Remarks
by
Boyd C. Myers, II
Deputy Associate Administrator (Operations)
Office of Advanced Research and Technology
National Aeronautics and Space Administration
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At the outset, I want to express my sincere appreciation for this chance to discuss a topic of interest not only to you but also to the Agency I represent. Management of Science is both the underlying concept and the overriding task of the National Aeronautics and Space Administration. How well we abide by the concept and carry out the task largely determines how successful we will be in accomplishing our missions and in acquiring new knowledge in science and technology.

The reach of our work extends into industry, colleges and universities, non-profit institutions, and cooperative programs with other government agencies; hence the points to be considered have direct or indirect bearing on all aspects of the nation's scientific and engineering community.

Today we are experiencing an unprecedented national and international attitude toward Research and Development. In years gone by, concentrated government attention to this overall field has focused on [redacted]ific areas as transportation, sanitation and health, and mili-[redacted]iveness. The quest for knowledge, per se, has never before receive[redacted]he degree of government support that it has today.

Of course this is not to say that the scientific revolution is a phenomenon of only the past quarter of a century. During the industrial revolution of the 19th century, science was closely allied with craftsmanship. As a matter of history, there had been a union of science and craftsmanship well before the 19th century. Science as a profession has come a long way since the establishment of the Royal Society of London in 1660. The placement of science, particularly the mathematical and physical sciences, by Condorcet, at the core of the French system of public instruction following the French Revolution, the establishment of the French polytechnic schools which encompassed both theoretical and practical work in the laboratory, and the system of technical schools that grew up in competition with the theoretical scientific tradition in the universities of Germany in the latter half of the 19th century were steps along the path to today's approach to research in this country. The distinguishing feature of the current era, however, is the compression of the time cycle from research to engineering to development to exploitation.

Further--and this is of critical importance to the topic of your discussions today--the newest fields of scientific knowledge are expanding perhaps even more rapidly than did the older ones. As an illustration, consider the rapid development in electronics versus the evolution of the reciprocating gasoline engine of another day.

Couple this dramatic expansion of knowledge with the urgent drive to further compress the research-to-application cycle, and we have just cause to be concerned about how best to support and exploit the nation's--and the world's--scientific potential. If we are to reap maximum benefits from this potential, it is essential for management efforts to follow the hair-thin line of constructive guidance that runs between casual indirection on the one hand and restrictive regimentation on the other.

Within NASA specifically--and the overall space and aeronautics effort of this nation in general--this is what we are deliberately attempting to do. It is imperative that we move continually toward goals and objectives--for the present, for the immediate future, and for the long range future.

How do we provide guidance without obstructing progress? The establishment of technological goals to be achieved in a measurable

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period of time is the first step in this delicate process of guiding science and engineering in an aeronautical and space program. This leads automatically to the necessity for continuing assessment of the progress toward these goals. This provides the basis for the judgments that allow us to alter the course toward these long goals.

In order to understand the application of these principles to our mission, a word of the evolution of NASA is in order. The National Aeronautics and Space Administration, an outgrowth and significant expansion of the National Advisory Committee for Aeronautics, which had almost a half-century of research experience, was established in 1958 and assigned three major research functions: to provide for the expansion of human knowledge of phenomena in the atmosphere and space; to conduct research into problems of flight within and outside the earth's atmosphere; and to develop, construct, test, and operate aeronautical and space vehicles for purposes of research and to explore space.

During its six-year history, NASA has developed further the NACA method of managing science which we hope will continue to help achieve national goals. At the heart of the method is management by professional scientists and engineers who are themselves engaged in work at the boundaries of their science and technology. Nine major installations with some 30,000 persons comprise the instruments by which this five billion dollar program is managed. About 90 per cent of NASA's appropriated funds are spent through contract with private organizations in universities, industry, and research institutes.

Creative research work within the field centers is provided by about 12,000 scientists, engineers and supporting people and is the key to maintaining a highly competent corps of professionals within the government service.

The unique aspects of our management effort is that while we have a pyramid organization for administrative purposes, we have a "flat" and direct approach to the scientific and engineering activities. That is, the so-called chain of command is not complicated by numerous paper-work channels. The man at the bench can readily deal with practically all levels of supervision on the basis of technical exchange rather than supervisory channels.

We are able to use this approach effectively because the breakout of our mission and the general assignments of our centers are determined according to established or planned competence in aerodynamics, structures, materials, guidance, propulsion, power generation, life sciences, and communications, for example.

Our newest center, the Electronics Research Center, in Cambridge, Massachusetts, is worth mention here. Heretofore, electronics research has been conducted as an important adjunct at a number of the centers and under contract at several contractors and universities. However, because of changing technology and very great impact of electronics--and particularly electronic component reliability problems--on the space program, it became increasingly evident that more direct, more concentrated management was in order. This new center is just now being established. We plan growth in the fields of communications, tracking, guidance, control, stabilization, instrumentation and data processing as applied to the unique problems of our mission. We foresee a 2100-man laboratory, with about $60 million dollars in facilities by 1969.

Inherent in this total scheme is the simple fact that we focus our work to the extent that 80-85 per cent is applied research. We try, and so far have succeeded, in maintaining an effort of about 15 per cent of our resources--staff and funds--for the broad thrust of basic research. We do this to make certain that the applied research that is applicable within the next ten years will have the fundamental base of knowledge.

