But if I asked for their release from this project, I

> would most likely have to give up my three best men, so I just sit here and don't do anything.

In many ways, the Apollo P.M. doesn't have the freedom of his counterpart in industry as far as building and maintaining his project team.

It also appears to us that the effective project manager is one who respects the viewpoints of his project interfaces and yet gets them to do what he wants. One P.M. noted for example:

> You have to understand who you're dealing with. An engineer in the labs may feel that we should settle for nothing less than zero leakage on a certain seal. He has a certain background, a certain psychological makeup that you have to understand, appreciate, and not violate. You can't tell a guy like that, go to hell, you don't understand the problem. This guy can be a Ph.D. and can darn well know exactly what he's talking about. So you've got to find within your own means the mechanisms for communicating with him... and then again you've got to realize that he's communicating with you....

The last problem I shall discuss is how P.M.'s evaluate information from those who are more technical than they are. One approach appeared to be to cultivate "third party information sources". One P.M. described his approach to information evaluation as follows:

> When a support engineer reports a recommendation I make him defend his position.... If he gets past that step then I have his defend his position to people of similar technical experience....

Implications

What have we learned about the role of the P.M.?

1. The effective P.M. knows how to use influence "levers" to get compliance from those on whom he depends.

2. Many researchers say that the "personality" of the project manager is the critical variable in understanding the project manager's role. We have demonstrated that there are many other important dimensions to successfully managing the project manager's interpersonal relationships.

3. Finally, we think that our research effort has identified several useful insights into project management. These insights will not only be useful to project managers but also to those who manage project managers.

UTILIZATION OF IN-HOUSE TECHNICAL COMPETENCE IN APOLLO PROJECTS

Bernard D. Wood

THE PROBLEM

The size, complexity, and various constraints of the Apollo Program have been discussed. Perhaps the most significant factor in shaping its management scheme was NASA's determination to maintain and utilize its own enormous in-house technical capability while being committed at the same time to the use of the private sector for producing the major part of its hardware and software. Professor Drucker will discuss relationships with contractors. What will be considered now is the problem of utilizing NASA's technical resources as effectively as possible in the circumstances.

The problem was attacked through the adoption of an apparently strong program/project management scheme. Project management had been used before. However, its exact forms as found in the Manned Space Flight program is undoubtedly unique. It is our contention that the extent of the in-house technical competence along with the commitment to depend on outside contractors shaped the project management schemes used. Moreover, the excellence of the in-house competence provided both the essential strength and the major difficulty in the management of Apollo projects.

THE STRENGTH

The strength of project management in Apollo came from the fact that each project manager, in dealing with a contractor, knew that he was backed up by an in-house competence that probably no industrial or DOD manager had enjoyed. This competence was not identical at MSC and MSFC for various reasons, nor was it utilized in the same way. But at both centers the

strength was reinforced by a most unusual circumstance: the Research and Development Operations Directorate at MSFC and Engineering and Development and all the other directorates at MSC had essentially the same commitment to the goals and the same desire for success of the Apollo program as did the program and project managers. This was true throughout the centers from the directors right down to the individual engineers and scientists. Indeed, many engineers and scientists throughout the two centers believed that the success of the program would depend much more on themselves than on the managers. And they were not only willing but anxious to take on that responsibility. What more could a manager ask for and where else in government or industry could he find such support? I do not mean to imply that no one cared who ran the show. But with the acceptance of a common commitment, the trade-offs necessary in center reorganization were more readily accepted.

THE DIFFICULTY

A major difficulty in the job of the project manager stemmed from that same in-house competence from which he drew his strength. Individuals in research, engineering and development had a pride in their own abilities that resulted in jealousies and even resentments against project managers. The managers frequently admitted that they naturally had less technical competence in the narrower areas of applied science than their counterparts in either the NASA Center organizations or the contractor plants, and yet they necessarily had the decision making power. This difficulty went beyond individuals since both R and DO at Huntsville and E and D at Houston had strong, well established line-management structures that fostered dual loyalties.

