Considerations and Guidelines for Research Management

KENNETH E. COOK, Highway Research Board

EDITOR'S NOTE: The following article was prepared by Mr. Kenneth Cook of the HRB staff. Mr. Cook is a member of the Ad Hoc Committee on Research Policy and Administration of the Department of Economics, Finance and Administration. In 1951, the Highway Research Board prepared a survey of how highway departments organized and administered their research programs. In 1965 it was decided to revise this report. To this end case studies have been developed on research management for 15 states and a questionnaire has been submitted to all 50 states. It is hoped that the material can be synthesized into a special report to be published in the future by the Board. The committee felt that the following article was of such a timely nature because many states are currently undergoing a revision in their research organization that it should be given immediate publication rather than waiting for the completion of the special report.

What Is Research?

One of the first problems in discussing research management is the definition of "research." Much argument has gone into attempts to define and classify the term. For those who are involved in research, it belong to the emotionally charged word category. Along with such words as "freedom," "equality," "justice," the definition of the term is dependent upon its environment and the psychological needs of those attempting to define it.

To administrators, research may be defined as obtaining answers to pressing problems for which they do not have solutions. They may make little distinction as to whether the information desired has already been set forth elsewhere and only needs to be retrieved or the problem is something for which there is no existing knowledge. The academician, on the other hand, with little funds, limited equipment and educationally oriented, may define research as the quest for new knowledge.

Many names are given to these different types of research. Perhaps the most liberal definition of research is the discovery of some fact or truth heretofore unknown to the researcher. With such a definition, the classifications of research can then be dependent upon the goals to be achieved through the research program.

Why Do We Need Research?

To anyone considering the institution of a research program or an evaluation of ongoing programs, the first question to answer is, "Why do we need research?" Too often we are prone to start off with the composition of the research program without first clearly understanding why we need research in the first place. What objectives can be obtained through research? Do we want to maximize our gain or minimize our loss? Perhaps we want to achieve an objective which we cannot now accomplish.

If the ultimate purpose of research is to obtain new knowledge, there must be a pre-existing need or desire for such knowledge. To satisfy this need means to bring about change. What is the existing or potential crisis that necessitates the new knowledge that will bring about such change? Is the purpose to satisfy physical, social, economic or psychological needs of the individual or society? Is the need to satisfy the researcher himself or management?

What Are the Different Attitudes Toward Research?

It is necessary to understand the motivations and attitudes of the public, management, and researchers toward any research program. While the effects may be similar, management's and researcher's motives may be substantially different, and both may be considerably different from society's objectives. For example, in a highway safety program, the researcher's motive, while it is directed toward public service, serves the individual to advance in his own career. Management's objective may be directed at placating public criticism and preventing further restrictive legislation and administrative requirements. The public attitude may be one of general concern and a desire to have a solution to the problem as long as it does not inhibit their freedom or cost too much.

In an industrial situation, management may feel a need for research, knowing that without it they will lose their competitive position in the market. Research to them means profit or loss in the future. To the researcher, a project may be an outlet for the individual's creative energies, and his efforts are not so much concerned with making profits for the company but rather with satisfying his own sense of accomplishment. Thus, before one can evaluate a research program or even clearly establish the goals, it is necessary to understand the people and environment in which the research program will operate. Behind the clearly articulated goals of a research program there are a multitude of unarticulated emotional needs which are its ultimate purpose. A research program that frustrates the needs of the public, the administrator, or the researcher will be self-defeating.

What Are the Goals of Research?

In a systems approach to research management, the first step is to identify the goals of the program. Once these goals are established they must be subdivided into specific programs and activities. A staff and organization structure must be created along with funding and planning processes. Coordinating and communication networks must be developed as well as operating and feedback systsms.

As part of setting goals, available resources must be allocated. Management must decide how much of the research program will be for the development of theoretical research compared with development of new technological advancements and problem solving. The developmental stage in research is expensive and often requires tremendous time, money, and manpower to translate an idea into a working process. How much of the research program efforts should be directed toward this area? Similarly, how much of the research efforts

should be directed toward improving existing processes and products? In developing the goals of research, consideration must be taken of the balance between research and available resources. In investing funds for research the sponsor should evaluate his own expectations as to his desired return on investment and the time period in which he should see such a return.

The concentration of efforts must also be considered. Should the organization concentrate its efforts on a few specialized areas in which there is high probability of success or for which it has already a technical competence, or should it devote its efforts to new areas of research?

There are often ancillary goals to research. At universities, research is generally viewed as a support activity to the instructional program. For the contracting or sponsoring agency, what are the attitudes toward such secondary goals? The goals of research, as noted previously, not only are different within an agency, but also may be substantially different between the agency sponsoring the research and those performing the research. Are these goals compatible, and if not, what other alternatives are available? How much competition should there be among research agencies, and how much duplication of effort both within the organization and among like organizations? The research program, if successful, will precipitate change. What resistance to change can be anticipated and how can it be overcome?

How Do You Develop a Research Program?

