If we are to grow as advanced technology grows,
we must realize the new importance of . . .

THE PROJECT MANAGER

By Paul O. Gaddis

In new and expanding fields like electronics, nucleonics, astronautics, avionics, and cryogenics, a new type of manager is being bred. Although he goes by many titles, the one most generally used is *project manager*. His role in modern industry deserves more scrutiny than it has received from students of management and professional managers.

Generally speaking, the project manager's business is to create a product — a piece of advanced-technology hardware. The primary tool available to him is the brainpower of men who are professional specialists in diverse fields. He uses this tool in all the phases of the creation of his product, from concept through the initial test operation and manufacturing stages.

This article will consider those functions of management which receive special emphasis in advanced-technology industry:

- What does a project manager in advanced-technology industry do?
- What kind of man must he be?
- What training is prerequisite for success?

Before going into these topics, let us first take a look at this new industry in which the project manager works.

Meeting Specifications

Advanced-technology industry is the kind of business where a complex product is designed, developed and manufactured to meet predetermined performance specifications. The advanced technology company is committed at the outset to succeed in meeting these performance specifications or acceptable modifications thereof.

In this kind of work the development phase is always substantial, since the essential function of the new industry is the adaptation of recent research findings to the solution of specific problems in creating a new product. But operating groups in advanced-technology companies do not themselves perform fundamental research. While advanced-technology practitioners recognize the essential need for a vital output of fundamental research, and are in fact dependent on this output for survival as an industry, they do not work in the fundamental areas.

Unit Organization

A project is an organization unit dedicated to the attainment of a goal — generally the successful completion of a developmental product on time, within budget, and in conformance with predetermined performance specifications.

The project staff will be a "mix" of brainpower, varying with the project's mission. For example, a project involving a high degree of development, such as one devoted to achieving a practical demonstration of ionic propulsion that can later be applied in rocketry, will have a high proportion of scientists to engineers and a high proportion of theoretically inclined personnel. In contrast, a project committed to attaining a successful full-power trial of a propulsion engine utilizing a proven solid propellant will have more engineers than scientists.

Projects are typically organized by task (vertical structure) instead of by function (horizontal organization). The relative advantages of "project" and "systems" organizations have been the subject of widespread controversy, and it is not my intent here to elaborate on this issue. The obvious organizational goal is to seek the advantages of both — the vertical structure in which the control and performance associated with autonomous management are maintained for a given project, and the horizontal in

which better continuity, flexibility, and use of scarce talents may be achieved in a technical group.

Unique Characteristics

A study of the project manager function must examine these topics: what he does, what he must be, and what training he needs. In considering these, I shall limit myself to the more or less autonomous project in which "real" management and personnel responsibility resides with the project manager. This autonomy is in contrast to the organization in which the project function is maintained by a "project engineer," who often is relegated to a staff position with responsibilities far outweighing his authority, and who must pursue tenuous relationships with a great deal of skill and persistence to achieve even modest goals.

Different Approach

How does the job of the advanced-technology project manager differ from the picture of the conventional manager in modern industry? For one thing, he is managing a higher proportion of professionals, from the working level of the "journeyman engineer" up through his subordinate managers. Even in manufacturing operations on advanced-technology products it is often necessary to introduce engineers and scientists to the laboratory in large numbers. As further evidence of the technological infiltration, note that purchasing groups for these projects are likely to be staffed by a substantial proportion of engineers.

In view of this, the project manager needs a different attitude regarding the classic management functions of control, coordination, communication, and the setting of performance standards. Moreover the professional attitude and approach is steadily gaining emphasis and more widespread acceptance throughout all of the engineering industries.

In learning to manage a group of professional employees, the usual boss-subordinate relationship must be modified. Of especial importance, the *how* — the details or methods of work performance by a professional employee — should be established *by the employee*. It follows that he must be given the facts necessary to permit him to develop a rational understanding of the *why* of tasks assigned to him.

Moreover, if this kind of employee is to be treated as a professional, he must have established for him performance standards of the highest order, and must be accountable for productivity at the professional level. He may be granted the prerogatives of a professional — independence of detailed supervision, freedom from administrative routine where feasible, and working quarters which afford privacy and comfort. But at the same time he must never be excused from the responsibility of having to *produce* in accordance with the exacting requirements of his profession.

