

GOVERNMENT AND UNIVERSITIES

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In the words used in the advance program to characterize today's session, "American success in the space age is predicated on the creative cooperation of Government, industry, university." Dr. Seamans discussed the Government-industry phase of this cooperation. It is my privilege to describe to you the relationship which has evolved between NASA and the universities.

At the beginning of the 20th Century, the Federal Government, the academic community, and industry behaved in most ways as independent entities whose fields of influence hardly touched. By the close of World War I, the interdependence of Government and industry had been established beyond any real doubt and was generally accepted; but the university remained a thing apart. It educated, in a more or less classical sense, a relatively small fraction of the population which was able to afford the luxury; but its contribution to what we now call "highly trained manpower," with direct resultant utility to society, was mainly in such fields as medicine, law, and the clergy.

Of course, the university was also the locale of scientific research. Largely uninfluenced by any demanding technology, this research proceeded in a leisurely and protected environment of scholarly inquiry. The principal motives were curiosity and the desire to exercise intellect. Publications were proudly esoteric in style, and there was little or no organized attempt to make the results of truly scientific endeavors known to the lay public, Government, or industry in general.

Technology was primarily the responsibility of industry. Concentrated largely in the chemical and automotive fields, it was limited in its scope and extent as much by the desires and production capabil-

ities of the sponsoring industry as by the amount of fundamental information available. No external stress demanded the kinds of drastic changes which only completely new concepts can generate, and no particular premium was placed on ultrashort response time in converting new principles into useful end items.

World War II changed all this. Under the pressure of military requirements, the customary roles of various segments of the economy were reexamined, and the Federal Government undertook mobilization of our total national resources on a crash basis. New fundamental knowledge, when quickly reduced to practice and employed against a less knowledgeable enemy, became a determinant in global conflict. In short, teachers, scientists, and engineers in universities were discovered to have ideas and capabilities which could contribute to the winning of wars!

In their own laboratories and in hastily erected Government installations, university people applied their imagination and creative talent to the struggle for national survival. The traditional disciplines of physics, chemistry, biology, psychology, electrical, and mechanical engineering merged into new areas of development of radar, sonar, biological and chemical warfare, nuclear energy, human factors, propulsion, and ordnance. The drives of pure curiosity and self-satisfaction gave way before the external urging of operational requirements.

The total effort was successful, and eventually the war ended. Some of the scientists and engineers who had been uprooted from their academic environments stayed with Government or with industry; others returned to the universities to begin rebuilding. But both Government and universities had learned a lesson which was not soon to be forgotten—and which was to prove as important in peaceful pursuits as in war—

namely, that true cooperation was the key to the successful accomplishment of things neither could possibly do alone.

During the following decade, a number of Federal agencies began to draw upon the scientific and technical resources available to our postwar society. Universities and Government began the long and sometimes painful process of learning to understand each other and to work together for the long-term common welfare. Some Government agencies, such as Defense, began to develop relationships along lines which followed their wartime associations. New ones strongly dependent upon modern technology, such as the Atomic Energy Commission, recognized the contribution which universities could make to the accomplishment of their mission.

When NASA came upon the scene in 1958, a number of basic principles and mechanisms for the conduct of research in universities under Government auspices had been developed. Through their participation in the research programs of Federal agencies, universities had become much more conscious of their direct role in the accomplishment of long-range national goals.

With the passage of the National Aeronautics and Space Act in 1958, NASA undertook the pursuit of three broad, essential objectives:

1. Expansion of human knowledge of space phenomena
2. Advancement of the technology of space flight and aeronautics
3. Development of the capability to apply aeronautical and space techniques to peaceful uses of mankind.

The challenge was a formidable one. It was plainly evident that, in such an undertaking, the common enemy was ignorance, and new knowledge would be the only effective weapon against it. In each area, NASA drew heavily upon the capabilities of universities. Each program office sought the help of specialized talent in solving its own particular problems—a natural stimulus for the initiation of research projects in qualified universities all across the nation. This became NASA's sponsored research program—a direct response to our programmatic needs.

During the first 3 years of its existence, NASA devoted about \$25 million to sponsored research and flight instrumentation in universities. With these relatively modest funds, universities began engaging

in research across a broad spectrum of fields—many of which had been sorely neglected—ranging from astrophysics and astronomy to aerospace medicine and exobiology, from fluid mechanics and plasmas to communication, data processing, and systems analysis.