Once the questions regarding goals have been resolved, the next step is to interpret them into specific research programs. Some of the questions that must be resolved in this area are: What effect will management's endorsement or lack of interest have on the research program? Management's interest is particularly necessary for theoretical or basic research. Management must be willing to accept high cost with little immediate payoff. Theoretical research is out of the mainstream of the organization's activities and frequently the researchers feel isolated from the rest of the operations. In order to keep the program funded and staffed, management must take a direct interest in the activities as they would in other long-range planning activities. Highly qualified researchers will only stay in an organization that not only tolerates them but endorses their research. On the other hand, problem-solving research can be more closely tied to the operating program, since it is principally concerned with problems on product use or modifications.

In developing a research program it is necessary to determine the balance between different activities under the overall research program. What programs should receive what amount of emphasis over what time period? In existing research programs, once a program has been initiated it tends to continue under its own momentum, frequently beyond its useful life, to the detriment of other needed research programs. The balance of a research program is not a one-time activity but a continuing process that should be reviewed periodically as part of a long-range research program.

In translating research goals into specific programs the time factor must be considered. It is easy to fall into the trap of believing that a problem can be overcome if only enough funds and staff are devoted to it. Knowledge is evasive and requires time to mature. Management must recognize this maturing process in research and should not expect immediate results. Research is more like agriculture than industry. In industry, greater efforts can be quickly translated into greater output. In agriculture, it takes time for plants to mature and this process cannot be substantially accelerated. Unless management recognizes this about research, there will be continual frustration at the comparatively slow rate of development of knowledge. Management may recognize

the need for research, and operating personnel may supply researchers with problems to solve, but the principal source of ideas is the researchers. As one industrial research administrator has said, "The success of the research program depends upon two things: first, management must feel a need for research, and second, you must procure good research staff, for without the creative researcher you can spend millions and still have nothing."

In planning a research program, consideration must be taken of lead time. The more theoretical or basic the program, the greater the time required to bring the research findings to an application stage. Where research programs affect a substantial segment of the population or environment, lead time may be thirty years or more.

How Do You Select and Control Research Projects?

Criteria must be established for the selection of projects and the assessment of the probability of success and expected gains under the constraints of staff, facilities and funds. The degree of formalization of the research proposal process depends to a large extent on the size of the research program and whether projects will be done by in-house staff or be let to contractors. Contracts for research require substantially greater details as to the obligations, responsibilities and liabilities of the contracting parties.

Probably 50 to 75 percent of the research proposals will emanate from the research staff. Those responsible for administration of the research program must determine who will select the projects to be undertaken. Management usually designates research administrators or research committees to select the projects. To be creative the researcher must be intensely interested in the projects that he is working on. At the same time, management will desire a certain type of research program which may or may not be compatible with the researcher's interest. Where there is no interest by the researchers, it may be better to recruit additional staff than force researchers to work on a project in which they have no interest, or else have the project done by contract research.

Priorities, schedules and backlogs of research projects should be considered. One of the limitations in the magnitude of the research program is the availability of staff. The researchers and administrators can generally keep project proposals well ahead of staff time available to perform the research. One advantage of setting up a backlog of research projects is that it helps to shorten the lead time required from the point of proposing the project to the actual initiation of research. With a project approved, the researchers may quickly get into the process of developing a detailed working plan. Advanced scheduling becomes extremely important in the developmental stage of the project because of the massive amounts of manpower and materials involved.

How Large Should a Research Project Be?

The optimum size for research projects and the time estimate for project completion must be considered. There has been a recent tendency toward large-scale short-term projects in government research contracts. It is hoped that the large-scale projects will be able to view a larger portion of the problem than a series of small projects could, and will more quickly lead to a resolution of the problem. The task force approach is often used in these projects. This approach may be feasible where the primary emphasis is on the developmental stage rather than the basic research stage. It may also be useful where the research is dependent upon gathering masses of data and analyzing them. However, if the research requires a great deal of creative thought by the researchers, the size of the project is better tailored around the individual re-

searcher and his required staff support. Large-scale research projects can be broken down into subactivities and tasks and delegated to individual researchers. The results of the individual research efforts must then be combined and synthesized into a final project summary. In this manner the large- and small-scale research projects differ very little since each must be broken down to the researcher-oriented project size.

The real problem with large-scale short-duration research projects is the utilization of research staff upon the completion of the project. Where projects are small and researcher-oriented, the discontinuance of any one project does not affect a large portion of the research program. On the other hand, if the project requires a substantial portion of the research staff, the discontinuation of the project may have some severe effects on the staff and the funding of a continuing research program.

Therefore, management must determine whether it intends to support research on a project-by-project basis or a basic foundation program. Under a foundation program, the research level would be relatively constant and the research staff could be developed on a career basis. If the research program is on an individual project basis or is allowed to fluctuate with the availability of funds, it may cause a basic insecurity in the research staff and make if difficult to develop a career-oriented group. For this reason it may be better to hold the research program at the more constant level even at the loss of short-term opportunities. Perhaps the developmental stage may be allowed to fluctuate more since it is more dependent upon massive manpower efforts and less on the individual creativity.

