R & D: New Awareness in Congress of Stimulus of Federal Research Stirs Envy of Areas like Boston

Boston. Ever since the idea hit home with members of Congress and chambers of commerce that federal expenditures for research can mean a good deal to a local economy, the Boston region has been one of the areas singled out for envy and attempted emulation.

Boston's envied attribute is an electronics industry which was bred of the wartime wedding between physics and electrical engineering. The industry's prosperous evolution during the past two decades is generally ascribed there to the influence of the universities and technical schools which abound in and around Boston and to the talents of their scientific and engineering alumni, and the growth of the "industrial-university complex" in Boston has been accompanied by a feeling, novel in town-gown relations, that scientists and engineers are pillars of the economy.

The electronics industry is actually concentrated outside the city limits of Boston and Cambridge on a circumferential highway which curves through the suburbs. Route 128 has become a synonym for the industry, and while people who work there may call it by such offhand names as "electronics gulch," the newspapers are inclined to use more exalted sobriquets, such as "Golden Diadem of the Hub of the Universe."

Early this year the news broke that the diadem would get a crowning jewel with the decision of the National Aeronautics and Space Administration to locate a new electronics research center, which ultimately will employ 2000 people and cost $50 million, in the Greater Boston area. The gold in electronics research has been largely federal in origin, paid for work done to meet defense requirements, and the NASA announcement, which appeared to open the way for Boston to forge ahead in space business, drew cries of sorrow and anger from members of Congress representing constituencies that yearn to share in the rewards of electronics research. In complaining, the legislators took the line that concentration of defense and space spending in a relatively few states amounts to taxing the poor to benefit the increasingly rich.

A fair head of steam is building up behind these complaints, since there is ample evidence that Massachusetts is one of the states—California and the Rocky Mountain states are even clearer examples—which have been winning an increasing share of the defense and space contracts.

The argument over the effects of federal spending for procurement and research, which had been going on in a rather desultory way for several years, seemed to develop a new precision and sharpness last year when the Department of Defense published a study called *The Changing Patterns of Defense Procurement*, which provided an analysis of shifts in the geographic distribution of defense contracts in the period since World War II.

What is now more clearly understood in Congress and among industrial planners is the inexorable economic logic of the trend in military procurement. There has been a movement away from vast purchases of mass-produced items, such as tanks, trucks, and ammunition, and much greater emphasis on highly complex and very costly weapons systems suitable for intercontinental warfare. The new weaponry, typically, requires very heavy expenditures for research, development, and testing, and entails relatively small quantity production. The proportion of scientists, engineers, and technicians to production workers is much higher now than it was in weaponry's pre-electronics age.

Closed Circle

In research-oriented industries like electronics, an upward spiral seems to set in, with production contracts flowing to areas where R&D work is going on and with production, in turn, leading to greater research capability.

One factor in the regional competition for federal R&D contracts which is only now receiving wide recognition is the importance of basic research. Because Congress feels that basic research yields no concrete results, it deems it inappropriate to pay private, profit-making industry for such research. As a result, most federal basic research projects go to universities or other nonprofit institutions.

Research funds for universities, however, have proved a potent kind of seed money. High-level university research in fields relevant to, for example, electronics tends to attract both industrial research laboratories and subcontractors to the scene, or so the university-industrial complexes around Boston, Los Angeles, and San Francisco indicate.

The DOD analysis showed that in 1961 the Defense Department spent some $431 million for support of research in nonprofit institutions, and that by far the largest portion (about $120 million) was spent in Massachusetts, with $119 million going to universities. California was second, with a total of $87 million; of this, $38.5 million was earmarked for universities and the rest went to other nonprofit institutions.

When NASA chose Boston for its electronics research center early this year, a hue and cry was raised to the effect that freshman Senator Edward Kennedy was redeeming his "more for Massachusetts" campaign slogan, with the help of NASA and the administration.

In Boston, however, credit for landing the electronics center seems to be allotted to (i) Boston's natural superiority in almost all things, and (ii) a concerted effort by regional leaders to make Greater Boston's case.

