ENHANCED TECHNOLOGY TRANSFER

Many factors, including improving education, encouraging capital formation, developing new markets, and encouraging technological innovation will improve the U.S. competitive edge. One element stands out as the most cost-effective action we can take: improving the transfer of commercially useful technology that the government is already supporting. Historically, U.S. laws and agency policies have not offered efficient methods or incentives to promote commercial use of government-developed technologies. In recent years, however, several laws have enhanced technology transfer, but the provisions of those laws do not fully apply to some of our major labs, and changes would be useful.

In the free enterprise system, protection of intellectual property by granting exclusive patent rights offers important incentives to justify investment. Frequently, the research investment that results in intellectual property falls far short of the total investment needed to convert an idea into a commercial reality. Although not all government-supported technology needs to be protected by exclusive patent rights, granting exclusive rights to risk takers is important when commercialization requires extensive additional development. Granting non-exclusive rights to many often results in insufficient incentives to pursue new inventions. This is a case where "giving to everybody often means giving to nobody." And a worthwhile invention would remain uncommercialized or--worse yet--would be picked up by foreign entities to the detriment of U.S. domestic economy.

Incentives to promote technology transfer by granting exclusive patent rights also can improve our control of economically useful information to benefit domestic industry. The present lack of incentives in technology transfer actually encourages technical people to release unclassified information to the world through traditional channels in technical journals and professional conferences rather than through patents. With incentives in place, it would be productive for the laboratories to focus more of this technical data into protectable innovation that is more directly useful in the U.S. commercial world. And, the use of patents as a publication channel would increase, without slowing the more traditional forms of technical communication.

Patents are one important form of intellectual property protection. Copyrights, most notably for software protection and the protection of "mask works" for integrated circuits, are also increasingly important. These items are increasingly valuable products from many of the laboratories. Occasionally, the laboratories develop information that industry would label "proprietary"; examples are new processes or data that may be useful to industry. Frequently, proprietary information cannot

be adequately protected by patents because such publication would teach anybody how to use such data in a way that would not be evident in a final product. There are presently either no provisions or limited provisions that allow government-funded laboratories to control all types of intellectual property for U.S. benefit. Of course, the government should retain rights to use the results of government-funded research for its own use.

Congress recognized these facts when it enacted legislation giving patent rights to universities and small businesses working under government contract. In particular, the Bayh-Dole Act and its amendments permit universities and small businesses that operate government laboratories to elect title to inventions made at those laboratories. For example, the University of California can take patent rights to inventions made at the Lawrence Berkeley Laboratory, which the university operates under contract to the Department of Energy (DOE). This encourages the university and the Lawrence Berkeley Laboratory to assist in the commercialization of inventions. Extending such policies to all government-funded laboratories is the cornerstone of an enhanced technology transfer program, and including patents copyrights, mask works, and proprietary and process data would further enhance the commercial value of laboratory technology.

Several exceptions built into existing legislation make technology transfer from DOE Laboratories difficult. These exclusions refer to weapons laboratories of the DOE and laboratories managed by large for-profit contractors, whether or not the contractor works without profit or fee. Some of our country's largest laboratories are excluded from Bayh-Dole.

On April 10, 1987, however, the President issued an Executive Order pursuant to the Bayh-Dole Act and the Technology Transfer Act of 1986. The President directed DOE and other executive departments and agencies to encourage and facilitate technology transfer among Federal laboratories, universities, and the private sector. The Executive Order directs that patentable results of federal research be granted to all contractors who perform the research, regardless of size.

If the nation intends to fully utilize the potential of intellectual property to spur technology transfer from all of the national laboratories, the law needs to be changed or interpreted to allow more efficient management of all types of intellectual property. The exclusions that preclude application of Bayh-Dole and the Technology Transfer Act to nuclear weapons-related laboratories should be eliminated. The President's directive should be wholeheartedly adopted.

Under DOE program oversight, royalties generated by licensing technologies from large commercial contractors operating

government-owned laboratories could be returned to the laboratories for further research and additional technology transfer efforts. Royalties also could be used for incentives to encourage staff to make more intellectual property disclosures. Presently,it is difficult for laboratories to accept royalties, even if all such royalties are used for additional research or technology transfer. This should be changed. Contractors that operate Federal laboratories should be able to enter into fair and reasonable arrangements with industry or third parties, such as universities or inventors, to encourage commercial development of laboratory-generated technology. Contracts would include plans for commercialization and, if expectations fail, there would be provisions to give another organization the chance to take over the invention.

Under certain circumstances, when the laboratories have unique capabilities, industry may wish to contribute funds for laboratory research programs. Current procedures for sponsoring programs at national laboratories require a lengthy negotiation. Such delays run counter to the spirit of maintaining competitiveness and waste valuable management resources. When there is no interference with laboratory programs, the laboratories should enjoy greater freedom in negotiating for such work.

In summary:

If the nation required a more uniform and progressive technology transfer policy for all government-owned laboratories, the result would include more inventions, more patent disclosures, more domestic commercial benefit, and more jobs for Americans. It would substantially enhance the technology transfer efforts of several major laboratories that undertake a significant share of our country's research.

Provisions that include the ability for all government-funded laboratories to directly and promptly negotiate agreements with risk-takers involving know-how and copyrights, in addition to patents, would be particularly useful. Business decisions involving new technology are inherently risky and uncertain, and delays, prohibitions, and uncertainties inherent in the present cumbersome processes inhibit commercial potential. The President's Executive Order of April 10, 1987, should be wholeheartedly adopted.

U.S. PATENT PRODUCTIVITY

Analysis shows a decline in inventive output for the U.S. chemical industry between 1965 and 1980 that may well be representative of industry as a whole.

Stephen F. Adler and Herbert H. P. Fang

On the basis of trends in patenting activity, one of us reported in an earlier study that there was compelling evidence of a decline in innovative activity in the U.S. for the period 1965–1975 (*1*). During the past decade or more, other observers have reached the same conclusion by other methods of measurement or reasoning (*2,3*). Since no one has yet proclaimed a renaissance of innovative activity, we may assume that things are still as they were or that they may have gotten worse.

The study reported in this article includes data from the mid-1960s through 1982–83 to get a longer view of this phenomenon. We have also examined several variables not studied in the first paper to see if we can better understand what accounts for the patterns of patenting activity both by U.S. industry and within various segments of the industry.

Recognizing that there are year-to-year variations in the patents issued by the U.S. Patent Office, most of the data used in this paper are running three-year averages reported for the second year of the period. The smoothed data for 1966–1982 (Figure 1) show that the total number of patents per year rose from ca. 60,000 in 1966 to ca. 75,000 in the early 1970s (*4,5*). Since about 1977, the level of activity has again declined to ca. 60,000. The data contain an important underlying message about the nationality of the inventors. Non-U.S. inventors have increased their absolute rate of generation from ca. 10,000 to ca. 25,000 patents per year. During the same period, U.S. inventors' production declined from ca. 50,000 to ca. 35,000 patents per year. In 1965, about 20 percent of U.S. patents were issued to non-U.S. inventors (Figure 2); by 1983, that figure had risen about 41 percent, and the Patent Office reports that for 1985 it was 43.9 percent.

The decline in U.S. inventive output is the most fundamental observation we have made. All of the other facts and observations that follow are merely elaborations of this.

In the earlier study we analyzed patent generation and R&D expenses over a decade for the 12 largest chemical companies. The R&D expenses were published figures corrected for inflation. The patent data were obtained from Information For Industry. A minor concern in the first study was that not all of the patents issued to any one company might have been counted because of assignments to subsidiaries with names that might not have been included. In the present paper, the patent data are those that were graciously supplied by each of the chemical companies (*6*).

The so-called "Big 12" companies can be used to monitor the activity of the chemical industry because they account for a large fraction of research expenditures and patent activity for that industry. For example, the "Big 12" spent ca. 40 percent of the industry's research dollars and got ca. 30 percent of the patents. Figure 3 shows how the "Big 12" share of the U.S. patents granted to U.S. inventors has changed between 1967 and 1980. Since 1974, that share has been down to a nearly constant 5.1 percent starting from ca. 6.5 percent at the beginning of the period. There is, thus, a double decline to be noted—(a) U.S.-invented patents have declined both in absolute terms and as a percent of the total patents, and (b) the chemical industry is getting a reduced share of that smaller pool.

Patent Productivity

"Patent productivity" is the ratio of patents issued in any year to the money expended on R&D in the same year. It has units of number of patents/$MM of R&D. Admittedly, this productivity quotient is simplistic because it ignores expenditures that do not have patents as an expected outcome. It also sidesteps the question of the time lag between the doing of the research and the issuance of the patent. Nevertheless, patent productivity is a concept that is useful for tracking an industry or a company to spot trends over a period of time. In this paper, the number of patents will always be the smoothed average and expenditures will always be reported as constant 1967 dollars by correcting actual figures with GNP price deflators (*7*).

Figures 4, 5 and 6 show the patent productivity for the "Big 12" as a function of time in groups of four companies arranged according to sales volume. The four largest companies (Du Pont, Union Carbide, D

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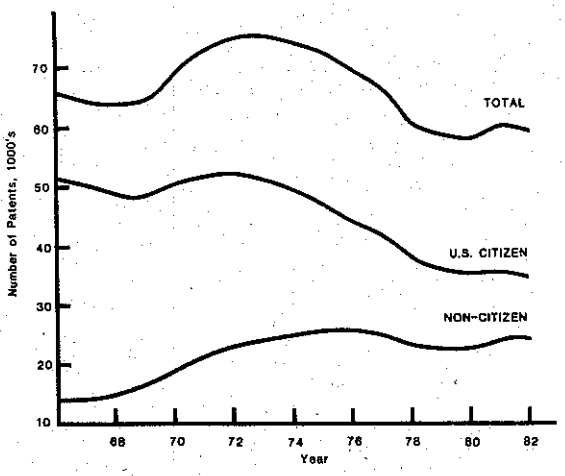

Figure 1.—U.S. Patents Issued.

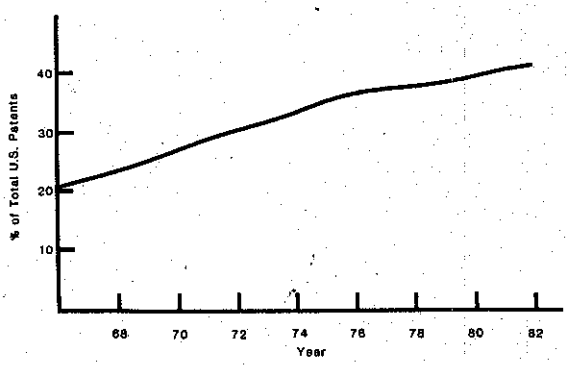

Figure 2.—Percent of U.S. Patents By Non-Citizens.

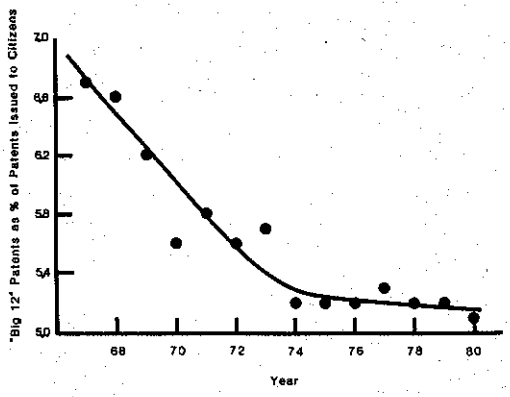

Figure 3.—Percent of U.S. Patents Issued To "Big 12" Chemical Companies.

and Monsanto) show a similar pattern. The data show an inverse relationship between patent productivity and company sales. This fact is examined in more detail in a following section. The middle group (Allied, Celanese, American Cyanamid and Hercules) follows a somewhat different pattern with time, with a more distinct maximum for each curve in the mid-1970s followed by a steep decline. There is once again the observation that patent productivity is apparently larger when sales volume is lower. In the third group, the curves for Ethyl and Stauffer have the maximum in the mid-1970s as noted in Figure 6, but Olin and Rohm and Haas have very different shapes. Also, one cannot say for Figure 6 that there is an obvious correlation between productivity and company size.

In the view of people who see research as a vital function of a corporation, sales might be expected to increase with more research (of the right kind). The same might be said of patents. That is, more research should lead to more patents. Figures 7 and 8 show how patents vary with R&D expenses for the "Big 12" (in constant 1967 dollars). The expected relationship of more patents with greater research expenditures is readily seen.