In developing a new research program, management must be willing to sustain the research program for a period of growth in which there is little payoff or return on investment. Just as many businesses fail during their early stages because of a lack of working capital, so research programs are susceptible to failure for lack of continued funding or confidence by management during their early stages of development where there is little payoff.

Where Should the Responsibility for Research Be Located?

The location of responsibility for the research program will have a substantial effect upon the content of the program. In establishing responsibility for research, consideration should be made of (1) the universality of the research problems; (2) agencies interested in the research topics; (3) the location of necessary resources; and (4) the organization that can accomplish the program at the least total cost. The more important a program is and the more effect it has on management policies and decisions, the higher in the management hierarchy it should be located. This is why research that will have long-term effects upon the future markets and profits of a company should be located close to top management. Application problems may be located closer to the operating agencies. This distinction is not exact and research agencies doing application-type research often have basic research mixed in. Similarly, organizations doing theoretical research are often asked to resolve operating problems. The key is to locate the research program close to the management decision-making source. If the appropriate level of management does not have an interest in the research program, it will not give it substantial support or backing.

The location of the necessary resources also will have an effect on the location of research responsibility. Many research programs have developed gradually, often as a result of testing functions which require highly-trained staff and testing equipment. As research programs grow from their embryonic stage, competence is built up to perform specific types of research. When research is formally recognized by management it is a natural tendency to locate it where there is already existing competency.

There is a question of whether operating units should perform research activities in addition to their normal functions, especially where research tends to be of the problem-solving type. While this may have the advantage of locating the research activities close to those needing the results, it has a number of liabilities. Generally, the type of personalities interested in research are different from those interested in daily operations and management activities. When the organization is asked to perform dissimilar types of activities, either the research or the operational phases may suffer, depending on the immediate needs or management orientation. Usually it is the research phase that will suffer, especially if there is a shortage of staff or funds, since the operating program must be continued. By locating research as a separate program from the operational activities, the reduction of the research program because of a limitation of resources is at least clearly defined for management.

The quotation "out of sight, out of mind" also applies to research. Where there is not a continuous communication process between research and those making policy decisions, there is a general tendency to discount the value or importance of research.

What Conditions Are Conducive to Research?

It is necessary to develop an environment conducive to research in order to develop a competent research staff working to the best of their creative abilities. This may be achieved by sufficient funding and willingness of management to back the program without pressure for immediate payoff. At the same time, however, management must see that money will not be wasted and will assist in achieving the goals of the organization. While the research program may be oriented to resolving problems and achieving goals of the organization, it must recognize that the key to success is the researcher and that the research program must be designed to encourage the uniquely creative capacities of the individual researcher. To do this, management must understand motives of researchers and must understand its own motives. It is necessary to integrate both toward achieving the best interests of the organization. Management must recognize that all inter-human relationships are based on a bargain between the two parties. Both management and the researcher are naturally prone to project their own motives and desires upon the total environment and sometimes fail to understand when the rest of the organization does not react in the same way as themselves. One of the principal causes of strife between management and the researcher is a lack of this understanding because of faulty communication between the two.

How Do You Coordinate a Research Program?

Coordination is based primarily on communications. The different degrees of centralization or decentralization of the organization, the location of research responsibilities, the organization of the research program under function or product lines, the coordination of the research program between two or more agencies, the use of in-house and contract research are all dependent on an effective two-way communication system. Students of management are aware of the importance of communication networks and the psychological interrelationships between management and the workers and that in modern society cooperation rather than command is the key to achieving the objectives of an organization. The resolution of such questions as the centralized control of research, both in-house and contract research, the combination of research and testing facilities, and the use of research coordinating committees must be viewed not in terms of formal organizational structure, but in terms of communication systems and whether they will promote or impede the goals of all agents involved.

Where once classical organization theory stressed formal one-way chains of command with elaborate definitions of scopes and functions, today's management behaviorists recognize that the real structure of the organization is a combination of the communications system with the decision-making structure.

Among researchers and research administrators there are sometimes strong feelings as to the location and coordination of the overall research program. Some would like to see the program highly decentralized, allowing the research decisions to be made by all the individual agencies participating in the program. Other research administrators would have a strongly centralized research program in which all in-house and contract research is channeled through one authority. There is often great jealousy and competition between in-house and contract research. The location of responsibility of the research program within the formal organization structure may be indicative of the value put on it by management.

What Are the Values and Limitations of Research Advisory Groups?