These points are illustrated by the actions of a line engineer in a West Coast company:

> This manager had cut his teeth on the air-frame assembly lines, but was now leading a group which was assembling and checking out highly complex air-borne electronics equipment. He decided that there was a real need in his group for a young electronics engineer who would assist in the interpretation of quality control tests.
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> After obtaining the necessary approval from management, he made several requests to the "professional employment office" to get such an engineer.
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> Following about two weeks of waiting, however, he saw that there seemed to be no intention to start action on his behalf in the personnel office. In exasperation, he finally called on the supervisor of professional employment, who was a doctor of engineering placed in this position to expedite the acquisition of key scientific personnel. The manager was told somewhat blandly by the young academician that the employment office had never been informed of the *reasons* why an assembly and test group should require the services of an additional professional electronics engineer.
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> After the manager had finished sputtering about line authority not needing reasons, he finally came to realize that his best course of action would be to explain in painful detail his need for the additional engineer. The supervisor accepted his reasons, and he got his new engineer in a week.

"Blind Flying"

Another unique aspect of the project manager's job is that his task is finite in duration. He cannot see a reasonably long line of repetitive or similar functions stretching ahead of him as his management counterparts in manufacturing or sales do. Nor can he modify his assembly line to manufacture a new product. He is managing a specific group of advanced specialists; the professional mix of his group is tailored specifically for the accomplishment of an assigned mission. If he and his group are successful performers, they will complete all facets of their job, and so work themselves out of a job, as quickly as

possible. This may be a year or less in some projects, and may run to five years and upward for long-range, high-budget projects.

In any case, the project manager must trust his corporate management, implicitly in most cases, to provide him and his forces with continuity of work on successive projects. Needless to say, the record of top management in achieving this continuity will affect the peace of mind, if not the performance, of the project manager and his entire staff.

Another feature of the project manager's job is the absence of feedback information during the early stages and often other stages of his project. Under the servomechanism analogy of management control, a manager establishes a closed loop in which the performance output of his group is fed back to him, compared with performance standards and corrective control action is then directed into the system.

However, in advanced-technology work, during the design phase of a project and before test results of newly developed equipment are available, the project manager often finds himself like a pilot flying blind, assisted by a relatively unproven set of instruments. His experience, judgment, and faith must carry him through until early test results become available; from this first feedback he can modify the design approach in a direction most likely to meet the acid requirements of further proof tests. Meanwhile, during these periods of blind flying, he may be forced to make long-term decisions which commit substantial funds.

Taking Risks

It is because of these "facts of life" in project work that crisis, uncertainty, and suspense are continually recurring to test the mettle of the manager and his staff. To illustrate:

A project group was developing a small liquid fuel missile for a military mission. Early in the project, it became apparent that a new high-capacity pump for the propulsion system was going to be needed.

After an exhaustive analysis of the problem, it was decided that the prospects for developing and proving the kind of pump needed, in the time interval permitted by the project schedule, were good enough to warrant committing the project to this pump.

A pump vendor was selected, and this vendor in turn set up his own subproject under a rigorous time schedule to develop the new pump in time for the missile application. As a matter of prudence, an alternate pump supplier was also charged with the mission of producing a pump to meet the requirements, using a different design approach from that of the first supplier.

During the months which ensued, the responsibility for the validity of the initial decision never rested lightly on the management personnel in the project. In the normal course of progress, substantial funds were committed to the propulsion system design and to the procurement of other components for the system. Moreover, it was at times necessary to make partly intuitive decisions based on the engineers' progress on the pump under development. These decisions in turn affected the design of the other components in the system.

For a period of five months, the entire progress in design and procurement of hardware was based on faith in the integrity of the original pump decision. This foundation became more substantial only when one of the two pump suppliers was able to place a prototype of his pump in a test loop and prove its performance. And even here there was risk, since many new components have worked beautifully in the prototype test stage but have been subject to failures when the manufactured versions were placed in use.