When the same analysis is made once more for patent productivity (number of patents/$mm of R&D), the picture is entirely different. We plot patent productivity against sales for two periods, 1971–75 and 1976–80 (*8*). Figures 9 and 10 show that productivity varies inversely with sales volume. What this says is that the efficiency of the R&D organization in producing patents goes down as the size of the parent corporation in constant 1967 dollars gets bigger. Is there no efficiency of scale in this process? We will return to this question again.

Figures 11 and 12 show the relationship of patent productivity to the percent of sales allocated to R&D. The two periods are once again 1971–75 and 1976–80, respectively. Although some scatter is seen in both plots, the predominant feature is an inverse relationship of patent productivity to R&D as a percent of sales. Both the abscissa and the ordinate refer to quantities that are the ratio of an output to an input:

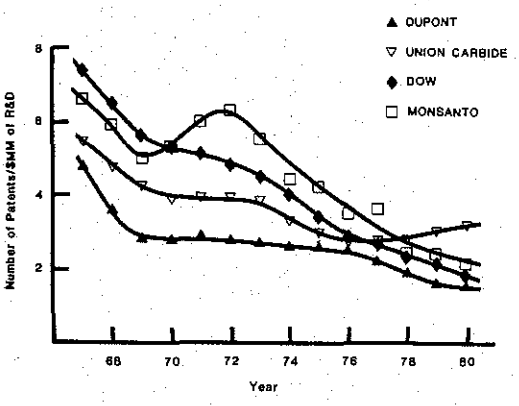

Figure 4.—Patent Productivity Vs. Time.

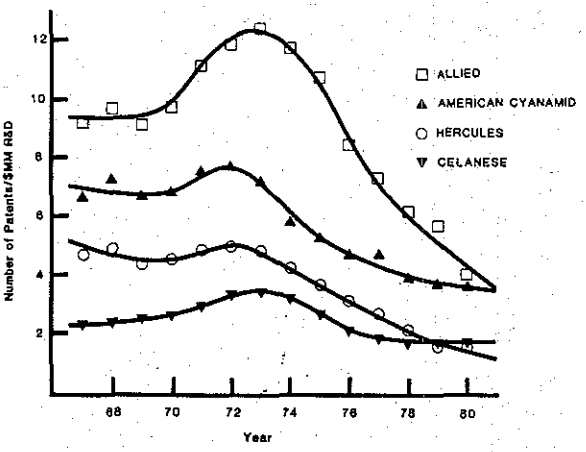

Figure 5.—Patent Productivity Vs. Time.

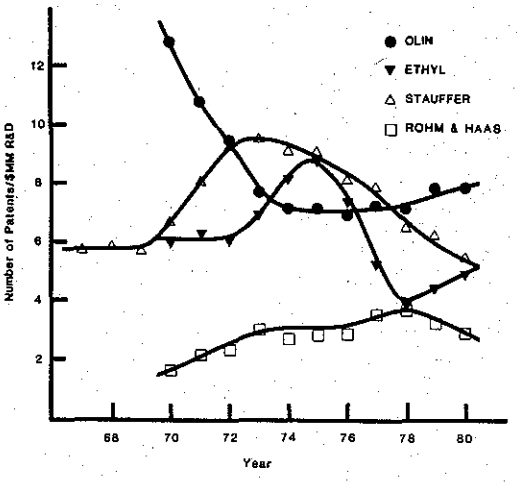

Figure 6.—Patent Productivity Vs. Time.

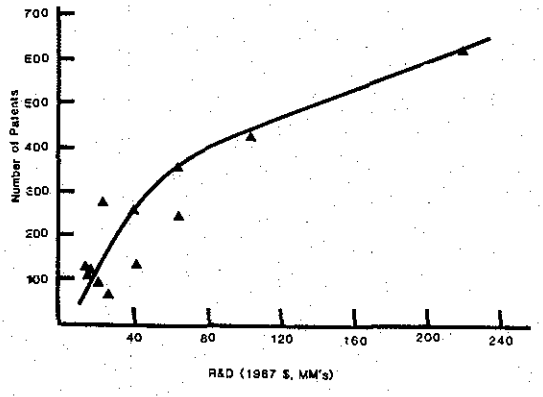

Figure 7.—Patents Vs. R&D (1971–75 Average).

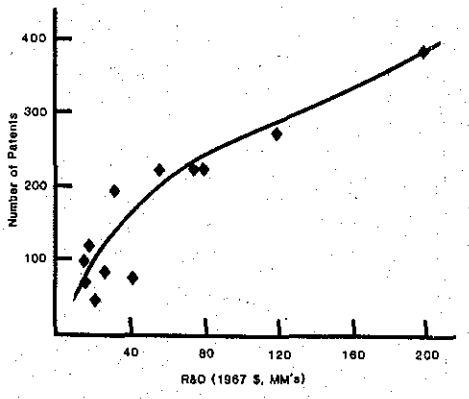

Figure 8.—Patents Vs. R&D (1976–80 Average).

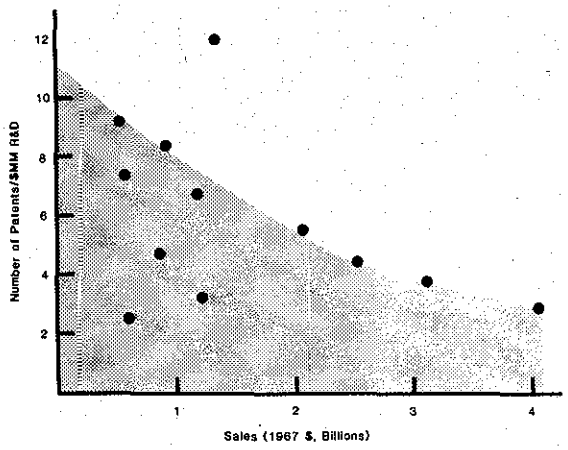

Figure 9.—Patent Productivity Vs. Sales (1971–75 Average).

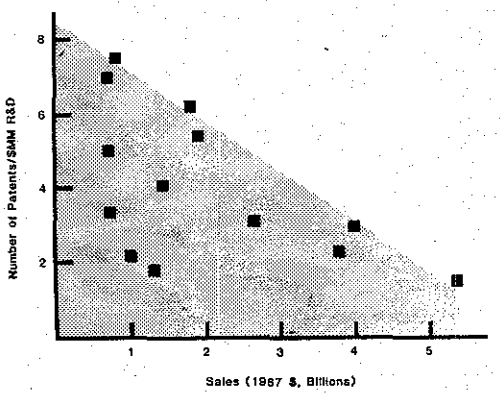

Figure 10.—Patent Productivity Vs. Sales (1976–80 Average).

$$\frac{\text{R\&D expenditure}}{\text{Sales volume}} \quad \text{and} \quad \frac{\text{Number of patents}}{\text{R\&D expenditure}}$$

It is also possible to see whether patent productivity increases with the absolute level of R&D expenditure. This is the most direct way to test the efficiency of the "process" of producing patents. In other words, if there is efficiency of patent productivity, we should see it reflected in the absolute size of the R&D organization and, therefore, in its annual expenditures. Figures 13 and 14 present these data. There is no doubt that, for both time periods, patent productivity decreases as the absolute level of R&D expenditure increases. It is not at all clear why patent productivity does not increase instead. The expected increase in efficiency is simply not there. In fact, larger R&D units become less efficient in the context of this paper.

One might wonder whether the findings about patent productivity for the chemical inudstry can be explained by the position of the "Big 12" relative to the U.S. as a whole. Table 1 shows the sales, R&D expenditures, sales volume, patents and patent productivity of the "Big 12" compared to total U.S. figures.

The table shows that sales, as a fraction of GNP, increased 17 percent but that R&D expenditures rose only about one-sixth as much from the early 1970s to the late 1970s. During that period the fraction of U.S. patents assigned to the "Big 12" declined 5 percent. (The patent statistics of the years 1982–84 show a modest upturn in the number of patents for the companies in the "Big 12." However, the ratio of patents to constant dollar R&D has continued to decline to ca. 1.2 for the group.) The large chemical companies invested more in research and got fewer patents out of the process. The data, when stated in terms of patent productivity, show that the "Big 12" had a decrease in the period studied that was half again as big as the 27 percent reduction experienced by the entire U.S. That is to say, the "Big 12" (and the chemical industry by extension) behaved like the whole country, just more so.

A comparison of the patent activity of the chemical industry with other industries is beyond the scope of this paper although it might lead to some important conclusions. However, one can choose representative companies from other business sectors and look for similarities in patent productivity. Table 2 presents such information for a group of companies compared to the "Big 12" and to Du Pont as a representative of the chemical group, and for the U.S. on average.

The data in Table 2 show that most of the companies have had reduced patent productivity and in three cases a larger reduction than is true for the "Big 12." Only one company in this group, General Electric, shows an increase of 14 percent. Further, the absolute level of productivity for the "Big 12" is higher in both periods than for any of the other companies reported. The picture that emerges is that most sectors of U.S. industry were declining in patent productivity over the decade of the 1970s and that the chemical industry is not atypical. Thus, if there is an innovation malaise, it is very widespread, and all sectors of U.S. industry need to be concerned.

Interpreting the Data

Before proceeding to a detailed examination of U.S. patent productivity, we should note that Gilman described another concept in 1981 which he called "patent inventivity" (*9*). This quantity is the ratio of patents issued to sales volume. He concluded from an analysis of patent inventivity that the largest companies were less inventive than smaller ones. This result was disputed by Jackson et al. who felt that Gilman had used a sample that led to an incorrect conclusion (*10*). Gilman and Siczek subsequently reported on a function that is the same as the one that we had

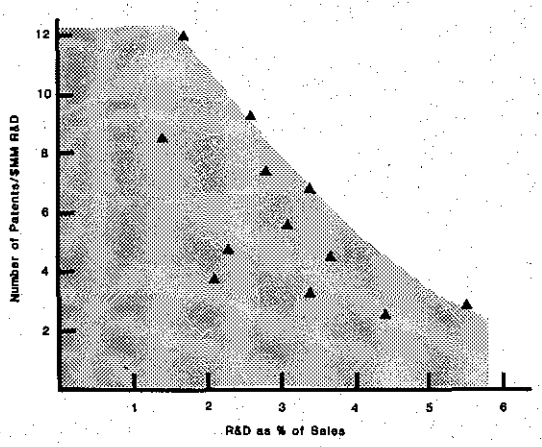

Figure 11.—Patent Productivity Vs. R&D As % of Sales (1971–75 Average).

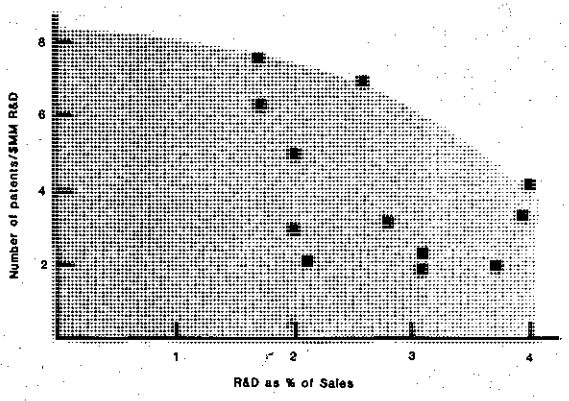

Figure 12.—Patent Productivity Vs. R&D As % of Sales (1976–80 Average).

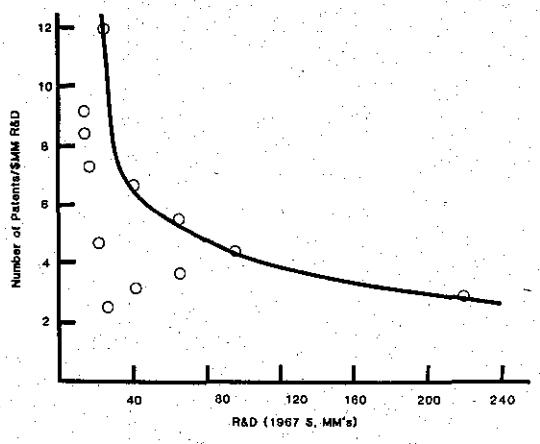

Figure 13.—Patent Productivity Vs. R&D (1971–75 Average).