Committees are often relied on for advice and coordination of research. Frequently, a wide diversity of interests and levels of management are reflected in such advisory groups. In developing a research program, the uses and limitations of advisory groups should be considered. Advisory groups, like all committees, have certain functions which they can perform effectively and others which they should not perform. They are of value for such activities as stimulating interest, eliciting general comments on a subject, providing multiple channel communications and disseminating information in general. Their primary activity is communication, not decision-making. If committees are asked to decide upon a course of action, the decision is often the least objectional to all members rather than the best solution. Committees are not expeditious means for arriving at decisions and they are generally not highly creative organizations. In research programs, when committees are used as the primary decision-making bodies, they may become merely a nominative group which approves the recommendation of either the research administrators or a strong individual or coalition group of the total committee. In developing a research organization, care should be used to decide what results are desired from an advisory committee.

Some research management utilizes executive committees, program and project advisory committees, long-range planning committees, research review committees and liaison committees. An executive committee usually includes members from middle and top management and generally considers problems of program size and direction. Because of its broad interests it is usually not the appropriate group for the establishment of specific projects or project priorities. If this group is used for the approval of specific projects, one of two situations may occur. First, the committee may tend to become too involved in research details and will lose sight of its overall function of determining the goals and the direction of the program. The designation of projects and priority schedules as well as the development of project content is better allocated to program or project committees. Where a research program is large, both a general program review committee and specific project committee may be desirable. Where the number of projects is limited, both activities may be performed by one committee.

Sometimes, because of the size, complexity or geographic location, it is desirable to set up a liaison committee composed of research administrators and principal researchers as well as technical experts within the subject field to keep a current review of the progress of the research projects and assist in any problems that might arise during the project. Many organizations utilize

research review committees to periodically review the progress of research activities. If the committee membership is broad enough, it is a good medium for communicating research findings to people who might be in a position to put them into practice. It is also an extremely good sounding board against which the researchers are required to crystallize and articulate their research progress and defend their research techniques and data. Such a research review committee, if it represents all areas within an organization interested in the research, offers a good two-way communication system between the researcher and the user.

One of the problems in utilizing committees is the difficulty in locating responsibility for decisions. For this reason many research organizations, in addition to using a committee structure, also rely on a separate administrative decision-making structure in which individuals are made responsible for decisions. The balance between the influence of committees versus individual administrators on the research program is principally determined on the personality strengths of the individual involved and the exigency of the situation. Where time is essential and there are strong, decisive administrators, research advisory groups will play a secondary role. Where time is not extremely important or where management does not feel a vital concern about research, research committees will exert a greater amount of influence. Where strong administrators are also members of the research committees, they will influence the committees to arrive at their point of view.

What Are the Values of In-House Compared to Contract Research?

One of the research management problems that has been difficult to resolve is the balance between in-house and contract research. The allocation of funds between contract and in-house research is usually determined by management on the basis of matching the availability of research staff and funds against the desired program. If the necessary staff and facilities can be generated within the organization, all research may be performed within the organization. On the other hand, all research may be contracted out to independent research agencies. Most frequently, research programs depend on a combination of both in-house and contract research. If it depends solely on contract research, management does not have as close control over the research project as it could if it were done in-house. However, by utilizing contract research, management need only buy that amount of research which it currently desires and thus can have a highly fluctuating program. One of the problems of using contract research is that management may have difficulties in finding anyone capable or interested in performing the desired projects.

Research, like many other management functions, frequently follows a concentration pattern in that the programs tend to be heavily concentrated into a limited number of areas over a given time period. In organizations which cannot employ a total research staff, the usual procedure is to develop an internal research organization capable of handling the areas of high concentration and utilize contract research for special areas for which they do not have competent staff or adequate facilities. Contract research is sometimes used when a new broad-based program is undertaken and there is not sufficient time to develop an adequate in-house research staff. If the program continues for a substantial length of time, the general tendency is to develop proficiency within the in-house research organization and to transfer the activities from contract to in-house research.

Because in-house research should be relatively stable, contract research may be reduced when it becomes necessary or desirable to decrease the research efforts of the organization. Where such a program reduction is neces-

sary, management must review the programs and assure itself that it is not defeating its research objectives and continuing a research program in-house that is no longer reflective of the organization's needs, while discontinuing a contract research program of vital interest merely because it is more sensitive to budgetary requirements.

What Is the Relationship Between Research and Development?

Just as in-house and contract research overlap each other, so do research and development activities. If we define research to mean the evolution of new knowledge then development is the translation of the knowledge into practice or use. Research in this case is directed more at the thought processes, the creation of new concepts and theories, new processes and inventions. Development is the formulation of procedures and technology for putting the new discoveries into use. It is difficult to clearly distinguish research from development and to separate research scientists into either exclusively research or development activities.

Management, while it may desire to set up a distinction between the research processes and the development processes, should not prevent the research scientist from also participating in the development stages or prevent those involved in development from also undertaking more theoretical or basic research projects. In some industrial research programs this fact has been recognized by permitting and encouraging a certain amount of basic research in the programs of operational divisions. The research staff that is devoted to theoretical research and more or less segregated from the normal activities of the organization is asked from time to time to assist or advise in developmental or operational problems encountered in the field. This interchange between theoretical activities stimulates the researcher, and productivity generally is higher than in situations where this interchange is not permitted.