To maximize the use of the in-house competence, and at the same time

minimize the jealousies and conflicts, required that responsibility and authority be intentionally vague. Professor Wilemon has dealt with the general problem of authority already. I will add only that, in maximizing in-house support, the delegation of responsibility has meant more than the delegation of authority. It is clear that the organization as shown on paper cannot be taken too literally.

THE TOOLS

There were three tools that made project management feasible in the Apollo program. The first was the establishment of Change Board levels within the program that exactly paralleled management levels. (Professor Pooler has dealt with the effectiveness of this in the resolution of conflicts.) There is a nice analogy here with counterflow towers in chemical process industries. Change requests and proposals bubbled up through the organization, resolvable conflicts being filtered out at each level. Management decisions cascaded down through the organization only after a thorough evaluation at the highest necessary level, so that directives and requests were never too far from an equilibrium state.

The second tool was matrix organization, pinpointing for any sub-system the managers, technical support personnel, resident managers at contractor sites, and contractor counterparts in a horizontal slice across the vertical structure of the different organizations. Whether this system is consciously displayed on charts as in the Saturn V Program at MSFC or is evident from the way in which tasks are broken down as in ASPO at MSC, it is essential as a concept in such a complex operation of using both in-house expertise and contractors.

The third tool was the telephone, the symbol of the constant informal communication among all elements, without which program and project management would have been impossible.

THE DIFFERENCES BETWEEN MSFC and MSC

Project management is not the same at the two centers. As Professor Pooler has pointed out, the differences have their reasons both in the history of each center and in the program components for which each is responsible.

To see the differences, we must look particularly at the role of the sub-system manager. As a "manager" at Marshall, he is not in an extremely strong position; in fact his role may be described as essentially coordinative rather than directive. He is, however, in a less ambiguous position than is his counterpart at Houston. He is clearly in the Program Management directorate, and is clearly in one corner of the triangle made up of his office, Science and Engineering, and the contractor. He himself must resolve conflicts within this triangle or refer the problem upward to a higher management level. Program Management, then, at Huntsville has a more direct line through which to control contracts. But its penetration of the working laboratories housing the great in-house competence meets the resistance of the line organization of that directorate and the resentment technical experts hold towards clearly separate managers.

MSC, in order to ensure closer identification of the functional directorates with the huge Apollo program and to prevent the Apollo porgram office from engulfing the whole center, reorganized to locate its sub-system "managers" in the Engineering and Development directorate. In so doing, they made a significant digression from conventional project management. This meant that

it was necessary to have project officers in the Program Control Division of the Apollo Spacecraft Program Office who would have "sign-off" authority on directions to contractors. These officers were to team up with the sub-system managers to monitor and direct contractors. At the same time, the CSM and LM Project Engineering Divisions of ASPO, as well as the CSM and the LM offices in ASPO's Systems Engineering Division had no formal direct lines to the sub-system managers on whom they were dependent. The CSM and the LM project managers had no distinct organizations of their own within ASPO. It is significant that both major project managers at Houston expressed regret at losing direct control over their sub-system managers.

Awkward and ambiguous as this scheme may seem, it did avoid at least some of the resentment towards project management that we found in some branches of the Huntsville "Labs", and it did avoid the necessity of stealing good men from the functional directorates.

But has the MSC version of project management avoided the long range danger pointed out by Professor Pooler who noted that a host organization must not be dominated by a project? And what would happen if there were many projects running concurrently? Could we afford to fragment Engineering and Development by making some of its people sub-system managers in order to insure E and D involvement in all the projects?

We might wonder too about the applicability of the MSFC model in different circumstances. With many programs, could the director of Program Management still act as manager of each program at that center? Would conflict between center and program loyalty still be resolvable?

We must conclude from our study of the Apollo program at MSC and at MSFC our less detailed study of KSC that no one model of program management can be

described as best for the purpose of optimizing the utilization of in-house expertise.

THE SUCCESS

What about the obvious success of the different management schemes found in the Apollo program? Certainly complex management schemes were necessary and were achieved, but why the tolerance for conflict and ambiguous authority? Given the in-house and contractor competence and noting the national commitment to a moon landing in the decade, on what did success depend?