Boston pride had been offended by the earlier decision to locate NASA's Manned Spacecraft Center at Houston. Because the new center is in the home state of Vice President Lyndon Johnson and in the home district of Representative Albert Thomas, chairman of the Appropriations Subcommittee which oversees NASA's budget, Bostonians assumed that politics played a prominent part in the choice of the site. At the same time, it appears that Boston had not campaigned very hard for consideration. The Massachusetts firms were largely occupied with military projects, and there seems to have been a feeling until recently that space business primarily meant boosters, and that electronics research for space was being done out in Southern California, where missiles and rockets are built.

This feeling has been changing rapidly. M.I.T.'s Instrumentation Laboratory has been given the task of developing the inertial guidance system for the Apollo moon-landing project, and M.I.T. has plans for a space center costing approximately $4 million, with NASA footing some $3 million of the bill. Industry in the Boston area has been looking with awakened interest at NASA's growing budget and last year united behind the Greater Boston Chamber of Commerce in a hard-sell effort to land the NASA electronics research center.

As for NASA, it appears that the decision to create a center for electronics research grew out of a feeling that the agency has an underdeveloped competence in electronics development. Since about 60 percent of the space-project

dollar goes into electronics and because many mission failures have been chalked up to failures of electronic components, something had to be done to correct the weakness.

In considering what to do, the NASA planners were faced with a choice of depending on industry and the universities to take over a greater share of research or of expanding "in-house research," perhaps by expanding some existing NASA center.

NASA was not seeking a solution to the electronics problems of the Apollo project alone, but was also looking for means to carry on high-quality electronics research for space into the indefinite future. Agency planners settled on the creation of a NASA-operated center which in 6 or 7 years would have a complement of 2000 people, 600 or 700 of them scientists and engineers.

In choosing the Boston area, NASA followed in the footsteps of the Air Force, which has picked the purlieus of Route 128 as the site of its Electronic Systems Division, which has responsibility for development of all major Air Force electronics systems.

The so-called Hanscom complex now employs more than 10,000 people, two-thirds of them civilians. In the Hanscom cluster are the big Air Force Cambridge Research Laboratories, divided into directorates for electronics and geophysics; the MITRE Corporation, which acts as the advisory staff to the Electronics Systems Division, and Lincoln Laboratories, which is concerned with research and hardware development in the field of air defense. MITRE was formed by M.I.T. and later cut loose from the parent institution, and the Lincoln Lab was formed largely with M.I.T. faculty and staff and remains under M.I.T. management, though it has completely separate status.

The considerations that prompted NASA and the Air Force to settle in the Greater Boston area seem to have been much the same as those which caused more than 400 companies connected with electronics to locate there.

First, it seems that the gap between university research and industrial research is much narrower in electronics than it is in many other fields, where the research scientist and the engineer have relatively little to say to each other.

Access to the university, then, is important not only because there are consultants close at hand but also because of the possibility of a two-way traffic in ideas and people, which NASA planners argue is necessary if research is to be of the highest quality. The presence of M.I.T., Harvard, and the other educational institutions of Greater Boston counted heavily, since government scientists would have opportunities to "upgrade" themselves by pursuing advanced study, attending lectures, and even by teaching.

More basically, the space agency wanted to locate where it could find and keep highly competent scientists, engineers, and technicians. Though such manpower statistics are slippery, Boston partisans in the competition for the NASA electronics center made the flat statement that New England contains a higher proportion of highly trained scientific and engineering personnel than any other section of the country. They stressed, also, the number of scientific and engineering graduates of the schools that are concentrated in the Boston area and the estimate that about 50 percent of both scientific and engineering graduates remain in the immediate area.

Boston's boosters argue, in addition, that not only is it possible to find scientists and engineers in the area or to attract them there but that Boston has what it takes to keep them and their wives and children happy. Educational opportunities, a changeable but stimulating northern seaboard climate, easy access to ski slopes in the winter and salt water in the summer, and the civilized pleasures of music, theater, lectures, galleries, and libraries are cited as complementing the appeal of professional opportunities in the region.