In March 1961, the President announced the acceleration of the national space program. Every component of NASA took stock of its strengths and weaknesses, examined its policies and procedures, and reevaluated its available resources. The critical reappraisal of NASA-university relationships revealed several clear facts:

1. Universities were already contributing significantly to the research needed by the national space program. This sponsored project research was vitally necessary and should be continued and augmented where required.
2. NASA and the Nation had needs which were not adequately satisfied by this sponsored research alone.
3. Many universities were able and anxious to do more but were constrained by the structuring of existing programs and apprehensive of greatly expanded project-type efforts which might destroy the institutions' internal balance. New administrative, organizational, and management concepts were at least as necessary as funds to implement new activities.
4. No other Federal agency was utilizing this reserve capability.
5. NASA could take advantage of this opportunity to strengthen its own program by using techniques which simultaneously improve the ability of universities to perform their unique and traditional functions and allow them the latitude necessary to optimize their performance while still remaining responsive to NASA's total mission requirements.

Working from these premises, NASA convened a group of 16 eminent members of the academic community who, together with nearly an equal number of NASA representatives, examined the general problem of strengthening NASA-university relationships. Upon the conclusions reached during these meetings in July and August of 1961, we developed the basic principles which have guided our relationships with universities during the past two years. Central to the development of such principles and the design of programs which give them form and substance is the

recognition of the need for new knowledge. NASA needs it to solve the problems which may prevent accomplishment of its mission—some of which cannot even be foreseen now. Universities, at least at the graduate level, have traditionally been involved in the total process of dealing with this knowledge—encouraging and implementing its generation, exchanging it among faculty and students, and communicating it to the rest of society.

Research, upon which we depend for the organized increase in our store of knowledge, cannot proceed without three basic ingredients: skilled people, adequate laboratory facilities, and support of day-to-day operations. Routine support of project-oriented research customarily concerns itself primarily with the last of these, since both requirements and results in this area are easier to identify and evaluate. This kind of research, with its direct responsiveness to specific technological program objectives, remains the major element of our university endeavors. We are proud of the accomplishments it has made possible during the past several years, and we have increased our sponsorship as NASA has grown. In addition, however, we have established other activities which augment and complement this project research, namely:

1. Encouragement and support of multidisciplinary research of special character which may be unsuitable for conventional project treatment
2. Graduate training in space-related science and engineering
3. Assistance in the provision of adequate university laboratory facilities for space-oriented research.

The first of these implements the view expressed by Mr. James E. Webb, Administrator of NASA, in a recent public statement:

Our policy is to place research contracts and grants at those universities where the scholars themselves, the consensus of the faculty, and the administration of the university are interested in having the work progress on a broad interdisciplinary basis, drawing together creative minds, knowledge, and resources from many fields, . . . for widely shared participation. Under this policy, NASA research proceeds within the university in the closest association with graduate and post-graduate education, thereby replenishing and augmenting the supply of highly qualified scientists, social scientists, engineers, and technical experts.

These special purpose research grants offer universities a considerable degree of flexibility in making

maximum use of their research capabilities. Some help fill gaps between related research projects, allow exploration of new avenues of investigation, or encourage the development of creative multidisciplinary enterprises. Others allow consolidation of associated activities or bring out the latent talent of groups which, by virtue of their size or experience, have not yet been able to participate in the space program.

We believe strongly that research which traditionally and rightfully belongs in the university should remain there and should be part of the normal university functions and responsibilities. Accordingly, we are not inclined favorably toward proposals to divert NASA funds for university research away from the central university complex or to create special research centers which diminish the side benefits of intimate association with the total educational process. Our efforts will, we hope, enable universities to strengthen themselves at the same time that they increase their role in support of this long-range national undertaking.

A growing space program will place increasing demands on the already limited supply of highly skilled scientists and engineers. The demand will be in two general directions—those technical personnel required to participate directly in the immediate programs of current space activity to solve current problems and those required to conduct basic research of a long-range nature, to teach new students and, equally important, to study and comprehend the vast amounts of scientific data acquired through increasing space experimentation.

In this country, the complex job of training or teaching, the conduct of basic research, and the attack on the fundamental problems of nature are concentrated in the university, where all three functions are part of our traditional educational system and to which our nation looks for the leadership in understanding the environment in which we live.