My conclusion is that it depended more than anything else on the dedication of the individuals throughout the centers and on their unreserved personal commitment to the clearly defined goals of the Apollo program. There were very real conflicts of interest, but they were resolved because all directorates and individuals recognized that cooperation was crucial to the success of the program.

THE PROJECT MANAGER - CONTRACTOR RELATIONSHIP

Eugene E. Drucker

The legal nature of the relationship between the NASA project managers and the industrial contractors is well defined by the terms of the contract. However, the actual nature varies widely in the Apollo program, going well beyond the contract specifications in terms of frequency of contact, informality and mutual aid.

There are several reasons for which variations in the relationship exist with the different contractors.

First, there is the change with time, as work goes through conceptual design, manufacturing and testing phases. In the beginning, the interface is concerned with primarily technical matters. But later on, schedules, inspection and check-out procedures, and tasks of this nature become prominent matters of concern.

Secondly, each contractors' mission is unique, the size of the contract varies widely, and the safety and reliability requirements of the product differ.

Thirdly, the Centers with whom the contractors interface manage differently, for reasons which my colleagues have discussed.

Finally, interpersonal skills play an important part in every human relationship. It is not the case, we feel, that formal organizational patterns and behavior norms are set up for all the project manager-contractor interfaces. Instead, the individuals establish methods of dealing with each other, depending on their personalities. Subsequently, the effective ways of doing business may or may not be legitimized by a formal structure.

There are a few general points to be made about the contractor organizations.

The contractor's or the NASA program managers in general do not have single counterparts in the other organization, although both have tried to bring this about. Counterpart personnel makes obvious points of contact and promotes ease of communication and the pinpointing of responsibility.

In reality, there is considerable overlap, rather than a clear cut, one-to-one matching of responsibilities. One NASA project manager interviewed interfaced equally with a contractor's program manager, his deputy manager and his chief engineer.

The contractors' program offices are generally strong--more so than NASA project offices. The greater freedom that industry enjoys to shift and reward employees is certainly an important reason for this.

The authority and importance of a project in a Company depends on the size of the contract. One finds a spectrum from a practically autonomous division to a relatively small project office operating in a matrix type organization.

The contractors' projects have a life span and undergo a metamorphosis from the conceptual phase, to a small program in a matrix to a large program and perhaps to a company division or a new company, and finally, often through a consolidation phase back to a matrix element.

While NASA project offices change also, they do not do so as rapidly or as drastically.

A significant difference between contract negotiations at Houston and Huntsville became apparent to us. At the latter center, the procedure is somewhat formal because of the separation of engineering and contracting.

Negotiations are therefore lengthier and more cumbersome than at Houston. There, negotiations are less formal because there is better liaison between technical and contracts people. The contracts people participate in the earliest stages of negotiations. The method is preferred by contractors. One contractor with experience with both centers remarked that he preferred to negotiate contracts with Houston but be monitored by Huntsville.

The resident NASA organizations play a very important and utilitarian part in the operation of the Apollo program, but they do differ in several ways at the two major centers.

The RASPO's out of Houston report to the Program Manager at MSC. They carry more authority, make more decisions on site and seem somewhat more effective than their Huntsville counterparts. The RMO's report to the stage managers at MSFC, seem to have less authority by reason of having to clear decisions with the MSFC Labs. By the same token the RMO's interaction with the contractors is less than the RASPO's and it is for this reason that the contractors prefer the RMO type of monitoring. At KSC, the Houston residents appear to carry more authority than the Huntsville resident personnel, who act simply as liaison persons. One contractor remarked that while decisions were formulated more rapidly at Houston, they were more thoroughly considered at Huntsville.

In the case of the resident offices, a one to one counterpart relationship is established at lower levels of organization between contractor management and NASA residents.

The resident office tends to become in part the contractor's ally. At the same time, if he is not careful, the resident manager may alienate his own program or stage manager. One of the important roles of the resident

manager is to foster the development of mutual respect between the contractor and NASA as a whole.

It is inevitable that some problems should exist between NASA and its contractors. These problems have been described by contractor personnel as follows:

1. There is excessive monitoring and penetration into Company affairs. Contractors get what is known as a "goldfish bowl" complex.