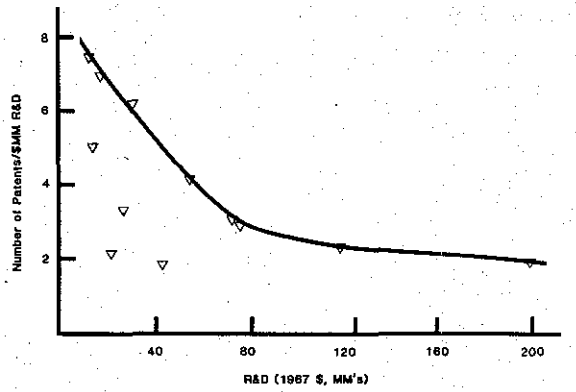

Figure 14.—Patent Productivity Vs. R&D (1976–80 Average).

previously called "patent productivity" (*11*). They looked at a broad range of companies whereas we looked in detail at the chemical industry. In this paper, we have examined only a handful of companies in other industries (Table 2).

In the earlier study, we speculated about the most likely cause or causes of the slowing in U.S. patent activity. Among the causes proposed and rejected in that study were the following:

- Companies are more careful or selective in choosing patents to file.
- Less R&D money is available because of funds diverted to meet regulatory requirements.
- There is more reliance on "trade secrets" vs. patents.
- The U.S. market is viewed as not worth the cost of getting patent protection.
- More stringent criteria are being applied by the U.S. Patent Office for allowing patents.

None of the above explanations makes any more sense today than it did in 1980. The one explanation that was thought to be most plausible then was that a shift in R&D orientation had taken place toward low-risk research such as product and process development. These activities are less likely to lead to large numbers of patents because they are designed to fine-tune formulations, discover new uses of a chemical or improve the process by which the chemical is made. We can test this hypothesis by looking at the record of three chemical companies with very different patent productivities. For each of three companies, Allied, Du Pont and Stauffer, the patents in each of three years were examined to find out what fraction were "composition of matter" as opposed to those with use or process claims only. It was assumed that larger numbers of composition of matter patents would correlate with higher patent productivity. Table 3 shows the results of this analysis. There is no obvious correlation between the type of claims and the number of patents per $MM of R&D for all three companies taken together. There is, however, an apparent

*Table 1—Sales, R&D Expenses and Patent Productivity**

	1971–75 avg.	1976–80 avg.	% Change
$(Sales)_{12}/(GNP)_{12}$	1.94%	2.27%	17
$(R\&D)_{12}/(R\&D)_{US}$	2.76%	2.84%	3
$(Patents)_{12}/(Patents)_{US}$	5.5%	5.2%	−5
$(Patent\ Productivity)_{US}$	2.2	1.6	−27
$(Patent\ Productivity)_{12}$	4.4	2.9	−33

*Number of patents per million of 1967 dollars spent on R&D.

Table 2—Patent Productivity in Various Industries

	Patent Productivity (# Pat/$MM R&D)		
	71–75 avg.	76–80 avg.	% Change
"Big 12" (Chemical companies)	4.4	2.9	−33
Du Pont (Chemical)	2.8	1.9	−30
AT&T (Communications)	3.0	1.0	−67
Hewlett-Packard (Electronics)	1.2	0.6	−49
General Electric (Electrical)	2.4	2.8	+14
Eastman Kodak (Photography)	2.7	1.2	−57
Merck (Pharmaceuticals)	1.9	1.8	−8
Motorola (Semiconductors)	3.0	2.6	−13
U.S. Average	2.22	1.61	−27

Table 3—Relationship of Patent Productivity To Type of Patent Claims

Company	No. of Patents Studied*	% of Patents with Comp. of Matter Claims	Patent Productivity No. of Patents/$MM R&D
Stauffer—1970	71	51	6.6
1975	127	60	9.0
1980	99	50	5.4
Allied —1970	39	26	9.7
1975	43	19	10.7
1980	38	11	4.0
Du Pont—1970	162	31	2.8
1975	112	39	2.6
1980	63	46	1.5

*All of Stauffer's patents were examined in the three years; one-third of Du Pont's and Allied's patents were examined.

correlation for each company by itself (Figure 15). Because of the few data plotted, it would be desirable to extend this analysis to other companies over more years to see if our observation is more than a coincidence.

It is undeniable that chemical and other companies have experienced a steady decline in both the number of patents granted and in patent productivity. The latter is a crude measure of the return on research investment. One can find a variety of explanations. Abernathy pointed the finger at management (*2*), whereas Kline indicated that we are about to enter a new age in chemistry (*3*). However, it is also possible that we are experiencing an effect in research that is analogous to the finding that "new oil is harder to find than old oil." Any resource that must be mined out becomes progressively more expensive because the most easily reached deposits are taken first. Is there such a phenomenon in industrial research? If there is, we should find that the money will increase that must be spent on R&D to achieve a fixed amount of progress. This should lead to the observations reported here.

Among the factors making research progressively more expensive is that the infrastructure required to do research in the 1970s and 1980s is increasingly sophisticated and expensive. For example, most research laboratories of any significance have analytical facilities that include NMR spectrometers, HPLCs, ESCA-Auger spectrometers, SEMs and the like. This equipment is typically run by highly skilled specialists. In an earlier time, analyses were thought to be adequate or acceptable with much simpler, less elegant and far less costly techniques. Also, the laboratory of

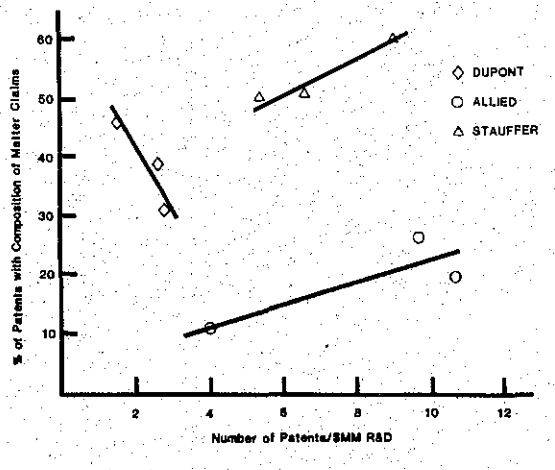

Figure 15.—Patent Productivity Vs. Type of Patent.

today is equipped with a full range of sophisticated computers and database searching facilities. These are only two examples that can be cited. No wonder R&D costs are escalating. Furthermore, this is a factor that affects the larger companies more than the smaller ones. The large companies are the ones most likely to feel the need for highly sophisticated facilities to match the technological demands of their research areas.

If one now adds the economic criteria attendant to new research, the picture of high costs becomes even more pronounced. The chemical industry has seen a steady decline in profitability in the last two decades, and new research must face far more hard-nosed criteria of profitability and return on investment than ever before. New chemicals that might have been considered acceptable in an earlier time may now be thought to be too unprofitable to develop. This leads to R&D that has fewer commercial successes as a fraction of the numbers of areas explored.

Finally, we should address the question of the adequacy of R&D funding in the U.S. Between 1964 and 1978 the level of R&D funding as a fraction of GNP dropped 25 percent, from 2.96 percent of GNP to 2.22 percent. By 1985, however, it had moved back up to an estimated 2.7 percent. Increased spending on R&D cannot of itself guarantee greater innovation, and there is probably no "right" level to ensure a revitalized atmosphere of innovation. Nevertheless we are encouraged by this dramatic turnaround. Now it remains to be seen whether the U.S. patent output as a measure of innovation also turns around and heads back up. ◎

It is possible that we are experiencing an effect in research that is analogous to the finding that "new oil is harder to find than old oil."

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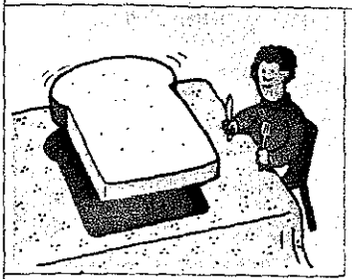
EDITED BY OTIS PORT

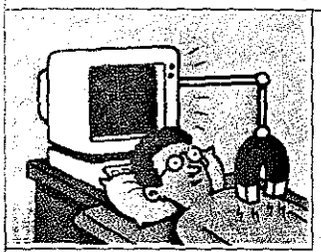
A NEW STAFF OF LIFE FOR DIETERS: FLUFFY CELLULOSE



Dedicated dieters know that the primary source of calories in such baked goods as bread and doughnuts is the flour, not added sugar or frostings. So the best way to cut the calories is to replace some of the flour with inert fillers. But current fillers are so unpalatable that if you substitute them for more than 15% of the flour, the result is too dense and gritty for even the most resolute dieter. That's because the fillers are cellulose derived from wood.

Now researchers at the U.S. Agriculture Dept. laboratory in Peoria, Ill., believe they have found just the filler for tasty diet goodies: a fluffy, fibrous cellulose made from non-woody plants. The new filler can be prepared from the husks or stems of bran, wheat, oats, and corn—and can replace up to 50% of the flour in baked goods. The result is so pleasing that "a taste panel couldn't tell the difference," says J. Michael Gould, a USDA chemist. The USDA estimates the product will quickly command a $500 million market. A half-dozen food-processing companies are lined up to license it.

PAINLESS ANGIOGRAPHY? GE IS WORKING ON IT



Virtually everyone who has undergone angiography wishes there were some other way to examine the body's blood vessels. To search for blockages that can cause strokes or arteriosclerosis, doctors inject dyes that show up in X-rays. The process is notoriously painful and lasts for hours. But it may soon be a thing of the past. Scientists at General Electric Co.'s R&D center in Schenectady, N. Y., have modified magnetic resonance imaging systems so they "paint" images of flowing blood on a computer screen.

MRI, which creates computerized images from the weak radio signals emitted by atoms in the body when they are exposed to a powerful magnetic field, is well known for its clear—but still—images of organs. To produce pictures of blood coursing through veins and arteries, GE developed a computer program that suppresses the signals from stationary tissues while highlighting the images of moving cells: the faster the flow, the brighter the image. The software will soon be available on GE's MRI scanners. Next, the researchers hope to adapt the technique to see the flow of blood inside the heart by canceling out the action of a beating heart.

CERAMICS COULD LEAVE COMBUSTION ENGINES IN THE DUST

Many automotive engineers are betting that ceramics will be the material of choice for tomorrow's super-efficient car engines. But ceramics may also be the key to a power source that could make some engines obsolete. Researchers at the Energy Dept.'s Argonne National Laboratory have built a prototype fuel cell that delivers twice the power and fuel economy of internal combustion engines—and double the output of other fuel cells. Fuel cells are essentially batteries with fuel tanks. They generate electricity directly from a chemical reaction between the fuel and a catalyst.

The secret of Argonne's fuel cell, says researcher Darrell C. Fee, is a new construction technique. The interior is made of thin ceramic sheets bent and bonded together like corrugated paperboard. The low-cost ceramic sheets function as the electrolyte part of the "battery," eliminating the need for the liquid electrolyte that weighs down most fuel cells. The Argonne unit can burn both liquid and gaseous fuels. Pound for pound, the ceramic design is so efficient that Fee says it might even be used in airplanes. And an electrical power plant using the new fuel cells could be 55%-to-60% efficient at converting fuel into electricity—vs. 30%-to-35% for coal-fired plants.

SUPERFAST CHIPS: A FRENCH STARTUP IS OFF AND RUNNING

Because they work at blinding speeds, so-called HEMT integrated circuits promise to form the basis for the next generation of computer chips. But the materials needed for high-electron-mobility transistors are so complicated that the technology is barely creeping out of the laboratory. To get HEMT speeds, the ICs must be "printed" on wafers that consist of a stack of exotic semiconductor materials—with each layer no more than a handful of atoms thick.

A European startup, however, believes it can give HEMT a push into the market by supplying such complex wafers. Nuyen T. Linh, former head of HEMT research at France's Thomson, last year left the electronics giant along with several members of his staff. They raised $4 million in venture capital and formed Picogiga, a startup in Les Ulis, near Paris. The company recently shipped its first wafers, which are produced by an esoteric technique known as molecular-beam epitaxy. ICs made with these wafers have switching times measured in picoseconds, or roughly 1,000 times faster than standard silicon-based circuits.

ONE SMALL STEP FOR GROWING FOOD ON THE MOON



Will men on the moon be able to grow food in the lunar soil? The answer is important to the dedicated band of scientists who believe that mankind will establish a permanent base on the moon. So in January they will launch experiments to find out whether wheat and perhaps soybeans will grow in lunar greenhouses. They won't fly there to plant the seeds, though—just to Florida's Epcot Center. The seeds will be planted in powdered rock quarried near Duluth, Minn., that closely matches the stuff on the moon.

Scientists at the University of Minnesota have already crushed and ground the first 200 lb. of ersatz lunar soil. Now they are working on imitating the glassy content of the real thing. Just mixing in regular glass won't do because the moon's glass—produced by the heat of meteor impacts—is light and porous. Kenneth J. Reid, director of the university's Mineral Resources Research Center, hopes that a plasma-arc furnace will do the job—and also drive off the moisture bound into the rock's minerals, making it even more like lunar soil.