However, NASA's major reason for picking Boston seems to have been that in eastern Massachusetts the electronics industry is a "generation" or so more advanced than it is in most other parts of the United States. Emphasis has long since shifted from the manufacture of components, now done more cheaply abroad in countries such as Japan, to research and development on the most advanced systems. As one executive of the Raytheon Company puts it (Raytheon is New England's biggest employer, with 33,000 persons working in the Greater Boston area), "Boston has a unique knowledge of communications theory and an understanding of complex systems. We're in the custom made business."

Boston's lead in electronics certainly has not solved all of the area's economic problems. At most, the industry represents about 20 percent of the region's economy, which still rests on such traditional bases as insurance and finance, printing and publishing, and conventional manufacturing. The electronics industry, furthermore, is essentially a defense industry and therefore subject to the ups and downs caused by the ebb and flow of contracts. Layoffs affecting high-level engineering and management people as well as production workers are not unusual, and the industry currently seems to be going through one of its "soft" periods, when some scientists and engineers with premium qualifications and experience reportedly are available.

But seen from outside, Boston appears to many members of Congress to be high on the list of areas which have prospered conspicuously through doing the government's work. Representative Henry S. Reuss (Democrat of Wisconsin) stated the view very clearly in a speech on the floor last fall when he said that when "federal funds for research are funneled into a few areas to the virtual exclusion of others, we are creating fundamental distortions. Not only are the immediate prospects of states like Wisconsin and others of the east north-central area unduly depressed. Their ability to contribute to the nation's future research needs is undermined. Indeed, by drawing talented personnel and industry away from our area toward California and the narrow coastal strip from Boston to Washington, D.C., we are drastically reducing the future economic growth prospects of our industrial heartland."

A lot of the bitterness inflaming the current controversy in Congress over the award of the contract on the TFX aircraft stems from frustration and discontent among members of Congress over the effects of federal policies on defense and space procurement and research.

In discussing the TFX dispute last week at his press conference, President Kennedy put the problem very succinctly when he said, "The fact of the matter is defense contracts have been concentrated in two or three states . . . because these states have had the historical experience and also because they have the engineering and educational infrastructure which puts them in a successful position."

The flow of federal funds to areas such as California, the Middle Atlantic States, and eastern Massachusetts has obviously reinforced the "engineering and educational infrastructure" of which the President spoke and has further improved their competitive position over other areas.

The administration's new civilian technology program is designed to stimulate research in areas where it is underdeveloped NASA seems to be making an effort to share the research wealth by providing grants to build new "centers of excellence" for space research at a number of universities and by supporting such projects as the new center at Indiana University, which will be devoted to finding industrial applications for developments in space technology.

But it is difficult to see how such programs will enable other areas seeking to excel in, for example, electronics research to overcome the combination of natural and federally bestowed advantages which Boston and one or two other areas enjoy.

Now, nevertheless, since the economic significance of federally sponsored research, including basic research, is better understood in Congress, federal research grants to the universities are likely to get more attention from the have-nots.—JOHN WALSH

Experimental Animals: Proposals to Regulate Use Bring Clash of Scientists and Humane Societies

A variety of legislation to promote the human use of animals in research laboratories has again been introduced into both houses of Congress, amidst indications that the legislators are showing more interest in the subject this year. Congressional sentiment is far from crystallized, but a well-publicized revelation of mistreatment of research animals at a Washington-area supply farm has shocked some congressmen into greater concern about humane-treatment legislation.

(The case, still under investigation, involves several hundred dogs and cats found dead at a now defunct farm in nearby Virginia which supplied animals to private and governmental research laboratories.)