2. NASA resident offices appear to be overmanned, especially in the latter stages of a program. The Civil Service system retards the trimming of the NASA work force.

3. From the contractors' point of view, there are excessive requests by NASA for information, briefings, proposals, etc. These communications, however, are required by the stringent configuration management practised at the end of the project.

4. There is some ambiguity in NASA management compared to contractors' stronger lines of authority. There is considerable overlap between HQ, Center program and project. There are generally no chief engineers designated as such by NASA on their projects.

5. Contractors sometimes get caught in inter- or intra-Center disputes.

6. There are 3rd party quality Control people, such as Air Force or Navy, on the floor in some plants which sometimes becomes awkward.

7. There is a tendency for NASA project managers to become more involved in technical details than the contractors' managers. This is partly because there is no chief engineer on the NASA project teams which in turn is a result of the fact that NASA is essentially a buyer of services. The contractors are essentially manufacturers.

Finally, some comparisons may be drawn between NASA and Contractor project management.

1. The contractor is motivated by the desire for profit, or for acquisition of an experience base for future work. This, incidentally, appears to be the main mechanism of technology transfer. NASA is not money oriented.

2. The contractors problems involve manufacturing, labor, unions, etc., while NASA has to worry about scheduling, supplementary funding, and controlling changes. Thus the roles diverge.

3. Contractors' project organizations are strong and pyramidal, having more power over people than the Civil Service system permits of NASA.

4. Contractors always utilize chief engineers. Both NASA and contractor project managers felt that such a position would have been useful to NASA project managers as well.

5. Contractor program managers delegate more authority than does NASA.

6. The prime contractor deals with its subcontractor much like NASA deals with the primes. He is subject to pressure from above and anxiety from below.

I hope I have shown that the style of project management in NASA is different from that in the contractor firms. As well, the relationship between NASA project manager and contractor is decidedly different at MSC and MSFC. Since projects were managed successfully at both centers, it would be difficult indeed to state that one system was superior to the other. The variations may well have been necessary, considering the backgrounds and missions of the two centers.

CONCLUSION

These summaries represent a set of significant observations and conclusions. Our final report will expand and integrate the summaries. We feel certain that these insights can be useful to NASA. We also feel that, as a seasoned interdisciplinary team, we can be of additional utility to NASA in examining other programs.

PUBLICATIONS LIST

ROLE OF THE PROJECT MANAGER

SYRACUSE/NASA PROGRAM

thru

June 1970

Grant No. NGL 33-022-090

THE PROJECT MANAGEMENT RESEARCH SERIES

Studies of Project Management
and Management Systems

The studies incorporated in the project management research series are supported by a grant from the National Aeronautics and Space Administration to Syracuse University. They are prepared by professors and graduate students from the following fields: business administration, engineering, political science, and sociology. The studies are related to an investigation of project management and management systems associated with the Apollo program.

The series includes five types of documents.

1. Working papers which are developed as interim reports of concepts associated with project management and management systems. These papers are exploratory in nature and serve as a focus for discussion and are subject to further refinement as the research program progresses.

2. Occasional papers which are developed in areas not directly related to project management and management systems but which cover topics of interest to the investigators which are generated through participation in the research project.

3. Reports which are unpublished documents submitted to NASA and other interested parties which represent the final results in particular areas of inquiry in the research project.

4. Theses and dissertations which are the unpublished results of the research efforts of graduate students associated with the project and which represent the writing requirements of their degree programs.

5. Publications which are articles, books, and monographs published by professional journals, commercial publishers, or the university.