One of the two developmental pumps proved clearly unsuccessful, while the other just barely met performance requirements on the test stand. This necessitated a vigorous redesign effort in the project. The pump performance specifications were somewhat relaxed, and the remainder of the system was altered to accommodate the new piece of equipment. Late changes had to be accepted, both on the drawing boards and in the shops, in the other components being procured for the system. In short, the project staff went through a period of technological "crisis." In this case, fortunately, the crisis was successfully resolved. The project's prototype missile was ready for test with only a minor delay in schedule.

Authority & Responsibility

Essential to the project management concept is a clear delineation of authority and responsibility. The manager knows that his basic responsibilities are to deliver his end product (1) in accordance with performance requirements, (2) within the limitations of his budget, and (3) within the time schedule that his company or customer has specified. In general, the manager will delegate by tasks, so that subordinate managers in his group will have these same three responsibilities for subprojects.

Success or failure may well hinge on the manager's ability to discern fine variations in emphasis among performance, budget, and time schedule needs and to resolve the continuous apparent con-

flicts which occur between them. During the life of an average project the relative importance of each of his three responsibilities may change several times. It can be fatal to overemphasize the schedule when dollars have become the governing requirement, or vice versa. Likewise, performance requirements must be met or trimmed to fit reality. The skillful project manager will aim for a balanced emphasis; he will try to stay flexible so he can shift and adapt to new circumstances as they occur.

Keeping Things Moving

Like the line manager, the project manager is at once a man of action, a man of thought, and a front man. As a man of action, his most important function will be the establishment and the preservation of a sense of momentum throughout all layers of his project. What he will strive hardest to avoid is "dead center" situations in which general inertia seems to become overpowering and his technical people for the moment see no direction in which to advance. Thus, the usual management function of trouble shooting, or of unraveling the knots, will occupy a great deal of his time.

The first-line supervisors — the "supervising engineers" — are by definition the men who play the key roles in guiding the day-by-day progress of a project toward its goals. Such a supervisor often bears the same range of burdens borne by his manufacturing counterpart; demands on his time can easily be overpowering if the project manager does not act to shield him from diversionary requirements.

At the same time, it should be borne in mind that in attempting to shield a supervisor, to free him to concentrate chiefly on the vital engineering job at hand, the project manager can unknowingly deal a severe blow to the supervisor's advancement potential. The supervisor is at a critical point in his career, at which leadership capability and administrative potential can blossom or be blighted. A general and basic tenet of management — the training of individuals for leadership — must not be shelved merely because the pace of an advanced-technology project seems at times to be overpowering. Instead the project manger must walk the middle course. For example, he may shield the supervisor from poorly founded requests for information by a staff office, while at the same time letting him resolve with the personnel department a tough question in personnel administration involving one of his engineers.

Dealing With Perfectionists

In pursuing his objective of maintaining momentum, the project manager must be constantly aware of the apparent disdain for time commitments which prevails on the part of the more theoretically inclined scientists and engineers. While this attitude is a rather deep study in itself, one part of it that must be understood is the drive for perfection that so often characterizes the professional mind. Any kind of promised delivery date inevitably involves a compromise with perfection, in that the product or study must be cut off, wrapped up, and delivered at that point, thereby leaving dangling the further improvements which the scientist would like to make. The tendency to finish the job to a ***T***, if allowed to run rampant, can result in continuous postponements of output and reduce the productivity of the project as a whole.

In the nuclear power industry, one can find in almost any reactor project a common example of the perfectionist and his tribulations:

> A nuclear reactor core — representing an investment of hundreds of thousands of dollars — must be loaded with a specific amount of fissionable fuel (usually uranium). The decision of just how much fuel is correct is one of the more agonizing which must be faced by industry technologists.
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> Typically, the loading is set by the designers using early calculations based on a series of simplified reactor experiments with varying quantities of nuclear fuel. While this first loading figure is adequate, it varies from the *optimum* depending on the performance of the nuclear designers in their highly complex and difficult art. Nevertheless, the prolonged processes of reactor core manufacture must be commenced without further delay, and during the ensuing year or longer the scientists undertake a detailed performance analysis of the reactor core with the established loading. This analysis is conducted by means of the most advanced high-capacity digital computers, and hopefully yields a confirmation of the fuel loading. Specifically it tells the designers how close they have come to the optimum loading; the nearer the optimum, the greater the reliability of the reactor, and the more economic its performance.
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> The perfectionist problem first arises when preliminary information about the fuel loading is requested by the manufacturing engineers from the designers. The nuclear designers are reluctant to part with what they feel are "premature" data. From this point on, the project

manager faces a tough series of decisions — he will have to balance the demands of the schedule with the incremental improvements in data to be gained by continuing the design study "one more week." The designers will be quite articulate in expressing the gains to be realized by deferring the schedule.