Research activities generally tend to be individually oriented. Development activities may require a massive amount of funds and staff. Often research programs do not put enough emphasis on the developmental stage. Even if the product of the research program is the development of new knowledge not requiring expansive development of hardware, development costs may be high because it takes substantial resources to provide the educational programs necessary to change the attitudes and behavior of a large organization. The staggering costs of development cause many research programs to concentrate at two extremes: (1) the development of new knowledge without its application, and (2) the resolution of operating problems. This lack of allocation of sufficient resources for development has caused a gap between technical knowledge and practice, especially in government research where the outcome of research is not reflected in future profits as it is in industry.

As society continues to grow and become more complex, the developmental costs and the lead time necessary for translating knowledge into practice will increase. The problem of translating research into practice will become even more difficult, especially in government activities, which generally have a wide impact on the environment. The tremendous cost of the current space or defense programs is extremely small when compared to the developmental costs necessary to institute any basic changes in national public programs such as transportation, education, health or welfare.

Of What Value Are Cooperative Research Programs?

A number of governmental agencies have utilized the technique of cooperative research programs to pool their limited resources. A cooperative research program permits a program that none of the agencies could afford

through their own resources. Its limitations are that it usually must rely upon contract research and there is no single agency responsible for its supervision or control. Since there may be a number of contributors of funds to the program, its management will suffer the same constraints that the use of committee management does. In considering the use of cooperative research programs, management should decide upon who should control the program and by what administrative techniques, how long the program should be continued and how it will be funded if one of the cooperating agencies discontinues its participation or wants a special facet of the program expanded.

The problem of ownership is intrinsic in all research programs. Who is to reap the rewards of new discoveries or ideas—those who made the discovery, those who promoted the discovery through the developmental stages into use, those who financed the program, or the general public? More and more where public funds are used to finance a research program, discovery rights become public property. The possibility of financial remuneration is not used as an incentive. In industry, generally as a part of employment contract, research findings belong to the company rather than to the researcher. This is also true in academic and governmental research.

How Are Research Projects Initiated?

Management must rely on the researcher as a primary source for project ideas. Even in research programs which are heavily oriented toward problem-solving, the researcher rather than the operating engineers and administrators generally is the principal source for research topics. Research topics suggested by operating or staff agencies tend to be of three types: (1) problems for which there is already technical knowledge, (2) problems too broad to be handled within the research program, and (3) problems which are of a trouble-shooting rather than a research nature. Because of their lack of familiarity with research, operating personnel are often inarticulate about their research needs. The researcher, if he is kept in contact with daily operations, may be in a better position to articulate the problems in terms of research proposals. In addition, problem-solving research is generally two-sided. First, answers are needed to specific problems, but if the problem is to be kept from arising again, not only must this specific problem be resolved, but the basic underlying factors must be understood. Problem-solving projects may ultimately lead to the development of theoretical research proposals. Research programs tend to be self-perpetuating, and the resolution of one project often precipitates similar projects to delve into other facets of the problem.

How Should Research Proposals and Projects Be Evaluated?

The contents of research proposals and the administrative procedures for their evaluation vary among research organizations and the personalities involved. Where there is very good two-way communication between the researchers and research administrators and when there is a feeling of mutual trust and competency, research proposals may be of a very informal nature. Where there is not this mutual communication and feeling of competency, proposals are more detailed and the review and evaluation process more formalized. Since the research process is ultimately dependent upon the capability and efforts of the researcher, no amount of formal review processes and working plan design will assure satisfactory results where there is not a competent, creative and dedicated research staff.

Generally, research proposals contain a description of the research, the scope of the program, the methodology and experiment design, the techniques

used to validate the findings, the personnel and equipment necessary to achieve the project, a list of the researchers who will be assigned to the project along with a biographical sketch and the proportion of time that they will allot to the project, and a proposed time schedule for completing different activities under the project. The principal difference between the research proposal and the working plan are in the degree of detail. The cost of developing a detailed working plan both in terms of money and staff time can be very high; therefore, unless there is some certainty of undertaking the research project, project proposals are not worth developing into detailed working plans. This is especially true where there is competitive bidding for research contracts. The costs of developing a working plan may be financed either by approval by the sponsoring agency to proceed based upon a proposal or it may be included as an overhead cost in the research contract.

Sometimes very formal criteria are set up for evaluating research proposals, especially contract research. In reality, the reviewer makes a decision on how well the research proposal conforms with his understanding of the research goals and programs and if the project design is similar to one that he himself would utilize if requested to perform the research. The other principal criterion is his evaluation of the capability of the research staff to perform the proposed project successfully. His knowledge of the research capability may come from his own experience with them, with others who have knowledge of their capabilities or from written description of their experience and background.

