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NEW ENGLAND: A RESEARCH-RELIANT REGION

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New England is developing into a research-oriented, research-dependent region. More and more its stock in trade is innovation, its life and work shaped by creative activities not only in fields such as science and technology but in many others. By taking the lead in innovation, in the arts, in the sciences and engineering, in craftsmanship, in the social sciences, in scholarship, and in other ways, New England has the chance steadily to renew its economy and to provide opportunities for its people to find fulfillment, each creative after his own fashion.

The great adventure of space provides our region a tailormade opportunity to exploit its specialized resources for innovation. By way of example, let us consider the interrelations of our national space program with education in New England and then discuss ways to insure that we do indeed take full advantage of our opportunity to become a research-reliant region.

Lest there be any misunderstanding, I would first make clear my views about the central role of educational institutions. Their primary responsibilities are teaching—the nurturing of new talent—together with the quest for new knowledge, and the perpetuation and dissemination of this knowledge. These responsibilities require an environment benign to scholarship, to contemplation and creativity, to disinterested curiosity exercised in freedom, and to ideal aims and long-term goals. The more successful our universities are in pursuing these goals and in maintaining these characteristics—in performing their special, time-honored function—the more successful they will be in serving needs of the economy and the Government. In discussing their relation, therefore, to the space program or any other program of national service, I emphasize that our educational institutions must first and foremost be places "of light, of liberty, and of learning," where there is a lively interaction of questing young minds, fresh and eager in outlook, with older minds full of wisdom and learning.

Since space exploration involves so many frontier problems and skills, it is not surprising it touches practically every discipline represented on the university campus—especially in science and engineering, but also in management, the social and behavioral sciences, and the humanities. We see this reflected in the kinds of space-related programs that are now to be found in our New England institutions. As Dr. Hugh Dryden has said, space is a social force which the university cannot ignore.

NASA's national program in colleges and universities sets the pattern for New England. In the short span of 6 years, NASA has grown to where it now accounts for about one-third of the Federal Government's total annual expenditures for research and development and almost half the Federal funds allotted for basic research. NASA expenditures at universities are now on the order of $90 million per year, with about half of this obligated under its sustaining university program and the other half in specific project grants for basic and applied research and development. University scientists and engineers have been involved in the space program since its inception, proposing and preparing equipment for most of the experiments carried in our scientific satellites and space probes or undertaking supporting research in the laboratory on such matters as energy conversion, heat-resistant and radiation-resistant materials, and inertial guidance systems. These experiments and research projects are carried out under specific project grants assigned to individual investigators, who usually in turn involve other professional colleagues and their students in the research. At the present time, it is estimated that over 4,000 experimenters located on some 130 university campuses are participating in NASA-sponsored research.

NASA's sustaining university program was begun in 1962, and essentially it is aimed at some rather important long-range goals. Foremost among these is recognition of the need to replenish and augment the nation's supply of highly trained scientific and technical manpower by encouraging able students to complete their work for the Ph. D. degree. Specifically, this training-grant program, as it is called, makes available to the individual graduate student an annual stipend of between $2,400 and $3,400 for a period of 3 years, in the hope that this will enable him to spend full time on his graduate study and complete his doctorate within a minimum time. The training grants are made by NASA to universities rather than to individual students and include an allowance with which the university can strengthen its graduate program in space-related sciences and engineering. The university also has full discretion in awarding individual predoctoral fellowships within its program, on the theory that the university itself is in the best position to evaluate a candidate's interests, qualifications, and need. At present there are 1,071 predoctoral candidates receiving support under this training-grant program at 131 universities, and eventually NASA hopes to add other universities having Ph. D. programs in the sciences and engineering and to have approximately 4,000 students in the "pipeline" to yield about 1,000 new Ph. D.'s each year in scientific and technical areas.

There are two other phases of NASA's sustaining university program. One is its grants-in-aid for construction of laboratory facilities at universities where needed for NASA-supported research. So far, there have been a total of 15 such facilities grants amounting to $17,642,000 to provide 504,000 square feet of new research laboratory space.

The other phase of NASA's sustaining university program is designed to stimulate wider university participation in long-range interdisciplinary research on the very forefront of all the sciences and engineering that may have a bearing on the future success of our space effort and space missions. This program is also designed to help build research strength in new fields in universities which have the latent capacity to grow into new centers of strength in research and graduate education. At present such special research grants have been made to 18 universities and involve a total of about $11 million.