In every nuclear project the time must come when, by management decree if necessary, the first loading data are released and further improvement is considered unwarranted. At this point, the manufacturing engineers commence to build the reactor, while the scientists begin the detailed, confirmatory analysis of the reactor they have just designed. In the nuclear industry, fortunately, the detailed analysis generally confirms that the originally established loading was near optimum, thanks largely to the very high caliber of scientists and engineers in this field.

Organization Planning

In addition to his everyday job of keeping the work moving, the project manager should put a good deal of thought into planning. The crux of effective performance of any project lies in the interrelationship between organizational structure and individuals. The art of organization planning involves the correct tailoring of organizational structure to available individuals, and vice versa. An often-repeated thought in the literature of scientific administration is that although the organizational structure of a project is important, if not vital, it will not make up for inadequate caliber of technologists in the organization. On the other hand, poor organization structure can tie up the output of top-notch engineers and scientists.

In advanced-technology industries, sound organization planning requires adroitness in recruiting scarce talent both from within and without the parent organization. It also involves the ability to utilize engineers and scientists who in some cases do not measure up to reasonable requirements for the project — the ability to shape a team which can "play over its head" when it has to. Sound organization planning in a project cannot be done without a thorough understanding of the personalities, the characteristics, and the attitudes of all the technologists, both as individuals and as members of their particular professional methodologies.

Heading Off

Advance planning is vital in a project. In this area, an important duty of the project manager is to avoid the crises that often manifest themselves during the design, manufacturing, and checkout stages. Perfection will never be attained, and the best efforts of the manager can serve only to reduce, never to eliminate these crises. Still, advance planning pays for itself many times over.

While technological crises have become accepted as an inherent part of our advanced-technology projects, it must always be realized that each of these crucial periods leaves residual effects throughout the remaining course of the project. Thus, the resolution of such a crisis generally involves a sacrifice of engineering principle for expediency, which may in turn lead to subsequent crises. Further, each crisis, with its resultant need for immediate solution, erodes the constructive attitude of the project's engineers and scientists, particularly the theoreticians.

Clearly, therefore, the more that can be done to avoid these situations in advance, the better. It is unfortunately true that *most* crises that arise during the course of a project can be traced to lack of adequate advance planning.

Selling & Reselling

At any time during the course of the project, the manager may be called on to act as front man to help shape or reshape the policies that affect his project relative to the corporate structure and the company's development objectives. Contrary to much opinion about the advanced-technology industries, "selling" is a never-ending job of a project manager, as it is of most other senior managers in the corporate organization. In the matters of acquiring scarce funds, people, and materials, the project manager must always be able to make an effective presentation, often on short notice. Many projects managers have suddenly found themselves, in mid-course, fighting for the very existence of their project.

While the outcome of many such struggles is often beyond the influence of any actions taken by the manager, it is true that in numerous other cases his actions as a fully informed representative of the project will have a profound influence on the outcome.

Man in Between

As the foregoing may suggest, life is not dull for a project manager. He is the man in between management and the technologist — the one man in the

organization who must be at home in the front office talking about budgets, time schedules, and corporate policies *and* at home in the laboratory talking about technical research and development problems. But he is not a superman. He cannot be expected to double as a member of the executive committee and as a scientist equally well. Being a little of both, he is different from both — and it is precisely this quality which makes him so valuable. In his own right he does what neither the front-office executive nor the scientists can do: accomplish the aims of his corporate management, while serving as a perpetual buffer so that the engineers and scientists can meet the technological objectives that only they can define and only their output can meet.

Clearly, therefore, the job is an unusual one. What manner of man is needed to fill it? What aptitudes should he have? What special difficulties should he be willing and able to handle?