A significant aspect of NASA's management concept pertains to the communication of ideas, theories, and discoveries among scientists and engineers. We are concerned here, not only with our own people but with their counterparts throughout the national and international scientific and engineering community. It is essential for people with like or kindred interests to attend meetings and seminars such as this and others--including such international groups as the European Scientific Research Organization, the NATO Advisory Group for Aeronautical Research and Development, and the International Astronautical Federation.

We conduct our own active publication and information exchange program and encourage participation in others. An example is a program we call Selective Dissemination of Information, whose purpose is to provide prompt announcements of new reports to scientists and engineers. In this program, a computer compares each man's "interest profile"--subject terms and phrases related to his work and interests--with subject indexes to be annotated in our abstract announcement journal (Scientific and Technical Aerospace Reports--STAR). An abstract of the report is mailed directly--and promptly--to the participant when his interest profile matches the subject of the document.

Just last week NASA and the Department of Defense agreed on a new common system which permits us to communicate details of our active programs in research and technology. This program involves some 45,000 items of research work. These items are reported on a form that includes a common digital language, which is important for rapid data processing and vastly improved communication. This system will greatly improve communication and coordination between the two agencies and minimize unnecessary duplication. It is visualized that the system can be extended such that any scientist or staff member from NASA or DOD will be able to obtain full basic information on any given type of work unit, by the most rapid information retrieval system we know how to build.

We have established cooperative programs with 69 countries. Varied types of activities from cooperative satellites such as the Ariel and Alouette with Great Britain and Canada; to participation in sounding rocket programs; to participation in meteorological and communications satellites; to other activities such as resident research associates in NASA centers are illustrative of a strong and growing exchange of science and engineering on an international basis.

Another integral and very major part of our total management effort concerns our support and sponsorship of universities. Currently we are working directly with 180 universities in research, training and space experiments. We establish grants for graduate training, financially support the construction of new or expanded institution facilities, and contract for studies to be conducted at various colleges and universities throughout the country. The scope of this program may be seen in the fact that last fiscal year our obligations to universities exceeded $100 million.

We do not make grants directly to students in training but provide total funds to the schools. The schools, in turn, evaluate the applicants, consider the courses of study and the proposed thesis, and make the grants according to their capabilities and the students' interests. By providing the support in this manner, we spread the grants over a larger area, avoiding concentration in two or three better known schools. This benefits the colleges that participate in the program and simultaneously broadens our educational bases.

We support university facilities because we know of a need for more research laboratory space than is available; it obviously will not be possible for universities to carry their share of the total space and aeronautics program burden unless this need is satisfied. However, we provide such support in light of certain important criteria: the relative importance of the research work for which the facility is proposed; the urgency of the institution's need; the competence, achievements, and potential of the scientific staff; and the nature or extent of the institution's commitment to work in the aeronautical and space sciences.

Where research is concerned, we are trying to give universities the opportunity to strengthen the areas of space-related work and stimulate development of new ideas and talent. The program also tends to encourage researchers to remain with their institutions and create a nucleus of interest that will attract younger people. NASA benefits by obtaining new information and, in some instances, new experiments for our scientific satellites and our laboratories. The nation gains significantly by the resulting increase in university strength.

Through all of our university program activities, the overriding purpose is to broaden the base of this nation's research activity. In addition, with regard to the graduate student trainees, we hope to attract more dedicated and highly motivated scientists and engineers into government programs. On this point, however, let me make one point clear: the students are in no way obligated to work for us in return for our support. There are no strings attached to the stipend other than those that any university or college would attach to scholarships. More than anything else, it is a way of encouraging the better qualified students to work for their Ph. D's immediately and on a year-round basis. If they do come to us, fine. If they go to private industry or enter the teaching profession, we still consider this a productive and favorable result.

Throughout the many facets of NASA's management of science, one primary characteristic should be quite clear. In a field of endeavor that depends so much on individual productivity, it is vital to success that the individual is recognized, encouraged, and fully supported. NASA goes to particular pains to make certain that such recognition, encouragement, and support are forthcoming.

We know, of course, that the outstanding people in the scientific and engineering fields--the best people--never want for these things. We are concerned with appropriate recognition and support of all researchers who in total make contributions to the success of our programs.

For support, we attempt at the outset of our planning that our scientists and engineers will receive adequate facility, equipment, travel, and funding support. This comes first--before any other financial allocations and commitments.

We also strongly encourage our people to prepare articles, papers, and reports on the work accomplished. Some of these find their way into scholarly publications, others will be published in professional journals, and all will be published in complete form by NASA. No matter what printed form they take ultimately, the individual researcher is identified as the author of his work.

Finally, we assist our scientists and engineers, particularly at the Centers, to further their own education or supplement their specialties by taking locally conducted courses. Such courses give the individual an opportunity to stay abreast of developments in his area in a broader sense than his work alone would otherwise permit. They may also permit interdisciplinary training, so essential to the successful conduct of individual space projects, and, perhaps equally important, they offer the opportunity for academic interchange of ideas, an ingredient that is essential to creativity.

I have not touched on the detailed processes, techniques, and mechanics of management. Rather, I have tried to give you the broader picture of our concept, philosophy, and general approach to research management. We make no superlative claims about our management of science, but our technical successes and scientific discoveries to date encourage us to believe that our approach is reasonably sound. We will go on to further perfect it--to the end that the National Aeronautics and Space Administration can fully and effectively accomplish the missions which the nation has every right to expect.

Thank you.