ROLE OF THE PROJECT MANAGER

Publication Number	Title, Author, Date
6223-WP-1	"The Role of the Project Manager and Management Systems in the Management of the Apollo Program," Richard J. Hopeman and David L. Wilemon, December 1968. 10 p.
6223-WP-2	"Systems Analysis and Management," Richard J. Hopeman, December 1968. 49 p.
6223-WP-3	"The Spectrum of Project Management," John P. Cicero, December, 1968. 13 p.
6223-WP-4	"The Apollo Project Manager - Contractor Interface," Eugene E. Drucker, October, 1969. 17 p.
6223-WP-5	"Project Management Authority: Some Preliminary Insights," David L. Wilemon, December 1968. 29 p.
6223-WP-6	"A Concept of Project Authority," John P. Cicero, March, 1969. 24 p.
6223-WP-7	"A Concept of Project Authority: The NASA/Apollo Programmatic Environment," John P. Cicero and David L. Wilemon, June, 1969. 42 p.
6223-WP-8	"NASA and the Apollo Program," William Pooler and Alphonse Sallett, July, 1969. 24 p.
6223-WP-9	"Project Management: A New Dimension in Complex Task Management," David L. Wilemon, July, 1969. 43 p.
6223-WP-10	"The NASA Scheduling System: Scheduling in the Apollo Program," (Part 1 of 6), R. J. Hopeman, July, 1969. 34 p.
6223-WP-11	"The NASA Scheduling System: Scheduling in Project Management," (Part 2 of 6), R. J. Hopeman, August, 1969. 28 p.
6223-WP-12	"The NASA Scheduling System: The Techniques of Scheduling in the Apollo Program," (Part 3 of 6), R. J. Hopeman, May, 1970. 21 p.
6223-WP-16	"Project Management at Houston," Henry J. Anna, August, 1969. 18 p.
6223-WP-17	"Project Authority: A Multidimensional View," John P. Cicero and David L. Wilemon, December, 1969. 18 p.
6223-WP-18	"The Apollo Project Manager: Anomalies and Ambiguities," David L. Wilemon and John P. Cicero, December, 1969. 21 p.

ROLE OF THE PROJECT MANAGER-Cont.

Publication Number	Title, Author, Date
6223-WP-19	"Relationships Between Research and Development Operations and Industrial Operation at MSFC," Bernard D. Wood, April, 1969. 27 p.
6223-WP-20	"Project Management and the Organization, Part 1," Henry J. Anna and H. George Frederickson, August, 1969. 66 p.
6223-WP-21	"Project Management as a Transferable Management System," David L. Wilemon, September, 1969. 24 p.
6223-WP-22	"Project Management and the Organization, Part II," Henry J. Anna and H. George Frederickson, October, 1969. 51 p.
6223-WP-23	"On the Application and Dissemination of Space Age Management Technology," David L. Wilemon, January, 1970. 19 p.
6223-WP-24	"The NASA-Apollo Contractor Interface: The Resident Management Operation," Barry L. Kelmachter, February, 1970. 14 p.
6223-WP-25	"NASA Priorities in Orbit: The Waxing and Waning of Moon Mania," H. George Frederickson and Richard A. Loverd, February, 1970. 9 p.
6223-WP-26	"The Power Spectrum in Project Management," David L. Wilemon and Garry R. Gemmill, February, 1970. 21 p.
6223-OP-1	"The College of Business Administration - Circa 1985," Richard J. Hopeman, October, 1968. 17 p.
6223-OP-2	"Reflections on Interdisciplinary Research," Richard J. Hopeman and David L. Wilemon, April, 1969. 22 p.
6223-OP-3	"Interdisciplinary Research in a University," Bernard D. Wood, April, 1969. 12 p.
6223-OP-4	"Managing Product Development Systems: A Project Management Approach," David L. Wilemon, July, 1969. 29 p.
6223-OP-5	"Bureaucracy and the Urban Poor," H. George Frederickson and Henry J. Anna, August, 1969. 20 p.
6223-OP-6	"Interdisciplinary Effort: Research or Problem Solving?", Eugene E. Drucker, September, 1969. 10 p.

ROLE OF THE PROJECT
MANAGER-Cont.

Publication Number	Title, Author, Date
6223-TD-1	"Impact of Budget Execution on Management Behavior: A Study of Managerial Perception, Interim Report #1," Harry J. Lasher, December, 1968. 117 p.
6223-TD-2	"Impact of Budget Execution on Management Behavior: A Study of Management Perception, Interim Report #2," Harry J. Lasher, December, 1968. 11 p.
6223-TD-3	"The Professional and Technical Qualifications of Apollo Project Managers, John Phillip Cicero, August, 1969. 151 p.