The impetus for regulatory legislation does not come from the scientific community, which has been intensely and nearly unanimously opposed to it, but from a group of lay humane organizations. The most formidable of these is the Animal Welfare Institute, whose president, Christine Stevens (the wife of Roger Stevens, a former finance director of the Democratic Party) is credited with achieving, almost single-handedly, the passage of the humane slaughter act of 1960, over the opposition of the meat-packing industry. The Animal Welfare Institute strongly supports a bill by Senators Joseph Clark (D.-Pa.) and Maurine Neuberger (D.-Ore.) which provides for close regulation of recipients of federal grants by the Secretary of Health, Education, and Welfare. Other humane societies are in the act, too, but they are divided on legislative remedies. The Humane Society of the United States, for example, calls the Clark-Neuberger bill "so weak as to be actually objectionable" and supports another offering, H.R. 4856, a rewrite of a similar proposal last year, which actually defines "pain" and "stress" and would place enforcement in the hands of the Justice Department. The American Anti-Vivisection Society takes an even more uncompromising position, opposing all legislation on the grounds that it implicitly sanctions inhumane treatment of animals, and joining forces with the scientific opponents of the proposals to forestall passage.

Organizations aligned in opposition to regulartory legislation include the National Society for Medical Research, the American Medical Association, the American Psychological Association, and several other private and governmental agencies.

The Clark-Neuberger bill—which at this stage seems to be attracting most interest—is based on the central principle that "living vertebrate animals used for scientific experiments shall be spared unnecessary pain and fear; . . . they shall be used only when no other feasible and satisfactory methods can be used to ascertain biological and scientific information." In support of this, the bill's formal provisions require, (i) that all users of experimental animals be licensed by the Secretary of Health, Education, and Welfare; (ii) that the Secretary receive an annual report from the researcher, specifying the number of animals used and the procedures followed; (iii) that brief additional statements be filed with the Secretary for all experiments involving pain to the animal (the Secretary may limit the number of animals used in painful experiments); and (iv) that inspectors be given access to animal laboratories and their records, and the authority to destroy animals under certain conditions.

The more substantive provisions set standards to be met as a condition of licensing and continued operation. These require, (i) that experimental animals be anesthetized, and that animals suffering from severe or prolonged pain be killed, except when this would interfere with the purpose of the experiment; (ii) that all animals used in practice surgery be anesthetized, and killed before recovering consciousness; and (iii) that certain standards of care and housing be maintained. Finally, a special unit would be created in the Secretary's office to administer the regulations.

A by-product of the lengthy controversy over animal welfare legislation is the appearance, for the first time, of moderate, compromise legislation that emphasizes *care* of laboratory animals. The National Society for Medical Research, the Veterinarians Association, and some other groups have indicated that they will not oppose constructive legislation providing federal assistance in animal care and housing, although most would still prefer voluntary activities in this field.

Compromise, in any event, will be difficult. A bill introduced by Congressman John Fogarty (D.–R. I.) to have the Secretary of Health, Education, and Welfare publish standards for animal care is approached tentatively and with misgivings by both sides. The Animal Welfare Institute regards it as a sign of progress but still a diversionary tactic; the NSMR views as one foot in the door of the regulation is still hopes to avoid.

All the bills are now in committee—Labor and Public Welfare in the Senate, Interstate and Foreign Commerce in the House—where they probably will remain throughout this session of Congress. Neither committee has yet scheduled hearings, though there is some prospect that the House may do so. With or without hearings, the issue will be around for a long while.—ELINOR LANGER

Erratum: In the article "Evolutionary mechanisms in pollination biology" by H. G. Baker [*Science* **139**, 877 (8 March 1963)] the fifth line up in the next-to-last paragraph (column 3, page 880) should have read: (. . . visited by large carpenter bees of the *Xylocopidae*). In the published version *Xylocopidae* read *Megachilidae*.

Erratum: In the report by E. A. Sueltenfuss and Morris Pollard, "Cytochemical assay of interferon produced by duck hepatitis virus" [*Science* **139**, 595 (15 Feb. 1963)] the first sentence of the last paragraph (column 2, page 596) contains a misplaced line. It should have read: "DHV-interferon interrupted psittacosis virus at the "red ball," noninfectious stage of replication."

Erratum: In the report by C. A. Chidsey, G. A. Kaiser, and E. Braunwald, "Biosynthesis of norepinephrine in isolated canine heart" [*Science* **139**, 828 (1 March 1963)], line 16 in the next-to-last paragraph (column 2, page 829) should have read: "It therefore appears likely that the whole rat has biosynthetic pathways for the formation of norepinephrine which are not present in the canine heart." In the published version the word *likely* read *unlikely*.