Educational institutions in New England are well represented in both NASA's sustaining university program and its specific research project grants. At present 89 predoctoral candidates at 15 New England universities are receiving NASA training-grant support; this represents 8 percent of the total trainees and funds involved and 11 percent of the universities in the national training-grants program. Of the 18 universities that have received special interdisciplinary research grants, 2 are located in New England. These are MIT and the University of Maine.

Facilities grants-in-aid have been made to MIT for construction of its multidisciplinary Center for Space Research and to Harvard for a biomedical research annex to its cyclotron for studies of proton interactions with biological materials, from which we will be better able to predict the risks of solar flare radiation to our astronauts and establish shielding criteria for manned spacecraft. Harvard also has a privately funded space-related biomedical research laboratory. This is the Guggenheim Center for Aerospace Health and Safety, which has been functioning for 6 or 7 years as a part of Harvard's Graduate School of Public Health.

There have been over 75 specific research and development projects undertaken with NASA support at 17 New England educational institutions. Among these are development of equipment for an optical satellite-tracking network by the Smithsonian Astrophysical Observatory, which shares staff and quarters with Harvard's Observatory in Cambridge, and the development responsibility that MIT's Instrumentation Laboratory has for the Apollo guidance system. Members of the New England university community have also made the first observations of the solar wind and the first measures of the boundaries of the earth's magnetosphere. They are undertaking theoretical research in relativity, cosmology, cosmic rays, and the physics of stellar interiors and making magnetohydrodynamic studies to explain the structure of spiral galaxies. They are developing instruments suitable for measuring neutron intensity in space and studying the mechanisms of alloy strengthening. They are determining the effects of plant growth hormones on plant development in the absence of gravitation and devising methods for remote automatic detection of bacteria. They are helping to create a new branch of geology—planetary geology—and are contributing to a better understanding of the kind of electrified plasma through which our earth moves.

NASA is also sponsoring research into the organization and management of large-scale technology-based enterprises, this study being the responsibility of the Sloan School of Management at MIT. And a group of three teachers' colleges in Maine and the University of Bridgeport in Connecticut have NASA grants to develop teaching materials in astronomy and other space sciences appropriate for students in the elementary grades.

These activities in our universities reflect the interest on the part of faculties and students in space science and engineering, together with their recognition of the needs of our space programs and the ways in which colleges and universities can help meet these needs. Unquestionably the space program has captured the imagination of students, especially those in engineering.

The activity of MIT may be cited as an example. More than 100 members of our faculty are now engaged in space-related education and research. On last count we had more than 180 graduate students involved in space research, and in 1960–61, 15 percent of our candidates for advanced degrees presented theses in fields related to space.

It is clear that space technology, as viewed by scholars in our universities, affords new opportunities for scientific observation and experiment, and for great advances in technology, which will add to our understanding of our own earth, its solar system, and the universe. It is clear, too, that NASA is contributing greatly to the pursuit of this understanding in our New England colleges and universities, and that our educational institutions are important factors in giving New England a place in space.

We may note with satisfaction the scientists and engineers from New England educational institutions who are providing top-level advice and assistance to NASA. The Science and Technology Advisory Committee for Manned Space Flight, recently appointed by Mr. Webb, includes Dr. Leo Goldberg, Harvard College Observatory; Dr. William A. Sweet, Massachusetts General Hospital; and Dr. Charles Townes, Provost of MIT, the latter being Chairman. Professor R. L. Bisplinghoff, on leave from MIT, is NASA's Associate Administrator for Advanced Research.

But what of the future? What are some of the requirements for keeping pace with space and for further exploiting our skills in innovation and our research-related resources?

There is the need, for example, for more strong centers for graduate study and research in New England.

Every informed study of the Nation's educational requirements for the decade ahead indicates that we must substantially increase the graduate capacity of our university system. This is especially true in science and engineering. In a presidentially endorsed report, the President's Science Advisory Committee recommended in December 1962, that the Nation increase its doctorate output in science, engineering, and mathematics to a total of more than 7,500 per year by 1970, this representing more than a doubling of our present output.