We all know that the doctoral degree is not the sole measure of advanced academic excellence and the trained mind, but it is the most reliable and uniform yardstick we have. Immediately upon acceleration of the national space program in 1961, NASA initiated a predoctoral training program, designed to help avoid an acute manpower crisis 3 or 4 years from now which might result in raids on other segments of the economy. This program provides 3-year predoctoral training opportunities to selected graduate students with the ultimate goal of acquiring their Ph. D. de-

grees. Training grants are made to the university, not to individual students. Under a principle of maximum local autonomy, trainees are selected by the senior members of the faculty who will supervise their graduate studies. The stipends and allowances granted are competitive but not so lucrative as to draw off from other areas of the institution, those students who would normally study in other fields.

Participation as a NASA trainee gives the student a direct identification with NASA goals and problems. It gives him the feeling of being involved in the bold new programs of the space age. In many cases, his professors at the university are directly engaged in research activity supported by NASA, so that the student also has a direct association with NASA scientists and space-oriented experiments. The ties thus formed provide additional motivation to the trainee to continue studies in this area and participate in some part of the national space program after graduation, at which time he is free to remain in academic work or to affiliate with industry or Government.

By the fall of 1964, 1,957 NASA predoctoral trainees will be participating in this program at 131 universities across the country. Eventually, we expect to be responsible for a yield of about 1,000 Ph. D.'s per year, a fair NASA share of the increased supply of highly trained talent which this Nation's technological growth is estimated to require.

In addition to our involvement in research and the stimulation of advanced training, NASA is authorized to grant funds to universities for the construction of laboratory facilities urgently needed for the proper conduct of research in space-related science and technology. By facilities, we mean exclusively buildings — "brick and mortar" — not research equipment. NASA does not customarily make equipment grants as such, but prefers to consider research efforts as whole entities, including the necessary instruments and tools to do the job.

Few would deny the importance of suitable facilities for industrial design, fabrication, or flight testing in industry; and they are equally important in university research. In spite of the nostalgic appeal of the concept of sealing wax, string, and unheated garrets, obsolete and overcrowded facilities do not really generate outstanding modern research, and many universities are already literally unable to accommodate their existing talent.

Facilities grants have been made on a highly selective basis, generally to institutions which are already deeply involved in NASA work. This is no general construction program, for such an undertaking would far exceed NASA's proper sphere of activity as well as its available resources. Important though they are, we do not finance the construction of classrooms, auditoriums, libraries, or cafeterias on campuses.

As part of the negotiations surrounding each major facilities grant, NASA and the university execute a Memorandum of Understanding which embodies statements of NASA policy and philosophy and an avowal by the university of its intent to seek ways in which benefits of NASA-supported research can be applied to the business, economic, and social structure of the United States.

The medium of approach to NASA in all these undertakings is the unsolicited proposal. Although there is always room for improvement in the quality of such unsolicited proposals, we have experienced no lack of quantity. For example, during the 4 years which ended last December, NASA's Grants and Research Contracts Division received 7,820 unsolicited proposals. Not all were from universities, of course, but they included endeavors in almost every conceivable area of science and technology. Naturally, not all can be accepted. Of every five research proposals currently being received, NASA supports one. Of the other four, perhaps two are of sufficient interest to merit support if additional funds were available, one represents research which is interesting but so similar to work already in progress that we would have to regard it as unnecessary duplication in our program, and one is substandard.

New England universities have participated in every phase of these NASA programs. Nearly \$17 million of NASA funds have already been directed into 82 active grants and contracts in 22 colleges and universities in the 6 New England States. Of these schools, 15 have predoctoral training grants with a total value of nearly \$2.5 million, for the 3-year support of 130 graduate students in space-related science and technology. There are 75 research grants and contracts in effect at 19 of these institutions, at a total annual level of effort of about \$4.6 million.

The first of our facilities to be completed and occupied was the biomedical annex to the Harvard cyclotron building. Our largest facilities grant to

date was to Massachusetts Institute of Technology (MIT) for its new Center for Space Research. One-fourth the cost of this building is being borne by MIT—an example of the cost-sharing partnership which we encourage and strive for, even though matching funds are not mandatory. Incidentally, the Administrator of NASA has determined that the national interest will best be served if title to both these structures is vested in the universities, rather than being retained by NASA. This has been done.

We are proud, as you are, of the excellence and leadership demonstrated by the universities of New

England—the major contributions of the large ones and the determination of the smaller ones to grow and improve. In the pursuit of its own mission objectives—which must always be its primary motivation—NASA tries to deal with these institutions and others like them across the country, in ways which give us the benefit of their initiative and creativity while strengthening them and preserving their essential academic integrity. On such a basis, we believe a true partnership between Government and universities to be desirable, possible, mutually profitable, and contributory to the welfare of the entire United States.