Reasonable "Projectitis"

The subject of "projectitis" may appropriately be examined here; it is a seeing of all things as though a particular project were the center of the corporate universe — the alpha and the omega of the development effort. This phenomenon of organizational beings as observed in World War II was called "theateritis." The late General Henry H. Arnold, in his autobiography *Global Mission*,[1] remarked that the disease of theateritis — the inability of an Air Force commander to be cognizant of the problems of war in any theater other than his own — caused him great concern and trouble in his personal dealings with his top field commanders. However, General Arnold noted at the same time that he would not have under his command any general who did not suffer from this disease.

The project manager on his own battleground needs a modicum of "projectitis" to generate the necessary drive and momentum to spark the project to success. These symptoms of projectitis will be observed by top corporate executives, but they will expect this malady and will themselves suffer with acute outbreaks from time to time, depending on which and how many of their projects are in the limelight.

However, when dealing with his engineers and scientists, the project manager must not suffer, or appear to suffer, from any blind or extreme case of projectitis in establishing schedular aims and policy objectives. If he does succumb to this tendency, perhaps as a result of pressure from an afflicted management, at least two adverse results may occur: (1) technological advancement in the development of his product, which in actuality is the most basic of the project's responsibilities, will suffer; (2) the human resources of the project (the most important resources in advanced-technology industry) will be reduced in efficiency and productivity.

Free Communication

The subject of communication deserves much attention in project management, just as in all management.

The theoretically inclined technologist, generally a man of imaginative creativity, as well, often, as his engineering brother with the more factual kind of creativity, inherently regards the right to communicate as the bread of life for an adequate scientific career. To this principle is related the cherished right to publish scientific work for the judgment of one's scientific peers.

Yet, there is a contradictory element in the attitude of scientists toward communication. It may be suspected, based on observations in any professional group, that there are some who pay only lip service to the ideal of free communication and who in reality are more than hesitant in communicating the results of their work, or their attitudes on any topic, to anyone connected with administration.

Vannevar Bush, in his book *Modern Arms and Free Men*,[2] noted the distinctly different reactions to communication which he observed among military men and academicians:

- In the military, there is vigorous and open debate on proposed actions before the decision. But when an office with clearly constituted authority makes the decision, the antagonists, acting under a basic doctrine of their profession, swing around to support actively the idea they had opposed.

- In contrast, under the customs which prevail in academic circles, the duly established decision signals the start of the fight. In this environment, it is very difficult to learn the nature of the opposition to administrative planning, since academicians are not inclined to communicate freely in such matters. Consequently, after deci-

[1] New York, Harper & Brothers, 1949.

[2] New York, Simon and Schuster, Inc., 1949.

sions are drawn there tends to be considerable passive and sometimes active resistance in the execution of the ideas.

The lessons here for the project manager are plain. He must expend considerable active effort in learning to communicate adequately with his scientists and in developing the communicative attitudes of his engineers. It has been clearly demonstrated that scientists and engineers who work in the operating environment can adapt their output to mesh with corporate schedules and budgets, if they are *adequately informed* regarding corporate policies and objectives. Budgets and schedules must not be mere edicts, but should be carefully prepared with the cognizance of and with the aid of the technologists who must live by them. Whenever occasional arbitrary actions originate in the realms of policy, they should be explained as carefully as possible, and on this basis they will be accepted and implemented.

The Next Project

The temporal aspect of a project manager's task may strain his capacities in dealing with people. Because the duration of a project is well defined, it is only human for the scientists and engineers who work on it to come to anticipate their next assignment, even though it may be a year or more away. This can result in a kind of divided allegiance, in which the engineers look to others outside the project who may be able to help them in gaining their next assignment.

The project manager must counter this tendency to cast about for the next task, for it will diminish his effective control of the present task. In this effort, he must be bulwarked by a potent company sales policy that has provided and will continue to provide new projects for professional employees. When he has this backing, the manager then need only follow a basic rule of managerial conduct — that of letting his people know where they stand. Frankness and integrity, when used in discussing the future, will allay their instinctive concern about the job that is over the horizon. It will convince them their role in future projects is assured unless they have been told otherwise.

Qualifications for Success

Some of the qualifications that a successful project manager must possess proceed logically from the preceding discussion:

(1) His career must have been molded in the advanced-technology environment.