MANSFIELD AMENDMENT

[COMMITTEE PRINT]

DOMESTIC TECHNOLOGY TRANSFER: ISSUES AND OPTIONS

PREPARED BY THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON
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represent these officials. Concurrently, Federal department and agency liaison is being fostered. In this manner ISETAP is attempting to bring together the diverse components of the intergovernmental scienee and technology endeavor. However, questions have arisen as to the effectiveness of the Panel and as to whether its operation is meeting the policy objectives of the legislation which created it.

Lack of visibility and recognition have been complicating factors in the establishment of a base support for ISETAP's activities in the intergovernmental arena. The absence of a means to enforce participation in the Panel's programs and a lack of authority to implement recommendations directly have been obstacles to the development of an effective program in the Executive Office of the President. The uncertainties surrounding ISETAP's activities, Presidential support, and the reorganization have not helped in this respect. The situation is such that the Panel can be expected to work best when and if it is perceived as being an influential element of the decision-making process at the Presidential level. The reorganization and the subsequent relationship with the Office of Management and Budget are anticipated to increase the effectiveness of ISETAP. An assurance of support for the functions and operation of the Panel from OMB and the President's Science Advisor, coupled with increased interaction with Federal, State, local, and regional representatives, are understood to be essential to the recognition of ISETAP's function and further cooperation with the Panel's programs and objectives.

POLICY STATEMENT AND REPORTS

The previous section has reviewed the establishment and operation of intergovernmental science and technology activities at the Presidential level through the Intergovernmental Science, Engineering, and Technology Advisory Panel. ISETAP is only the most recent organizational response to a series of activities which extends back over more than the past decade. This section documents past attempts to develop a domestic technology transfer policy beginning with the New Technological Opportunities Program instituted in 1971 by the White House Domestic Council and including various other executive, congressional, State, and local endeavors. These activities resulted in numerous studies, statements, and recommendations concerning the issue of the intergovernmental utilization of Federal research and development results. Many of the recommendations are identical; all are related. They are discussed here to present a total picture of how our present activities are responsive to the needs and priorities indentified in the initial studies of the concept. Current technology transfer activities are discussed in subsequent sections and analyzed in terms of the policy issues and suggestions delineated here.

ACTIVITIES FOR INTERGOVERNMENTAL SCIENCE AND TECHNOLOGY DURING THE NIXON ADMINISTRATION

New Technological Opportunities Program (NTOP)

In July of 1971, the White House Domestic Council, at the direction of former President Nixon, initiated the New Technological Opportunities Program to examine Federal involvement in support of non-

defense research and development. Under the leadership of William M. Magruder, the endeavor was to study ways to apply high technology to the solution of social and economic problems. This effort was the first such undertaking which recognized that the R&D capabilities of the Federal departments and agencies provided opportunities in the domestic and foreign technology transfer arenas.

Organized into three interagency task forces—problem identification, economic incentives, and international technology transfer—the NTOP study team requested agencies to identify technological activities related to potential domestic or foreign endeavors. Given a free hand, a list was drawn up which represented an enormous commitment of funds if it were to be implemented. Complicating the situation was the absence of accompanying analyses of economic, political, social, or environmental impacts. The Executive Office of the President subsequently decided that the time was not right for such a massive undertaking. Instead, an incremental approach was adopted. This attitude was reflected in the President's address to Congress in March 1972.

Intergovernmental Technology in President Nixon's Science and Technology Message

Former President Nixon's address to Congress on Science and Technology, delivered on March 20, 1972, was a major acknowledgment of the benefits to be derived from the Federal research and development endeavor. The statement was an announcement of a new effort to support and utilize science and technology for the improvement of the Nation's economy and its quality of life. The President called for new "partnerships" between Federal institutions, private industry, State and local government, universities, and research organizations to apply R&D results to civilian needs. Observing that "Federal research and development activities generate a great deal of new technology which could be applied in ways which go well beyond the immediate mission of the supporting agency," the President said States and localities need to play a central role in the decision-making process surrounding the application of these technologies.

In order to develop these Federal/State/local relationships, the Science Advisor, in cooperation with the Office of Intergovernmental Relations, was directed to serve as the focus for a discussion of the issues by the relevant Federal agencies and State and local representatives. Further, the needs of State and local jurisdictions were to be prioritized in a systematic way and the resultant data incorporated into the decision-making process at the Federal level. Alternative methods for improving access to Federal technical resources were to be discussed as well as mechanisms for the aggregation of State and local markets in such a way as to produce economies of scale.

FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY (FCST)

The address to Congress by President Nixon paralleled work under way within the Federal Council for Science and Technology concerning State and local issues. The Federal Council had been created by Executive Order 10807 issued by President Eisenhower on March 13, 1959, and was designed to assist the various Federal departments and agencies in the coordination and management of problem-solving in science and technology. Located in the Executive Office of the Presi-

dent until 1973, the Council's membership was composed of Federal policy officials from thirteen departments and agencies and observers from other Federal units with the President's Science Advisor as Council Chairman.

In mid-1973, the Federal Council for Science and Technology (FCST) was transferred from the Executive Office of the President to the National Science Foundation whose director served as Science Advisor to the President. FCST was abolished when the National Science and Technology Policy, Organization, and Priorities Act (Public Law 94–282) was signed into law on May 11, 1976, and in its place a Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) was established. Many FCST functions were absorbed by the newly created FCCSET. The intergovernmental responsibilities of the unit were taken over by the Intergovernmental Science, Engineering, and Technology Advisory Panel also created by the legislation.

The major portion of the work of the Federal Council for Science and Technology was conducted through interdepartmental committees which addressed specific issues. During the period of its operation, the Council established several units which dealt with State and local utilization of Federal research and development. A discussion of these committees and their work follows.

FCST Committee on Intergovernmental Science Relations

The Federal Council established the Committee on Intergovernmental Science Relations in 1969 to study and suggest methods to improve the interaction of Federal, State, and local research and development programs and policics. Composed of twenty representatives from Federal agencies, the Committee was directed to:

- Inventory and evaluate the impact of Federal policies and programs on the scientific and technological activities of State and local governments.
- Inventory State and local science and technology activity and appraise its relation to Federal programs.
- Formulate, in consultation with representatives of State and local governments, recommendations for Federal initiatives to strengthen this activity and Federal cooperation with it.
- Identify the need for scientific resources, including manpower and institutional requirements, of State and local governments, and assess the adequacy and impact of Federal programs bearing on these needs.
- Recommend policies, procedures and programs to improve management, information exchange, planning, and coordination of Federal science and technology activities with related activities of State and local governments.[1]

A report, "Public Technology, a Tool for Solving National Problems," was issued by the Committee on Intergovernmental Science Relations in May of 1972. The document was the result of numerous meetings with State and local officials supplemented by a series of formal presentations to the group by representatives of State and local governments, congressional experts, and manpower specialists. A draft of the report was reviewed by a representative from each State, by local officials, by the twenty participating Federal agencies, and by independent experts in the field. Three days of hearings on

[1] Committee on Intergovernmental Science Relations. Federal Council for Science and Technology. Public Technology, a Tool for Solving National Problems [1972]. p. vii.

the study were held by the Science and Technology Committee of the National Legislative Conference.

The issues addressed by the Committee included cooperative programs between States and the Federal Government; State, local and regional science and technology organizations; manpower utilization by State and local jurisdictions; and Federal legislative initiatives to foster non-national S & T capabilities. The resultant report stressed the importance of improving State and local science and technology capabilities so as to meet the increasing demands of these jurisdictions in terms of the provision of goods and services. The committee addressed the issue on two levels—increasing the role of science and technology in the State and local decision-making process, and expanding the impact of State and local needs in decision-making within the Federal departments and agencies conducting research and development. The report discussed the interrelationships between the Federal government and State and local utilization of science and technology. It delineated several observations among which were the negative and unintended impacts of certain Federal policies and practices on State and local decisions and the lack of a sense of diversity between States or localities in terms of problems and possible solutions. What the committee suggested were new, more flexible arrangements which would improve the transfer of technology between jurisdictions and facilitate the flow of information between governmental units.

The recommendations which the committee made were designed to serve as guidelines for addressing the issues. Among the proposals delineated in the written report were: (1) development of mechanisms to strengthen the input of State and local needs and priorities in the Federal science and technology decision-making process; (2) identification of Federal programs and activities relevant to State and local decision-making; (3) improvement of the scientific and technological capabilities of States and localities; and (4) development and support of science and technology dissemination mechanisms.

FCST Committee on Domestic Technology Transfer

To facilitate the coordination of the technology and information transfer process in the relevant Federal departments and agencies, the Federal Council for Science and Technology created the Committee on Domestic Technology Transfer in April 1974. The Committee's expressed purpose was to

- Exchange information and experience on Federal agency efforts to disseminate technology
- Collect, compile, disseminate Federal agency data on technology transfer programs, contact points, support resources for use by State and local governments and private industry
- Exchange information on agency organization and experience for receiving user information of technology transfer needs and priorities.[2]

In pursuit of these objectives, the Committee published the "Directory of Federal Technology Transfer" in June of 1975. This book detailed Federal department and agency activities involving the domestic transfer of technology so as to publicize the resources available to State and local governments. Research capabilities, transfer policies and practices, contact persons, and user groups of over forty programs

[2] Linhares, Alfonso. An Overview of Federal Technology Transfer [1976]. p. 17.

were described. It was designed to serve as a guide for State, local, and industrial users in interacting with the Federal system.

An updated and expanded version of the Directory was published in June 1977 by the Federal Coordinating Council for Science, Engineering and Technology. In August 1978, it was decided that the Office of Science and Technology Policy and the National Science Foundation would jointly publish the Directory in the future and the Committee on Domestic Technology Transfer was abolished.

At the request of the Committee on Domestic Technology Transfer, the Office of National R&D Assessment of the National Science Foundation conducted a study on Federal technology transfer activities in twenty-five departments and agencies. The report, "Federal Technology Transfer, An Analysis of Current Program Characteristics and Practices" (published December 1975), addressed methods for assessing and improving technology transfer and utilization programs and practices. The analysis was directed towards Federal, policy level officials who input into the decision-making process. It outlined those factors influencing the transfer of technology which are amenable to policy decisions. Among the findings with legislative relevance are:

(1) The expression of support for technology transfer from top agency officials is an important influence in the extent of transfer activities.

(2) Agencies which have effective technology transfer programs tend to: (*a*) have specific allocations for tchnology utilization programs; (*b*) designate technology transfer responsibility to one unit with that mandate alone; and (*c*) use locally-based field offices staffed by Federal employees.

(3) Face-to-face transfer of information, expertise and technologies is most effective.

(4) The formalization of technology transfer programs with locally based staff and delineated budgets increase the success of the transfer and utilization activities.

FCST Committee on Federal Laboratories/Task Force on Intergovernmental Use of Federal R&D Laboratories

In 1967, the Committee on Federal Laboratories was established to inquire into the effective utilization of the Federal research and development system. In response to an increasing interest in expanding the use of Federal laboratories beyond their parent department or agency, a Task Force on Intergovernmental Use of Federal R&D laboratories was created by the committee on August 1973. Building on work published by the Council of State Governments, the General Accounting Office, and the National Action Conference on Intergovernmental Science and Technology Policy, the Task Force issued a report entitled, "Intergovernmental Use of Federal R&D Laboratories." [3] This study underscored the importance of tapping the technical resources of the Federal laboratory system to identify and meet the needs of State and local jurisdictions in the provision of goods and services. Given the increasing demands on these non-national units and the President's stated intention to institute a new policy of intergovernmental cooperation, a more flexible approach to the utilization of

[3] Federal Council for Science and Technology. Committee on Federal Laboratories. Intergovernmental Use of Federal R. & D. Laboratories. Washington, U.S. Government printing Office, 1974. 30 p.

the laboratories was acknowledged to be a significant component of the effective resolution of many State and local problems.

In its study of the issue, the Task Force determined that there were various institutional barriers to the effective utilization of the Federal laboratory system including budget and manpower limitations; lack of, or ambiguous, policy directives; and conflicting priorities. There appeared to be no legal obstacles to the use of these laboratories with the possible exception of the uncertainties surrounding the interpretation of the so-called Mansfield Amendment in the Military Procurement Act of 1970 (to be discussed in detail at a later point in this chapter). However, there was no clearly defined statement on behalf of the executive branch which would delineate the need for interagency coordination and thus provide the support for agency activities to this end. Because of the lack of integration between the participants in the intergovernmental transfer process and the stated benefits to be accrued by a coordinated effort, the Task Force report recommended that a systematic approach for technology transfer activities be institutionalized in, and between, agencies. The report also advocated greater use of the provisions of the Intergovernmental Personnel Act of 1970 and the Intergovernmental Cooperation Act of 1968, as well as a clarification of the Mansfield Amendment to promote the utilization of Federal research and development results from Department of Defense laboratories.