In 1959–60, the output of New England institutions in these fields was just under 400, or 13.7 percent of the national total. If we accept the recommendations of the President's Science Advisory Committee and if New England is to maintain this percentage of the national total, it will have to increase its output of doctor's degrees in science, engineering, and mathematics by 165 percent between now and 1970, or from the present total of approximately 400 to over 1,000 per year. Even if we do not accept an increase of this magnitude, a substantial expansion is clearly essential.

NASA's national fellowship program is designed to increase the number of students pursuing doctoral studies. New England should have no lesser goal than to seek to maintain its present percentage of the total production of doctorate degrees, and in fact its interests would be well served if it could increase its proportion of the total national production.

Of the 40 institutions in the United States giving the most doctorates, there are presently only 4 located in New England. In the years ahead, it will be important to have additional great graduate centers in this region. It is especially important that the region's total output of doctorates in science, engineering, and mathematics be increased by expanded graduate study in institutions other than those which have already expanded their output. You will recall that it was President Kennedy who said, "We need many more graduate centers, and they should be better distributed geographically. New industries increasingly gravitate to, or are innovated by, strong centers of learning and research. The distressed area of the future may well be one which lacks centers of graduate education and research." The growing needs of our technological society as manifested in the space program clearly declare expanded graduate education to be an important educational goal for New England.

The growing requirement for graduate study is by no means all. Postdoctoral study is growing. Already the number of postdoctoral fellows in the United States exceeds 25,000, most of them in the sciences, medicine, and engineering. The explosion of knowledge makes career-long study a growing necessity for professional men.

By way of example, the rapid emergence of new technologies introduces a much higher rate of professional obsolescence, especially among engineers, applied scientists, and physicians. There are probably many thousands of engineers in the United States who find themselves out of date and who face a reduction in effectiveness unless they can master new fields and technologies not taught when they were in professional schools. This "prevalence of newness" which marks our time poses wholly new demands for education continuing through the practicing life of almost all kinds of professional men.

For example, the recently announced Center for Advanced Engineering Study at MIT is being specifically developed to afford engineers already at work in managerial or research capacities in industry an opportunity to return to college to increase their familiarity with the many areas of science and technology that have emerged since they graduated. It is also designed to equip engineering professors from other universities to expand their programs to the doctoral level.

New England will need more of this kind of "in-service" education.

In stressing these needs in higher education, I do not minimize the equally great needs to strengthen our precollege schools. New England is once again a center of innovation in the teaching process. It was in the Boston area that a national curriculum-reform movement originated. The New England region needs to avail itself of these new advances, especially in the teaching of the sciences, more extensively than it has. We have school systems unmatched in the Nation, but not enough of them if our young people are to be appropriately educated for a period where adaptability to change and higher skills will be increasingly important.

I stress these needs in education in relation to New England's space program because education is my field, but I hasten to emphasize that our success in this region in promoting and maintaining a science-based industry depends upon a coalition of skills and different kinds of institutions.

Drawing upon the jargon of their profession, economists have conceptualized our system of generating, teaching, and distributing knowledge as "the knowledge industry." We have another grouping of activities now under rapid development which might be described as "the innovation industry" and that innovation industry is especially adaptable to our New England environment. To be successful, however, it will require a concert of skills involving bankers, managers, lawyers, engineers, scientists, and entrepreneurs. Education and research cannot alone support the innovation industry.

By better relating industry and education, we can reduce the lag between discovery and application; by reducing tariff barriers among different fields of learning, among institutions, and among the professions, we can cultivate a free trade of brains and skills which can be one of New England's most exciting assets.

One word more. We in this region, both in industry and in education, can best serve the national space program and better strengthen our own economy if our participation comes about because we have something to bring to the national effort that is uniquely helpful, new, and unmatched elsewhere. This means we must be a seedbed of new ideas and a creative resource that the Nation cannot fail to utilize. It may well be that New England has a special and unique role in the use of space for the advancement of science. Our universities are steadily extending their activities, as already mentioned, in astronomy, planetary geology, physiological responses to space, cosmic-ray physics, meteorology, communications, and geophysics in the broadest sense. May there not be an essential industrial counterpart to these developing activities, and may not New England be in a strong position to become a major center for the technology of space science? We have major contributions to make all aspects of space science and technology, but it may well be that the kind of partnership represented in this field would be a natural one for us to exploit.