(2) He must have a working knowledge of many fields of science, the fundamental kind of knowledge which he can augment when necessary to delve into the intricacies of a specific technology.

(3) He must have a good understanding of general management problems — especially marketing, control, contract work, purchasing, law, and personnel administration. The concept of profitability should be familiar to him.

(4) He must have a strong, continuous, active interest in teaching, training, and developing his supervisors.

In reviewing these qualifications, one can observe the emphasis on the *integrative* function in the operations of the project manager. There is an ever-present requirement for the joining of many parts into a systematic whole. Describing the processes by which the integrative mind works is, of course, difficult, for they are largely indefinable, just as the requisite qualities for managerial personnel are not subject to scientific definition. It is clear, however, that the integrative mind must deal with intangible factors as well as the tangible, and that there is need also at times for an intuitive process in the formulation of judgment and decision (especially where men's reactions are an important factor). It is perhaps in this respect that the outlook of a good project manager differs most sharply from that of the researcher:

> The methodology of scientific analysis and experimentation has been carefully developed over many years and is a part of the indoctrination of young men in training for a scientific career. This indoctrination breeds a distrust of intuition and a tendency to disregard intangibles. Further, the analytical mind will not draw its hypothesis until all relevant data have been observed and interpreted. If a hypothesis must be drawn before this, it must be thoroughly qualified and hedged in the interests of scientific accuracy.

In project organizations, it is recognized that the analytical mind produces the concepts by which the project advances toward its goal. But without the integrative function, often nothing would be done with the concepts originating in the analytical function. The topnotch manager of an advanced-technology project must be capable of both integration and analysis, and must understand that the rigorous training of professional technologists with its emphasis on analysis sometimes impairs their integrative ability.

Friendly Differences

In discussing the attributes of the project manger, it soon becomes apparent that he has much in common with his corporate brethren in research administration. The research director also works in advanced technologies and holds similar responsibilities. His usual task is to lead research groups in planning and developing new products which will fit into his company's future marketing plans.

Tactics vs. Strategy

However, there are subtle, yet substantive, differences in the managerial approach of the advanced-technology project managers and that of the research administrator. In military parlance, the former is a tactician, the latter essentially a strategist.

These differences may be illustrated by a look at the typical kinds of meetings in which these two managers are likely to be engaged:

- For the project manager, it is a clutch meeting with officials of a key supplier — a meeting which is the result of previous efforts falling short of their goals. The chief engineer and the manufacturing superintendent of the supplier firm are present, well primed with reasons why they cannot make scheduled delivery of a critical piece of hardware, without which the project manager cannot complete his product.

  After the opening formalities are over, this meeting begins to resemble a kind of combat. The enemy is inertia. There is a persevering, chips-down type of resourcefulness on the part of the project representatives. They must cross-examine all of the advocates who say that the key component cannot be made — the supplier's designers who say the design cannot be completed as intended, or the accountant who says it cannot be built for anywhere near the original cost estimate, or the manufacturing engineer who says it cannot be built the way the denizens of the ivory tower designed it. Then these reasons must be refuted, or if they stand up under this scrutiny, the project's designs must be altered to accommodate a simpler component. In *some* way the project must acquire a usable component, and the threatened loss of schedule or budget must be recouped.

- The research administrator's first meeting may be with a budget committee. The controller proclaims that while he can measure the input to the new research program well enough in terms of its cost, he cannot measure the output very well at all (and really is it worthwhile anyway?).

  The second meeting is with a marketing committee. The sales manager states that he cannot understand why a certain research group after two years has not produced the widget which he is sure will revolutionize the market.

  The third meeting is with a staff committee, where the research manager is straining to acquaint policy people with the company's technical problems so that they may appreciate the broad implications of these problems.

Both these roles require resourcefulness. It might be said, however, that the project manager's task requires an *intensive* resourcefulness, in which his efforts are ever directed against obstacles to progress. Conversely, the research administrator must display an *extensive* resourcefulness in meeting his primary objective — i.e., supplying his company with enough new product, and at the right time, to protect its market position against the competitive forces of product obsolescence. This requires him to handle some tough intangibles: How do you measure the output of a research group, or its impact on the company's market position? How do you evaluate the feasibility and potential payoff of new product concepts?