The published report suggested several guidelines for intergovernmental activities and the promulgation of a draft policy statement for expanded interagency cooperation in the utilization of Federal laboratories, but made it clear that each agency would have to develop its own specific procedures dependent on its mission and operation. Despite the support by the Federal Council which voted its approval of the report in plenary session on April 11, 1974, the President never accepted the recommendations contained within the document. It is believed that this was a result of a negative reaction by the Office of Management and Budget to the proposals contained in the report.[4]

GENERAL ACCOUNTING OFFICE STUDIES RELATING TO INTERGOVERNMENTAL TECHNOLOGY TRANSFER

The General Accounting Office (GAO) provides Congress with oversight on the operation of the executive departments and agencies. In conjunction with this mandate, GAO has produced several reports dealing with Federal activities in the intergovernmental transfer of technology.

"Means for Increasing the Use of Defense Technology for Urgent Public Problems" [5]

The study undertaken by the General Accounting Office addressed the relative roles and responsibilities of the Department of Defense and other Federal agencies in the technology transfer process; the legislative and organizational factors which influence the activity;

[4] U.S. Congress. House. Committee on Science and Technology. Subcommittee on Domestic and International Scientific Planning and Analysis. Interagency Coordination of Federal Scientific Research and Development: The Federal Council for Science and Technology. (Committee Print) Washington, U.S. Government Printing Office, 1976. p. 180.

[5] General Accounting Office. Means for Increasing the Use of Defense Technology for Urgent Public Problems. Washington, U.S. Government Printing Office, December 29, 1972. 58 p.

and the need for improved policies and procedures to promote the transfer endeavor. The resultant report, dated December 29, 1972, discusses the issues associated with utilization of defense-related technologies and technical expertise to meet and solve problems in the civilian sector.

The authors were concerned with increasing the returns from investments in research and development in the Department of Defense by applying the results of the science and technology efforts to delineated needs in both the civilian-oriented agencies and State and local jurisdictions. In analyzing the practices and prospects of using DOD as a technical resource, GAO raised various issues that it felt deserved further consideration. Among these was the absence of clear policy guidelines for the transfer of technology between governmental units. Compounding this was the uncertainty surrounding the legislation pertaining to DOD nondefense activities in the Defense Procurement Authorization Act (Public Law 91–121) and the 1971 Department of Defense Procurement and Research Authorization Act (Public Law 91–441). This legislation, discussed in detail in a subsequent section of this chapter, has served to induce hesitation on behalf of DOD officials to issue policies and develop programs to promote technology transfer, although it is believed that the legislation does not prohibit these activities as such.

The GAO study details the barriers to the intergovernmental utilization and transfer of technology created by personnel limits and accounting practices within the Department of Defense. In terms of DOD relationships with other Federal departments and agencies, the study indicated that each civilian agency differs in the methods by which, and the extent to which, it uses defense-related technology. Again, the absence of clear policy guidelines and a legislative mandate for such activities is noted. The findings underscored the increased benefits to be derived from the "active" transfer of technology by which face-to-face contact is achieved as opposed to the "passive" form of transfer which entails the passage of information through reports and documents. The authors stressed the importance of personal interaction in problem-solving and expressed doubt that technical documents transferred to another unit could match the problems encountered.

Following this review, the General Accounting Office made several recommendations designed to address the inadequacies of present transfer endeavors. Among the recommendations made, the report expressed the need for a clearly defined and stated governmental technology transfer policy emanating from the Office of Management and Budget or the Office of Science and Technology. It also called for the issuance of guidelines for formal transfer activities within, and between, governmental units and for the establishment of a technology transfer consulting team whose purpose would be to assist in the matching of Federal technical resources with national needs. In making these recommendations, GAO designed suggested guidelines for an OMB policy directive on interagency sharing of technology and for Department of Defense technology transfer with other Federal civil agencies and departments but stressed the importance of each agency developing its own program to meet its operational style. In response to these recommendations, OMB stated that it is the policy of the Federal Government to promote technology transfer but that

written guidelines for Federal agency transfer endeavors would not be forthcoming. Commenting on this response, the GAO report reiterates:

> We recognize that there is and has been a general, although informal, policy encouraging the sharing of technical resources within the Government. However, civil agencies differ widely in their approaches to seeking and using these resources. We believe, therefore, that active and effective sharing requires a specific reiteration by OMB to elaborate on the policy, to provide guidelines for reasonably uniform and consistent implementation, and to establish a basis for monitoring compliance. In our opinion, civil agencies need the stimulus that could be provided by an OMB directive encouraging active interagency transfer methods. A statement such as we recommend should provide a framework against which each civil agency could promptly begin to establish its own policies, procedures, and transfer methods in consonance with the President's policy.
>
> The civil agencies whose activities are discussed in this chapter generally agreed to the need for policy guidance from OMB. Some of these agencies specifically supported an OMB policy that would require each agency to establish its own specific guidelines and implementing mechanisms for technology transfer.[6]

"Technology Transfer and Innovation Can Help Cities Identify Problems and Solutions" [7]

This General Accounting Office report is a study of the California Four Cities Program. The program, cosponsored by the National Science Foundation and the National Aeronautics and Space Administration, was designed to determine whether or not technology could be applied to State and local problems. The report concluded that, on the basis of its analysis of the operation and results of the endeavor, Federal technical assistance can provide solutions on the State and local level. It stated, however, that an understanding of the innovation processes as well as an understanding of the approaches toward acceptance of new technologies on behalf of non-national governments are necessary to the success of the transfer endeavor.

In the course of its study of the technology transfer activities of the Four Cities Program, GAO observed several barriers to the transfer process. Among these obstacles are: social, political, and economic constraints beyond technology; a lack of market aggregation mechanisms and practices to foster private sector involvement in public technology; and a tendency to avoid risks in government activities. In conjunction with these identified barriers, the report also delineated several conditions which influence the utilization process. The need for effective communications between city and Federal personnel, as well as between the Federal agency representatives themselves, and the importance of the strong support from local government officials are delineated as conditions necessary for successful intergovernmental technology transfer.

"Inventory of Current Federal Laboratory Studies" [8]

Brief mention is made here of an unpublished study conducted by the General Accounting Office which identified existing studies of R&D activities and utilization in the Federal laboratories. It was performed at the request of the Chairman of the House Committee on Science and Technology. The report identified 34 studies by Federal departments and agencies. Of these only approximately eight address cross sector utility of labs and technology transfer issues.

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[6] GAO, op. cit., p. 37.
[7] General Accounting Office. Technology Transfer and Innovation Can Help Cities Identify Problems and Solutions. Washington, U.S. Government Printing Office, August 6, 1975. 55 p.
[8] U.S. General Accounting Office. Inventory of Current Federal Laboratory Studies. Unpublished report. May 1978. 65 p.

unnecessary duplication of special service functions; and to authorize all departments and agencies of the executive branch of the Federal Government which do not have such authority to provide reimbursable specialized or technical services to State and local governments.

The provision of technical expertise to State and local governments under this act rests on the assumption that these goods and services cannot be furnished through ordinary business channels. As stated in Title III, Sec. 302:

. . . such services shall include only those which the Director of the Bureau of the Budget [now the Office of Management and Budget] through rules and regulations determines Federal departments and agencies have special competence to provide. Such rules and regulations shall be consistent with and in furtherance of the Government's policy of relying on the private enterprise system to provide those services which are reasonably and expeditiously available through ordinary business channels.

Legislative History

January 26, 1967—S. 698 introduced (Government Operations).
July 2, 1968—Senate report: 1456 to accompany S. 698.
July 23, 1968—Companion bill: H.R. 18826, introduced (Government Operations).
July 29, 1968—S. 698 passed Senate after adoption of committee amendments.
August 2, 1968—House report: 1845 to accompany H.R. 18826.
September 15, 1968—S. 698 passed House amended in lieu of H.R. 18826.
October 1, 1968—House agreed to conference report.
October 4, 1968—Senate agreed to conference report.
October 16, 1968—Measure signed into law by the President.

Military Procurement Authorization Act of 1969/Public Law 91–121 (S. 2546) November 19, 1969

Military Procurement Authorization Act of 1970/Public Law 91–441 (H.R. 17123) October 7, 1970

Description.—Title II, Section 203 of the Military Procurement Act of 1969 authorizing funding for the Department of Defense, provides:

None of the funds authorized to be appropriated by the act may be used to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function or operation.

Title II, Section 204 of the Military Procurement Authorization Act of 1970 contained similar but not identical language:

None of the funds authorized to be appropriated to the Department of Defense by this or any other act may be used to finance any research project or study unless such project has, in the opinion of the Secretary of Defense, a potential relationship to a military function or operation.

Implications.—The Department of Defense, which is responsible for approximately half the Federal R&D budget, asserts that it is constrained in the application of DOD technology to meet State and local needs by the provisions of Public Law 91–121, later modified by Public Law 91–441. However, the history of the two bills indicates that the intention of Congress was not to entirely restrict non-defense oriented research and development activities in military laboratories.[12] After Public Law 91–121 was enacted, the Department of Defense

[12] GAO Report. Means for Increasing the Use of Defense Technology for Urgent Public Problems. p. 23–24.

terminated various projects which did not appear to have "a direct and apparent relationship" to a military operation. The latter bill modified the restriction, limiting the funding of projects to those determined by the Secretary of Defense to have a "potential relationship" to the defense endeavor.

The general interpretation of the legislation and the discussion concerning the modification of the original language of the restriction is that technology transfer efforts are valid provided they do not interfere with the primary mission activities of the Department of Defense and provided they are furnished on a cost-reimbursable basis. These endeavors are viewed as salient to the support of Government and thus strengthen our national defense. The practical guideline which has been followed in the past few years is that spending for nondefense-specific research and development by DOD be limited to 3 percent of the total funds.

Uncertainty has surrounded the issue of whether the so-called Mansfield Amendment to the Military Procurement Authorization Act continues to be valid. This question was addressed in a report written by David R. Siddall, Legislative Attorney, American Law Division, of the Congressional Research Service, dated March 16, 1978, which is included verbatim:

VALIDITY OF PUBLIC LAW 91–441 SECTION 204, THE MODIFIED "MANSFIELD AMENDMENT"

In 1969 Senator Mansfield proposed and the Congress passed an amendment to the military procurement authorization law for fiscal year 1970 which prohibited funds authorized *by that act* from being used to carry out research projects or studies not having "a direct and apparent relationship to a specific military function or operation." Public Law 91–121, § 204, 83 Stat. 206.

In 1970 the authorization bill for 1971 (H.R. 17123) was passed by the House without any similar amendment being included. The Senate Armed Services Committee recommended that the provision be included in the bill without change "in order to provide the same restrictions on research and development funds for fiscal year 1971." Senate Report 91–1016 at pp. 99–100. On the Senate floor, this Committee amendment to H.R. 17123 was considered as part of an amendment proposed by Senator McIntyre to add a section expressing the sense of Congress that funds for the National Science Foundation should be increased. 116 Congressional Record 30367. The Amendment unanimously passed the Senate. H.R. 17123 therefore went to conference containing a Senate-passed section 204 with language identical to the Mansfield Amendment, which was section 203 of the immediately preceding military procurement authorization act (Public Law 91–121).

In Conference the language of the Senate-passed section 204 was modified from the original provision requiring "a direct and apparent relationship to a specific military function or operation" to a requirement that the Secretary of Defense determine the existence of "a potential relationship to a military function or operation." A second change to the section altered the language so that instead of the provision applying "to funds authorized to be appropriated by this Act," the provision was made applicable to "funds authorized to be appropriated to the Department of Defense by this *or any other Act*" (emphasis added). The question presented is whether this second change, providing for the section to be applicable to "any other" act, is permanent law applicable to all subsequent Defense Department funds for research projects and studies.

The original version which the Senate placed in H.R. 17123 specifically applied only to funds authorized by the Act. The language was specifically changed in conference to include "any other act." There was no comment concerning this change in the Conference Report on the bill (House Report 91–1473), nor in debate on the House floor.