One of the problems, especially in contract research, has been that often the research is not done by the designated principal investigators, but by less experienced staff under the general supervision of a principal researcher. The result is that while the program follows the general pattern set forth by the principal investigator, since the subordinate researchers do not have the same wealth of background and experience they must first develop their own knowledge in the field before they can proceed with the advanced research that the project demands. Since the development of the basic background or knowledge takes both time and money, either the project will not achieve the desired results, or it will require greater allocations of time and funds. The use of the technique of having research performed by neophytes under the guidance of a principal researcher is a good teaching device and may provide a source for future researchers. However, if it is not clearly defined in research proposals, management may not understand that the research project is serving a dual function of education as well as the advancement of knowledge and the sponsors may feel that the research is not providing a fair return on investment.

Since the success or failure of any research project lies with the capability of the principal researcher, in approving a research proposal management should assure itself that there will be some provision for keeping the research project going if the organization loses the principal researcher. If the research is such that it cannot be immediately continued by other research personnel, the project should be designed to be in phases that may be completed within given time units, so that a loss of the researcher will not result in the loss of the total project. This is more than merely keeping progress reports of the project. It means a clear definition before the research project is initiated of the step-by-step procedures that will be taken to complete the project. As each one of these steps is accomplished, the results should be recorded in such a way that if the project loses the researcher, it will minimize the loss of the total project, and subsequent researchers taking over the project will know not only what has already been accomplished but what the next scheduled phases of the project are.

Thus, though research proposals may be kept short because of the cost involved in their preparation, management should assure itself that there is a detailed working plan for each project before the project is actually undertaken. In addition to assuring that the experiment or theory has been thought through to its culmination, the use of a detailed working plan will help proportion the research efforts. Without it there is a tendency to concentrate too much effort on the beginning phases of a project and not enough at the end because of a lack of funds or time. Also, by setting projects up into phases it allows the projects to be modified over a given time period to reflect new information and needs.

Research, like other human endeavors, is sensitive to fads. As the individual's, the organization's, or society's interests shift, there will be a shift in the research program. Although there may be many areas which need research it is only natural to expect that those attuned with the times will receive the greatest interest and emphasis. In developing an overall research program, management must keep in mind that fads are generally short-lived. It must incorporate into the research program not only fads but also the less popular research needs. Management must also be willing to back research which will be needed in the future, but for which there is no current popularity.

The larger the project and the longer the period it is to continue, the greater the effort required in preparation of the proposal, and the greater the effort necessary to integrate the overall project prior to its inception. Large-scale, short-time projects sometimes do not allow adequate time to develop the research systems, staff, or maturation of knowledge to assure a fair return for the funds invested. Therefore, lead time for well thought out large-scale research projects may take a considerable amount of time. This means that not only must management determine the time that it would like to have the research results, it must also plan for the necessary lead time to develop proposals and working plans, undertake the actual experiment, develop the necessary hardware, staff and procedures and successfully market the idea. Sometimes research is criticized by people who do not realize the amount of time it takes to bring a research proposal into fruition. From a public relations standpoint, it might be advisable to integrate into the overall research program, short-term projects directed toward current fads and interests.

How Is the Research Program Financed?

Sometimes in the development of a research program little consideration is given to the effect that the sources of funds will have on the program. An administrator who controls the sources of funds for the research program will directly or indirectly control the overall program. In fact, this is management's key technique to controlling the research program. Through the allocation of resources the program may be altered or diverted through administrative procedures. Any administrator who has authority to endorse or prohibit the flow of funds into research has control over the program. Sometimes legislators have found that funds which they have appropriated for specific purposes and programs have been re-directed and re-diverted by administrative interpretation. The budgetary authority to expend funds is essentially a negative power in that it may prevent the use of funds for programs and projects, but does not have the alternative of authorizing funds for new programs.

The fund structure itself may affect the research program. Where funds are earmarked for specific purposes, they become relatively insensitive to changing needs and emphasis. By earmarking funds for research, an advantage is gained in that research is not in competition with other programs which may be of more immediate interest to operating managers. The earmarking of funds makes the research program more independent of the rest of the ac-

tivities of the organization. However, with this independence come a number of liabilities. One of the liabilities is that, in not being in a competitive position with other activities, the research program may not be in proper balance with the overall functions of the organization. It may be receiving too little as well as too much support. On the other hand, earmarking funds provides a basic foundation program upon which to build a continuing research program which is not sensitive to being raided by other activities.

Because it is difficult to measure the value of research, especially long-term research, it is difficult to establish the criteria for allocating funds to research in terms of measures of performance. In most instances, since the development of a research program is a gradual process over time, the allocation of research funds is based on previous rates of expenditures plus allowances for new programs. In other instances, the allocation of research funds is based on percentage figures or other arbitrary bases not directly related to the research needs. What is needed in a research program is a source of guaranteed funds to support a minimum program, and in addition, additional funds for emphasis in current areas of interest. The use of a foundation program plus additional funds provides management with the opportunity to curtail additional funds unless the research program is sensitive to its needs, while at the same time it protects the researchers from having to absolutely comply with the wishes of management for fear of having the total program eliminated.

What Are the Necessary Accounting and Cost Control Systems?