The project manager, in his tactical role, is closely related to line-operating management. In the research administrator's strategic role, there are many elements of the key staff adviser's functions, as well as the requirement for leading engineers and scientists in a research program. This program generally represents a wider road, traveled under less exigent circumstances, than the narrow road and fast pace followed by the advanced-technology project.

Reporting Progress

A further insight into the differences between these two types of managers may be gained by considering the way that status accounting is handled. Enlightened research administration has generally learned that it is unwise to burden a research team by requiring from it regular status reports on a periodic basis. Rather, it is preferable to require the team to submit a report only when it has something to report, since research advances do not come by regular increments of the calendar.

However, in the advanced-technology project, periodic status reports are appropriate and valuable. A report showing the absence of advance during a reporting period is an important indicator of trouble to project management.

Thinkers & Doers

Before the Sputnik era, William H. Whyte, Jr., leveled a very penetrating criticism against attempts to make scientists conform to the organization in U.S. industry.[3] Since the Sputniks, others have jumped on this rolling bandwagon and have generated an impressive indictment of the smothering of individuality and inhibition of creativity resulting from the integration of scientists and engineers with organized corporate groups.

While most of this criticism has validity, it should not be interpreted to reflect adversely on the project method of getting advanced-technology results. Project people know and understand that basic and fundamental research is being slighted in this country; they realize that project staffs — the doers — will run out of work to do unless the storehouse of basic scientific knowledge is effectively and continuously replenished. They are also keenly aware that the laissez-faire environment, the unorganized structure, of the world's great laboratories has been the origin of technological advancement.

Using Lab Output

The project method has proved to be an effective way of *utilizing* the scientific output of the thinkers in the laboratories. The project — i.e., group, organization, team, task force, or whatever name it may go by — has piled up a fine record of accomplishment since the days of the famed Manhattan Project. Certainly, there has been a requirement of conformity; and, usually, little latitude has been allowed the scientists and engineers in determining the areas in which they will work or the subject which they will investigate, because of requirements for interlocking efforts on a large scale. Yet the records of achievement remain.

For those men with the mental and personal endowment for the project kind of work — the men of factual creativity, the applied scientists, the practicing technologists — there is no element of professional degradation in this work. On the contrary, this kind of professional finds the project pace challenging and exhilarating, as can be easily verified by observation — and far preferable to the apparent aimlessness of the pure research environment.

Two Streams of Knowledge

The real indictment of the organization can come only when professional technologists are misused, when the group tries to fit the square peg into the round hole. Those scientists who are genuinely creative, and who can justifiably exhibit the individualism of a fundamental researcher, are rare. It is a shameful waste to attempt to use such men in a project — a waste to the nation, in that their output is hobbled and misapplied, and a loss to the project effort, in that they probably will not contribute to its progress.

Discerning men have long observed that "project people" are inspired by more immediate, if less exalted, goals. In the words of Francis Bacon, penned about 1620 in the preface to his *Novum Organum*:

> "Let there be therefore (and may it be for the benefit of both) two streams and two dispensations of knowledge; and in like manner two tribes or kindreds of students in philosophy — tribes not hostile or alien to each other, but bound together by mutual services . . . let there in short be one method for the cultivation, another for the invention, of knowledge.
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> "And for those who prefer the former, either from hurry, or from consideration of business, or for want of mental power to take in and embrace the other (which must needs be most men's case), I wish that they may succeed to their desire in what they are about and obtain what they are pursuing. But if any man there be who, not content to rest in a use the knowledge which has already been discovered, aspires to penetrate further . . . I invite all such to join themselves, as true sons of knowledge, with me, that passing by the outer courts of nature, which numbers have trodden, we may find a way at length into her inner chambers."

Role in the Future

The United States today faces the enormous problem of how to regain undisputed technological leadership. The character of American technological advancement during the next five years will shape our future and determine our survival or extinction.

The role to be played by project management in these years ahead will be challenging, exciting, and crucial. Truly it will be the acid test of the project manager and the project concept, but it will be much more than that. It will be a momentous trial of free enterprise, business administration, and progressive industrial management as we know them today.

[3] *The Organization Man* (New York, Simon and Schuster, Inc., 1956), Part V, "The Organization Scientist."