In the Senate, however, this change in language was discussed. 116 Congressional Record 34585-86. Senator Mansfield, questioning whether the addition of "any other act" would include the previous year's Act, queried Senator Stennis as to whether the "prohibition is prospective only, and in no way retroactive to up the

standards required last year in the funding research." Senator Stennis' reply, made after consideration of the issue, was that the section "acts prospectively only and will not affect funds for fiscal year 1970, the fiscal year just closed, funds that have not been expended." Senator Mansfield later in the same discussion restated the agreed interpretation that "its application, if any, will be under the terms laid down by future appropriations acts."

The conferees specifically removed language from this section which would have limited its application to funds authorized by the Act itself. Language was added to make the section applicable to "any other Act." This language was agreed upon by the conferees after spending ". . . an awful lot of time determining the proper course of action. . . ." (Rep. Rivers, 116 Congressional Record 34152 col. 3) We therefore conclude that section 204 of Public Law 91–441 continues in force until repealed or amended and its provisions are applicable to all Defense Department funds used to finance research projects and studies.

Intergovernmental Personnel Act of 1970/Public Law 91-648 (S. 11)
January 8, 1971

Description.—The Intergovernmental Personnel Act of 1970 was developed to strengthen the ability of State and local governments to deal with the problems under their jurisdiction. The various needs were expressed in House Report 91–1722 to accompany S. 11:

> Growth in population and increasing urbanization of the United States are greatly extending State and local government responsibilities. Citizens are demanding more effective government, better education for their children, more and better roads and public transit facilities, clean and plentiful water, unpolluted air, better police and fire protection, more and better recreation facilities, more and better hospitals, better facilities for the treatment of mental illness, programs for safeguarding economic security, and many other services. New and urgent urban problems have developed. . . .
>
> These mushrooming demands generally have been beyond the financial capabilities of the State and local governments to meet. Accordingly, there has been a continually increasing need for Federal aid. . . .
>
> The need of State and local governments for substantial financial assistance is only one of the main facets of the overall problem of meeting the demands of our citizens and of making our population centers fit places to live. Also critical is the fact that many of the States and local governments, now and in the foreseeable future, lack the highly qualified administrative, professional, and technical personnel in the numbers required to plan, innovate, organize, and execute the wide variety of necessary programs.

This legislation created a program of grants and training assistance designed to give State and local personnel the administrative, professional, and technical skills vital to governmental operation. Intergovernmental cooperation in grants administration is fostered through the establishment of an Advisory Council on Intergovernmental Personnel Policy appointed by the President. Not to exceed 15 members, the Council acts to advise the President on programs, problems, and policies concerning public administration, State and local capacity building, training, and intergovernmental assignment of personnel.

Grants are made available to State and local jurisdictions for programs to develop and institute improved personnel administration methods. State and local employees may be permitted to participate in Federal training programs under the provisions of this law and funds are designated for nonnational jurisdictions to ". . . train and educate . . . professional, administrative and technical employees and officials." Title IV provides for the temporary assignment of personnel from States and localities to the Federal Government and vice-versa.

cc: B. Merrifield
B. Ortna

aa: ~~ITA~~ (for information)
cc: EA, GC, BJC, MFS

PROTECTIONISM IS DESTRUCTIONISM

614038

o Protectionism hurts Americans more than it hurts the foreigners it is aimed at. President Reagan says, "They ought to call it destructionism."

o During the past three years, the U.S. has experienced record trade deficits, yet our unemployment rate has fallen by about a third and 10 million more Americans have joined the workforce.

o Europe, on the other hand, is far more protectionist than the U.S., but has experienced economic stagnation for more than a decade. Total employment in Western Europe is virtually the same today as it was 10 years ago; since the labor force grew over the same period, unemployment has increased.

o Protectionism is occasionaly defended by some on national security grounds. Today, our national security depends on maintaining a technological edge over potential adversaries. Protectionism breeds stagnation and, even in such critical industries as semiconductors, is likely to be inimical to national security.

o Protection does not affect total employment. It simply shifts employment from more efficient industries to less efficient industries. Net affect lower productivity; lower national income.

The Costs of Protectionism

o Protectionism forces a massive transfer of wealth from ordinary Americans to the special interests. The cost of protectionism falls most heavily upon low-income Americans, because of higher prices on basic consumer goods.

o Import controls to protect 19 industries from foreign competition cost American consumers a staggering $56 billion in 1984 alone, according to a study published by the Institute for International Economics, a liberal Washington-based think tank. The study also found:

-- The per-industry cost ranges from $27 billion to protect the textile and apparel industries, down to about $100 million to insulate the canned-tuna industry.

-- It cost $1 million to save a single job in the steel industry in 1984; and $240,000 to save a single job in the orange juice industry.

-2-

o The International Trade Commission estimates that 1981-1984 Japanese auto import restraints saved 44,000 jobs in the U.S. automobile industry, but cost American consumers $16 billion. In other words, each job saved in the U.S. auto industry cost Americans about $90,000 per year.

o Economist Michael Munger estimates that the cost of protectionism today is between $1,500 and $2,000 annually for a family of four -- more than most families pay in federal income tax.

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o The cost of protectionism falls heavily on the poor. According to the Federal Reserve Board of New York, protection of sugar, clothing and automobiles was the equivalent of an income tax surcharge of 66 percent on a family earning between $7,000 and $9,350 in 1984.

Lessons of History Clear

o The 1930 Smoot-Hawley Act raised duties on nearly 900 items, from champagne and dolls to hand tools and farm products, pushing America's tariffs to their highest levels in the 20th century.

o A total of 59 countries protested to the U.S. Government about the danger Smoot-Hawley posed to the world economy, then reeling from the effects of the 1929 stock market crash. Over 1000 economists signed a petition urging Congress not to pass Smoot-Hawley, and asking President Herbert Hoover not to sign it.

o In the teeth of these protests, the measure passed both houses of Congress (with the Senate voting for the measure on Friday the 13th, June 1930) and was signed into law.

o Within months of enactment, our key trading partners began raising their tariffs and establishing exchange controls.

-- U.S. merchandise imports fell from $4.5 billion in 1929 to $1.3 billion in 1932, the lowest level since 1908.

-- U.S. merchandise exports fell nearly 60 percent from 1929 to 1932.

o Liberal and conservative historians agree that Smoot-Hawley deepened the Great Depression by encouraging other countries to erect trade barriers; isolating America's economy behind a high-tariff wall; and undermining European war debt repayment efforts.

Selected Quotations on Protectionism

Protectionist moves basically profit special interests at the expense of the consumer and at the risk of retaliation -- costing Americans their jobs.

--- Ronald Reagan
Remarks to the International
Forum, U.S. Chamber of Commerce
April 23, 1986

This philosophy of the free market -- the wider economic choice for men and nations -- is as old as freedom itself. It is not a partisan philosophy.

--- John F. Kennedy
Message to Congress on
Foreign Trade Policy
January 25, 1962

This is the first [shareholders] meeting where we can report things have never looked better... The Japanese have already added $1000 to their sticker prices and I expect they'll be adding $1000 in the next six months. That awful advantage we've been complaining about

is gone and we think it's a great time to sell cars.

--- Lee Iacocca
New York Post, May 15, 1986

Protectionism is no solution to the economic problems we face. A highly industrialized country like the United States would suffer greatly if the doors to international commerce were closed.

--- Senator Walter Mondale
Congressional Record
December 13, 1974

What point is there in propagating sound economic principles if the electorate is set to have the country run on the principle that the objective in trade is to get rid of as much as possible and get as little as possible in return?

--- Economist Frank Knight

HOUSE OMNIBUS TRADE BILL - AN INVITATION FOR RETALIATION

o If enacted into law, H.R. 4800, the House Omnibus Trade bill, would be a serious step backward for U.S. international trade policy. Many provisions of the bill would undercut the President's recent success in Tokyo in engendering a new round of trade-liberalization talks.

o H.R. 4800 would severely damage the U.S. economy, destroy American jobs, reduce our international trade competitiveness, and embroil us in trade conflicts with virtually all our major trading partners.

o The big losers under the House bill:

-- Consumers who would pay higher prices on thousands of products;

-- Workers in many of the most dynamic U.S. industries, who would find overseas markets closed to them; and

-- Farmers would face additional financial hardships.

o As nine members of the President's Cabinet asked in a joint letter to the Congress, "Why should we jeopardize the livelihood of the five million Americans whose jobs depend on exports?"

Examples of Unsupportable Provisions of H.R. 4800

o H.R. 4800 would require mandatory quotas against exports from countries with large and persistent trade surpluses vis-a-vis the United States. Japan, Taiwan, and West Germany would be immediately subject to these quotas. This violates GATT and invites massive trade retaliation against U.S. exports, particularly agricultural commodities, aircraft, chemicals and data processing equipment.

o The bill would make denial of "internationally-recognized worker rights" an unfair practice actionable under Section 301. This standard would come back to haunt U.S. exporters -- in

right-to-work states, for example. The concept of "internationally-recognized worker rights" is ambiguous at best. Congress has never recognized what that means.

o H.R. 4800 would unilaterally redefine what is an illegal subsidy, making some subsidies countervailable even if they are available generally (like irrigation and roads). This provision would invite retaliation against U.S. timber exporters, for example, who receive subsidized electricity.

o The bill would require mandatory Presidential retaliation in certain Section 301 cases by an inflexible deadline. Legalism in place of negotiation is no way to conduct U.S. foreign and trade policy.

o H.R. 4800 would prohibit the President from authorizing tariff cuts for certain import-sensitive articles. This would make it hard to get many nations to the bargaining table in a new GATT round; could make some mandated U.S. negotiating objectives impossible to achieve.

o H.R. 4800 would require a 40 percent reduction in items under national security export controls -- a meat-axe approach to export decontrol that ignores national security.

o The bill would also establish a Council on Industrial Competitiveness to carry out industrial planning -- a discredited scheme that would pit one industry against another. Americans don't want it and don't need it.

o H.R. 4800 could add to the budget deficit. Preliminary analysis indicates that H.R. 4800 would cost taxpayers an additional $6.5 billion over the next three years.

Building Blocks of a Bipartisan Trade Bill

o There are a number of important changes to U.S. trade law that would improve America's ability to compete. Supportable provisions of the H.R. 4800 include:

-- Expanding protection for U.S. intellectual property rights; and

-- Providing the President with negotiating authority for a new round of multilateral trade negotiations.

o The Administration supports a number of changes in existing law, which are not presently included in H.R. 4800:

-- Amending U.S. antitrust laws to promote competitiveness of U.S. industries;

-- Establishing a "war chest" to support mixed credit loans to enable U.S. exports to compete effectively;

-- Amending the antidumping and countervailing duty law to provide a predictable pricing test covering non-market economies; and

-- Amending our trade laws to put a deadline on dispute settlement and to contain a fast-track procedure for perishable agricultural items.

o November 1, 1985: Retaliated against the EC's failure to negotiate a settlement to the long-standing GATT citrus dispute by imposing duties on EC pasta exports.

o October 16, 1985: Secured market-opening concessions from Taiwan on tobacco, wine and beer; and from Korea on motion pictures, in response to the threat of a 301 case.

o Throughout 1985: Successfully concluded MOSS talks with Japan in four areas: telecommunications; medical equipment and pharmaceuticals; electronics; and forest products.

Ongoing Trade Initiatives:

o The Reagan Administration has taken the unprecedented step of initiating four Section 301 unfair trade practice cases, concerning:

-- Brazilian informatics;
-- Korean insurance;
-- Japanese tobacco; and
-- Korean intellectual property rights.

o Unless the European Community rescinds its illegal quotas against U.S. agricultural products and provides compensation for increased tariffs, the United States will establish equally restrictive quotas and increase tariffs on their products entering our market.

o The President ordered a fact-finding inquiry to determine whether the European Community would unfairly penalize American exports of as much as $125 million work of meat if they implement their meat inspection programs.

o President Reagan has ordered an investigation of Taiwan's automotive export performance requirements. This is the first case ever initiated under Section 307 of the Trade and Tariff Act of 1984.

o For the first time, the United States has self-initiated an anti-dumping case against Japan on 265K RAMS computer memory chips.