In developing the budgetary accounting and cost control system for use in connection with the research program, management must consider how tightly project cost controls should be exercised and upon what criteria they should be established. If costs are not a key factor or if there is an excess of unallocated research funds, project cost controls tend to be lax, especially for individual projects, and are more generally in terms of programs or total expenditures for research. As funds become increasingly scarce, tighter budgetary controls will be utilized. If performance units cannot be established to measure a project, then the adherence to tight project cost controls is merely the adherence to the arbitrary decision of how funds ought to be allocated.

If project cost controls do not readily lend themselves to actual direction and control of the research program, they are helpful in measuring the progress of a project and often indicate a point of no return where a project may be discontinued. Researchers have a tendency to keep projects on the books so they may be reactivated should the need arise at some later date without having to go through the formal procedures of project proposal and approval. Project cost control statements may indicate this situation and precipitate a management review of the project.

In spite of its limitations as a control device, the budgetary process is an effective planning tool. It is more important for contract research than for in-house research. In-house research projects are subject to other control devices which are more effective than the use of funds. With contract research, budgetary reimbursement for research becomes an important device for assuring the completion of the project. Most research projects provide for a monthly billing procedure for work completed, but set aside an amount which is not to be paid until the project is completed to the satisfaction of the sponsor. One of the current budgetary cost problems in research is the high overhead costs charged to projects. These overhead costs may be as high as 50 or 100 percent of direct costs and there is no easy way that the contractor may ascertain whether they are valid or not.

How Can We Communicate or Retrieve Research Findings?

With the tremendous rate of growth in research in all fields, there is the continuing problem of communicating research findings, not only within the organization, but to other agencies involved in similar types of research. This is particularly true with governmental research. It has been estimated that rate of knowledge is doubling every ten years. In the United States alone, there are several million scientific journal articles, books and manuscripts published every year. Even if he wants to, it is impossible for a researcher to keep abreast of all the developments in his field. Recent advances in electronic data processing, storage and retrieval systems are attempting to handle the massive process of locating ongoing and completed research in specific areas. However, they have not resolved the problem of sorting through the mass of literature to extract the important information. This is still left up to the individual researcher and even if he is provided with sources of information relating to his field of research, this process may be so time-consuming that it may be cheaper to reproduce the research in its entirety rather than search out and verify research done elsewhere.

There is, in addition, the problem of assuring the validity of research done elsewhere. Researchers may be reluctant to accept research not done under their own supervision. Not only is there a need to develop a storage and retrieval system for research information, but as part of this system, there is a need for sorting out important findings and verifying the results.

In recent years there has been increased use of conferences and symposia as techniques for communicating research findings to the scientific community. Face-to-face contacts among researchers allow them to quickly distill the essence of other research programs and verify them through two-way question and answer systems. It allows the researcher to judge the caliber of the other researchers and the validity of their results.

If communication of research findings is difficult among similarly oriented researchers, it is even more difficult between researchers, management and the community. Research findings may never be utilized because they are not put into terminology that can be understood by those who can use them. Management should be concerned that research is translated into a form that can be utilized by potential users. Within an organization, this may be done by committee meetings or conferences in which researchers discuss their work and findings with administrators and potential users.

What Are the Sources and Criteria for the Selection of Research Staff?

The recruitment of researchers and the criteria for their selection has been a continual problem for management. Many types of selection techniques have been proposed but at the present time there is no procedure that will give a high predictability of success. Psychological and performance tests provide an indication of a candidate's performance in given limited situations. Education and training, while they may provide indications as to the candidate's performance in an academic atmosphere, may not provide a reliable criterion for determining research capabilities. The candidate's working experience shows his past field of endeavor but may not show the area in which he has the greatest potential creativity. The use of competitive examinations and written tests may not be good measures of the characteristics necessary to be successful in the research situation. Thus, while all of these factors enter into the selection of a candidate, none of them are sufficient to predict his potential accomplishments.

Thus, the criteria for selection should be dependent upon the need to eliminate candidates before they have had an opportunity to demonstrate their abilities in the actual research environment. If research candidates are in oversupply or if the costs are too high to permit the candidate to demonstrate his capabilities, then sufficiently selective devices must be designed to provide only the number of candidates which the organization can accommodate. If costs of facilities do not have to be considered, the ideal situation for the selection of researchers would be to provide an opportunity for all candidates to demonstrate their capabilities. Their own lack of interest or demonstrated inability would then be the principal criterion for eliminating them from the research program.

Sometimes, however, the criteria for the selection of research staff are not based on a need to minimize cost or overloading of research facilities but rather on ego images and vested interests of those setting up the criteria. Research is no different from other professions in that the professionals like to establish the criteria for recruitment and measures of success according to their own knowledge, experience, education, and qualifications. By defining their own qualities as those prerequisite for success researchers or administrators automatically define themselves as being successful. However, a study of history will demonstrate it is often one generation's failures that are the succeeding generation's successes. The arts and the sciences are replete with multitudinous examples of how the truly creative person was rejected by his own society.