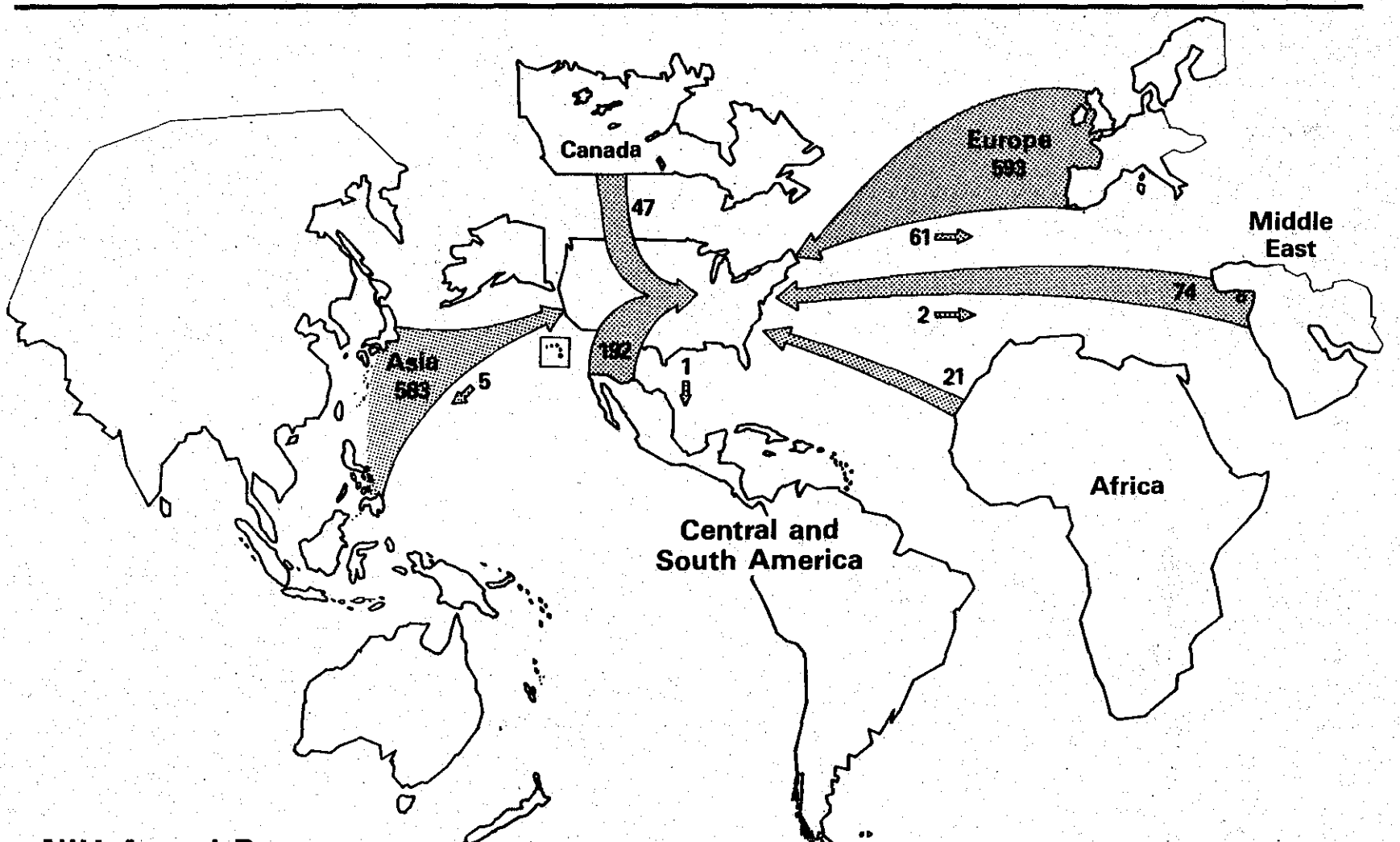
o The Administration is countering foreign subsidized agricultural exports by concluding over $400 million work of sales under the Export Enhancement Program. The Reagan Administration is also countering foreign subsidized export financing by aggressively using existing authorities. For the first time, the Export-Import Bank has extended concessionary financing to a U.S. firm for a sale in the U.S. market.

International Negotiations and Cooperation

o The Tokyo Economic Summit adopted new arrangements for closer economic policy coordination by the major industrial democracies. These arrangements should lead to improved growth, smaller trade imbalances and greater stability in international exchange rates.

o At the Tokyo Economic Summit, leaders of the seven major industrialized democracies and representatives of the European Community endorsed the early launch of a new round of multilateral trade negotiations, targeting the September GATT Ministerial meeting for decisive progress.

SCIENTISTS' MOBILITY, FY 1985



NIH Award Programs:

To the U.S.: International Research Fellows, Scholars-in-Residence, Exchanges, NIH Visiting Program Participants

From the U.S.: Senior International Fellows, Exchanges

TABLE 1

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
PROGRAM DISTRIBUTION; FY 1985

	Participants	$ Costs
Visiting Program	1,403 Foreign	$24,077,100
Guest Researcher Program	558 Foreign	-0-
Intl. Research Fellowships	100 Foreign	3,374,000
Senior Intl. Fellowships	46 U.S.	1,165,000
Eastern Bloc Hlth. Sci. Exch.	20 U.S. 6 Foreign	47,980
French, Swedish, Swiss, German and Irish Fellowships	49 U.S.	1,042,000
French CNRS Exchanges	4 U.S. 6 Foreign	110,448
Scholars-in-Residence	8 Foreign	476,697
Total	2,081 Foreign 119 U.S.	$30,293,225

TABLE 2

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
DISTRIBUTION BY GEOGRAPHICAL AREA; FY 1985

Geographical Area	Foreign Scientists to U.S.	U.S. Scientists to Foreign Country	Total
Europe	988	108	1096
East Asia & Pacific	636	8	644
N. Africa/Near East/S. Asia	321	2	323
Latin America & Caribbean	107	1	108
Sub-Saharan Africa	29		29
Total	2,081	119	2,200

TABLE 3

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
DISTRIBUTION BY COUNTRY; FY 1985

Country	Foreign Scientists to U.S.	U.S. Scientists to Foreign Country	Total
Japan	397	3	400
Italy	196	2	198
United Kingdom	162	33	195
India	168		168
France	105	12	117
Israel	104	2	106
China, People's Rep.	92		92
Canada	81	11	92
Germany; Fed. Rep.	83	8	91
Australia	52	4	56
All others (65)	641	44	685
Total	2,081	119	2,200

INTERNATIONAL OPPORTUNITIES FOR UNITED STATES BIOMEDICAL SCIENTISTS

I. NIH Mechanisms

A. NIH Mechanisms to Conduct Research Abroad

1. National Research Service Awards - Postdoctoral and Senior Fellowships (48)*
2. Research Grants and Contracts
3. Special Foreign Currency Program**
   - a. India (58)
   - b. Israel (20)
   - c. Poland (9)
   - d. Yugoslavia (32)

B. Specific Fellowships for Conducting Research Abroad

1. FIC-Supported
   - a. Senior International Fellowships (45)
   - b. NIH-French CNRS Program for Scientific Collaboration (6)***
2. Foreign-Supported
   - a. Finland (1)
   - b. NIH-French CNRS Program for Scientific Collaboration (6)***
   - c. France-INSERM (2)
   - d. Federal Republic of Germany (open)
   - e. Ireland (1)
   - f. Israel (4)
   - g. Norway (1)

*( ) Approximate number of U.S. scientists supported annually
** Grants and travel support for U.S. collaborators and foreign scientist participants
*** Supported under a bilateral agreement

h. Sweden (4)

i. Switzerland (4)

j. Taiwan (open)

C. Health Scientist Exchanges***

1. Hungary (2)

2. Poland (1)

3. Romania (11)

4. Soviet Union (1)

5. Yugoslavia (5)

II. Sources

A. Publications

1. Directory of International Opportunities in Biomedical and Behavioral Sciences

International Research and Awards Branch
Bldg. 38A, Rm. 613
Fogarty International Center
National Institutes of Health
Bethesda, MD 20892

2. A Selected List of Fellowship Opportunities and Aids to Advanced Education for U.S. Citizens and Foreign Nationals

The Publications Office
National Science Foundation
1800 G Street
Washington, D.C. 20550

B. Organizations/Agencies (not included in publications above)

1. International Cancer Research Technology Transfer Programme (ICRETT)
rue du Conseil-General 3
1205 Geneva, Switzerland

2. Epilepsy Foundation of America
   4351 Garden City Drive
   Landover, MD 20785

3. Computerized Bulletin Board (being developed)
   Contact: Russell Morgan
   National Council for International Health, Inc.
   Suite 605
   1101 Connecticut Avenue, N.W.
   Washington, D.C. 20036

4. Japanese Government Research Awards for Foreign Specialists
   International Affairs Division
   Promotion Bureau
   Science and Technology Agency
   2-2-1, Kasumigaseki, Chiyoda-ku
   Tokyo, Japan

5. International Fellowship Program for Foreign Scientists,
   FORMEZ, Training and Studies Center for Southern Italy
   Via Salaria 229
   00199 Rome, Italy

C. Medical Students' Opportunities

1. "A Student's Guide to International Health"

   International Health Task Force
   American Medical Students Association
   1900 Association Drive
   Reston, VA 22091

2. MAP-Readers' Digest International Fellowships Program
   Box 50
   Brunswick, GA 31520

STATE-OWNED PATENTS SPREADING ABROAD

Tokyo KOGYO GIJUTSU in Japanese Mar 86 pp 44-48

[Article by Mitsuo Suzuki, director of the Japan Industrial Technology Association]

[Text] Why International Technology Cooperation Is Now Important

With a turnabout from the first oil crisis, the focus of world technology development trend has been shifting toward lightness, thinness, shortness, and smallness [micro] from heaviest, thickest, longest, and biggest [macro]. Countries in the world are fiercely competing for the development of high technologies, amid the great surge of new technologies from the 1970's toward a peak in the early 2000's.

Emerging as advanced technologies are the technology for utilizing limited sources of energy on earth, electronics technology for fostering an information society, new materials technology for bringing about metamorphic progress in industries, and biotechnology with diverse potential.

The collapsing condition of the Japanese economy after World War II has achieved a marvelous recovery through the support of technical assistance from abroad and the concerted efforts of the people. As a result, Japan has now established a high technology level worldwide.

While Japan has currently achieved economic growth through active industrial activities based on high technologies, other countries have increasingly been seeking Japan's technical cooperation. Public opinion is taking root in that Japan should further promote contributions intellectual to the international society through technologies.

As regards technologies under such international circumstances, the recent activities concerning technology transfer and popularization of the Japan Industrial Technology Association (Inc.) (JITA) engaged in activities of spreading state-owned patents of the Agency of Industrial Science and Technology (AIST) at home and abroad will be outlined (see Figure 1)

Transfer of state-owned patents

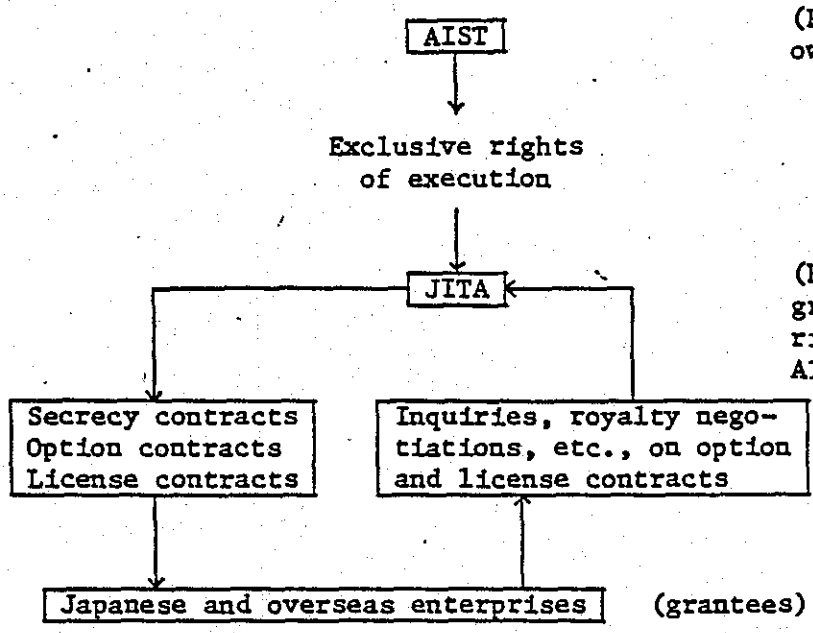


Figure 1. Technical Transfer System of AIST's State-Owned Patents

Activities of High Technology Interchange Missions

JITA has been sending missions to the various European and American countries annually since 1983 to introduce AIST's state-owned technologies in support of AIST and other quarters concerned. The dispatch of the missions is part of the technology interchange between Japan and the various European and American countries, and is also in response to criticism that Japan is not providing technology exports in comparision with the enthusiasm for exports of manufactured products. Among AIST's state-owned patents, 20 to 30 themes, which have been applied for industrial use by Japanese companies or those prospective technologies are selected annually for overseas supply upon approval for technical cooperation by the companies involved.