Perhaps in research more than in any other field, the individual must be sensitive to changes in the environment or field of knowledge far in advance of the general community. Where a researcher is dealing with lead times of a generation it must be expected that the consensus of the present community will not be sensitive or favorably disposed toward the researcher's ideas or capabilities. Where the research function is, however, directed toward solving existing problems or is of a highly applied nature, current criteria for selection may be more valid in terms of their predictability of success. Often the research program is limited by the criteria for the selection of staff in that, if the criteria for staff recruitment are such that they accept those researchers competent only in applied or problem solving areas, then regardless of management's desire for a theoretical research program this will not be possible, because the existing research staff will not be available and the recruitment of additional staff will not provide the necessary characteristics.

Management should give careful consideration to such questions as:

· How much weight should be given to education versus experience in recruiting employees?

· Should the staffing of research departments be handled under the same classification system as the recruitment for regular operating employees?

· Should the criteria for the selection of all researchers be the same, and if not, what should be the criteria and in what ratio should the different types of researcher be employed?

Management should look at each criterion carefully to determine first, why it is needed, and second, what its effect will be upon the development of a qualified research staff and upon the long-term research program of the organization.

Usually, it is easier to obtain research funds than qualified researchers. If young professional people are not immediately attracted into the research area the probability of attracting them at a later point in their career is small. Because of the lead time necessary for the development of a competent professional research staff as well as lead time necessary for the completion and implementation of research, management should continually evaluate and fore-

cast needs for research personnel. Because of the scarcity of professional research staff, the professional researcher should be provided with sufficient technical and clerical staff so that his time is not allocated to activities that can be done by sub-professional and technical personnel.

How Do You Provide for Career Progression in Research?

Along with developing a recruitment system, management should also clearly define a career progression system for researchers. In some research organizations, research is looked upon as a dead-end street and if the researcher is to progress in his profession, he must leave research and go into other operational functions of the organization. In many organizations, salaries and career progression are based upon administrative responsibilities. The larger the number of people or magnitude of program that the individual is responsible for, the higher in the organizational structure and the larger the salary received. In recent years, this concept has been undergoing a change, and today there is greater recognition of the distinction between administrative capacities and technical competence. A highly creative individual who likes to work in semi-seclusion may be a very valuable asset as a researcher, but may be a failure as a research administrator. Unless provisions are made whereby a man can make a lifetime work in research, there comes a point in his career that if he is to advance further he must leave research activities and assume administrative responsibilities.

Management and the ability to deal effectively with the human as well as the physical environment is becoming a highly specialized art requiring professional training as well as interest and inclination. The difference between a researcher and a research administrator is not so much the-inability of the researcher to learn management techniques, but rather a difference in interest. As long as management puts higher rewards on administrative functions than on the performance of research, the ambitious researchers will strive to become administrators. If adequate satisfactions, recognition and remuneration are provided within the research framework, then a competent researcher would not have the inclination to shift out of research into other activities.

Because of this isolation of the research function from the central activities of the organization, management should consciously make an effort to make the researcher feel that he is a part of the overall organization and stimulate him to participate not only in the activities of the organization, but also in professional activities outside the research organization. In this way the researcher will identify not only with his internal group, but also with the total professional environment.

Many organizations use some form of performance rating system to evaluate their employees. These rating systems are used in considerations for salary increases or promotion based on the belief that a supervisor can effectively evaluate the individual's performance and usefulness to the organization. If the organization is sufficiently small and two-way communication between all members of the staff is possible, the need for a performance rating system would not exist. However, as an organization grows the communication network increases at a geometric rate and it is impossible for management to know each staff member individually and be able to evaluate his productivity or usefulness to the organization. Therefore, rating systems have been developed in order to provide management some form of evaluation of performance upon which to base salary increments and career advancement.

The use of effectiveness or performance rating systems for employees is closely tied to management's philosophy toward salaries. In a shortage economy of past decades, salaries were heavily relied upon as the primary motivat-

ing factor for work. In an affluent society the motivational value of money rapidly decreases. As an individual's expectations for current consumption are satisfied and as his long-term expectations and provisions for security are taken care of, the value of money decreases while other motives increase in importance.

If a researcher's interests are to continue to expand throughout his career, management must see that he is provided with ample opportunities for stimulation by new ideas and opportunities. Training programs, participation in professional organizations, and conferences are some of the techniques for keeping abreast of current ideas and developments. Typically, the operating staff is less interested in reflective thought processes than are researchers. Unallocated time should be provided for researchers to delve into new ideas and to catch up in their own field of specialization.

This article has discussed some of the decisions that management must make in establishing or evaluating a research program. First, management must feel a need for research. Second, it must clearly define the research goals and programs and translate them into time-scheduled plans. A research organization must be established, funds provided, and a staff recruited. Procedures must be developed to achieve the maximum benefits of research by translating research findings into practice. Management must understand the researcher and his motives and provide a situation in which both management goals and the individual's goals can be mutually achieved.