Missions comprising top technicians or leaders concerned in charge of technical development at such companies visited governmental organizations or research institutes of major enterprises in the various European and American countries to ascertain the needs of such countries (possibilities such as technology transfer and joint development). From this side, technical presentation was provided and at the same time relative discussions pursued.

Institutions visited by year follow:

1983	Sweden	(state) STU (Swedish Technology Development Agency) (private) ASEA Co., Volvo Co.
	West Germany	(private) Dynamite Nobel Co., Siemens Co.
	France	(state) CESTA (Advanced Technology System Development Center) (private) Toulouse City Chamber of Commerce and Industry
1984	United States	(state) Raleigh, North Carolina--Research Triangle Park (research consortium) (private) SWRI, IITRI, SRI (all nonprofit think tanks)
	Canada	(provincial) Montreal Urban Community (research consortium)
1985	Sweden	(private) IDEON (research consortium) (private) SKAPA (creative technology exhibit)
	Ireland	(state) IDA (Irish National Research and Development Agency)
	Britain	(state) BTG (British Technology Group, formerly NRDC) (private) Berkeley Tech Mart '85
	France	(state) CESTA (private) Rhone Poulenc Co.
	West Germany	(private) Bayer Co.

Fortunately, the dispatch of the missions over the past 3 years has resulted in steadily spreading state-owned technologies abroad due partly to the active cooperation of domestic licensee companies and various foreign governmental organizations and overseas companies. Among the themes presented, some concrete results are beginning to emerge, such as supplying information and samples, to include possibilities for future technology transfer and joint development, and the conclusion of secrecy contracts.

Table 1 shows typical technologies presented by the past three missions. A few examples among overseas responses to the missions were the request from Martin Marietta, a major U.S. enterprise, for a supply of several tens of kilograms of high-performance electromagnetic wave shield materials on a sample basis. Kuraray Co. and two other companies are now conducting experiments for practical application of the materials under the guidance of AIST's Industrial Products Research Institute. General Motors Corp. (GM), a major U.S. automaker, Alcan Canada Co. of Canada, Hinkley and ICI of Great Britain, and many other companies have shown interest in revolutionary fine ceramics processing technologies, and negotiations for a contract are now underway with a certain company. The ceramic technologies involved are the ceramics-metal

Table 1. Technologies Introduced Abroad Through State-Owned Patents

Category	Title of technology	Institute that made discovery	Year introduced		
New materials	High-performance electromagnetic shield material	Industrial Products Research Institute	1983	1984	
	Ceramics-metal bonding	Osaka National Industrial Research Testing Institute (NIRTI)		1984	1985
	Ceramics-ceramics bonding				
	Zirconia sintet	Nagoya NIRTI	1983		1985
	Easy-to-sinter alumina	" "		1984	
	Lubricating agent for die-casting, forging	Osaka NIRTI	1983	1984	
	Lanthanum-chromate for heating	Daikoshi NIRTI	1983		
	Carbon-ceramics compound	Kyushu NIRTI		1984	
	High-performance pitch carbon fiber	" "	1983	1984	1985
	Ultrahigh-molecular polyethylene gel yarn	Research Institute for Polymers and Textiles		1984	
	Hydraulic injection plastic molding	"		1984	
	High-flux precision filtration membrane and its system	National Chemical Laboratory for Industry, Kyushu NIRTI, Osaka NIRTI	1983	1984	1985
	Photocrosslinkage polymer and screen printing	Research Institute of Polymers and Textiles	1983	1984	
	Gas separation using polyimide hollow fiber	National Chemical Laboratory for Industry			1985
	Ion exchange fiber and rare earth metal separation	Research Institute of Polymers and Textiles	1983	1984	1985
	High-performance deodorant	National Chemical Laboratory for Industry	1983		
Biotechnology	Production of oils and fats by mycosis	National Chemical Laboratory for Industry	1983		
	Production of gamma linolenic acid by mycosis	"		1984	1985
	Production of heat-resisting lipase and dissolution of oils and fats	Fermentation Research Institute		1984	1985
	High-performance cellulase	"		1984	
	Solidification of oxygen by ultrafine fiber carrier	Research Institute of Polymers and Textiles			1985
	Solidification of oxygen by photocrosslinkable polymer	"			1985
	Production of fry feed from alcohol fermentation wastes	Fermentation Research Institute			1985
	Artificial joints	Mechanical Engineering Laboratory			1985
Electronics	High-performance amorphous silicon solar battery	Electrotechnical Laboratory		1984	1985
	Semiconductor magnetic sensor and its applications	"		1984	1985
	Assessment of amorphous silicon manufacturing process under CARS system	"			1985
	ICTS system for detecting crystal defects	"			1985
	Nonvolatile semiconductor memory with floating gate	"			1985
	High-output GGG laser	"			1985
	Optical disk pickup (SCOOP)	"			1985
	Magnetic garnet film for optical IC	"	1983		

bonding and ceramics-ceramics bonding where research for practical applications is being conducted by Sumitomo Cement Co. and Daihen Corp., respectively, under the guidance of AIST's Osaka Industrial Research Institute. Negotiations are also underway with (Reuter) Gas Werke Co., a major West German pitch processing company, concerning technology to manufacture high-performance carbon fiber now being developed for practical application by more than 10 companies, including Nippon Carbon Co. Regarding lubricating agents for forging and die-casting, Hanano Shoji (Inc.) has completed development of manufacturing technology, and is now being made practical with a large amount of samples being supplied abroad for testing, while Great Britain's (Fuoseco) is seeking technology transfer.

In addition not only enterprises, but also Britain's BTG (R&D agency) and France's CESTA (advanced technology center) are requesting long-term, deliberative cooperative relationships with JITA missions, and are showing an active stance toward future technology interchange with Japan.

Progress in R&D of those technologies have been conducted by research institutions under AIST's umbrella with the cooperation of private-sector companies. Behind-the-scene movements concerning technology transfer through various channels have also been observed, and attention focuses on future developments.

Technological Transfer Based on Trusting Relationship

"The more information is assimilated, the more its essence is improved," is a wise statement about data bases by Tokyo University Professor Hiroshi Inose, last year's Cultural Merit awardee. In technology transfer, too, a certain preparatory period is initially required for the exchange of technologies and related information and establishment of a relationship of mutual trust between the provider and the receiver of technologies. The first problem in negotiating transfer of state-owned technologies abroad is that it takes considerable time to establish such relations of trust. Perseverance is required as in an extreme case where the party completely lacking information mutually about the other party begins from scratch. In addition, based on relations of trust, the supplier and receiver of technologies must seek terms on conditions which will mutually benefit both sides from a long-term point of view. Under such circumstances, recent trends for the future technologies or in exploring new areas such as cross-licensing and other forms are increasing.

Next is the establishment of relations of trust regarding protection of patents. The state-owned technologies to be definitely transferred abroad at present are basically on condition that the technologies involved are patented in the recipient countries. Accordingly, it is important that such technologies are fully protected under the recipient countries' patent system and in the operation thereof.

In the various countries visited by JITA's advanced technology exchange missions in the past 3 years, hardly a problem occurred due to the high reliability of the patent protection measures. However, of late, Japan has been strongly urged to expand technology transfer to the newly industrialized countries (NICS) and developing nations. The problem of patent protection in those countries will therefore be an issue to be resolved in the future.

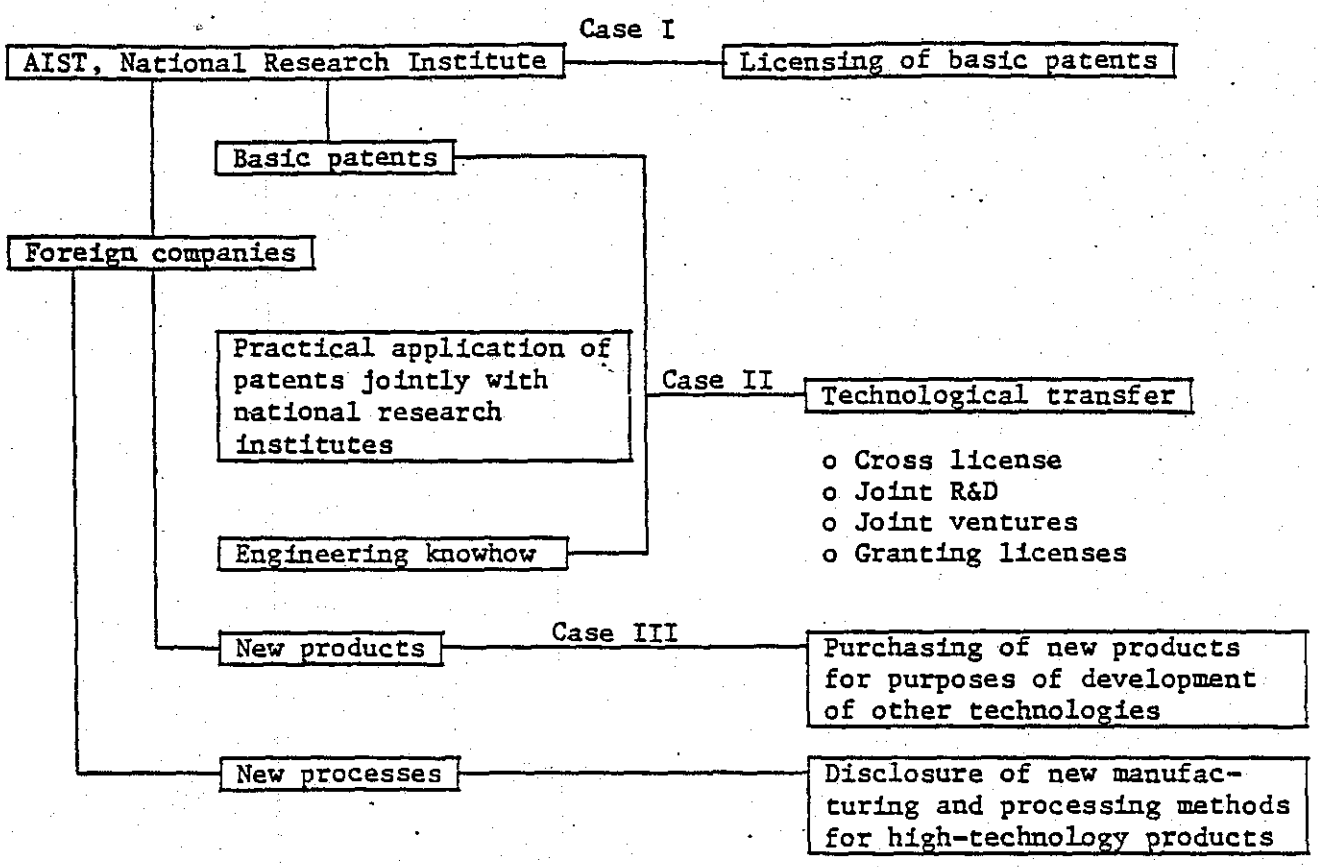


Figure 2. Technology Transfer of State-Owned Patents Abroad

Four Cases of Technological Transfer and Procedures for Transfer

Transfer of state-owned patents has various backgrounds depending on the technologies involved, which is not easy to generalize into one format. However, it can be classified roughly into four cases as shown in Figure 2.

Case I is the licensing of basic patents owned by the Agency of Industrial Science and Technology and of patents jointly owned by the national research institutes and private companies. Case II involves providing all the information necessary for commercialization ranging from basic patents owned by the AIST to related patents, manufacturing know-how and product specifications, etc., possessed by the implementing companies--in other words, the complete transfer of technologies. Depending on circumstances for the suppliers and the receivers of technologies, Case II can be subdivided into four types, i.e., cross-licensing mutually between companies, joint development by both companies for furtherance of technologies involved, establishment of joint ventures between companies based on mutual agreement and conditions for local production and sales, and the unilateral supply of all the technologies to the other country's enterprise in exchange for payment of certain remunerations.

In Case III foreign companies purchase products of technologies involved from the contract-implementing firms of Japan and use such items as a basis to develop new processes or new products. In Case IV foreign companies produce and process products on a contractual production basis, using high technologies developed from basic patents owned by the AIST. For example, one plan now under negotiation is the contractual production of special parts by a foreign enterprise using the "ceramics-metal bonding technology."

Table 2. Procedures for Technology Transfer

First stage Secrecy agreement	Providing secret information and samples necessary for assessment of technologies involved
Second stage Option agreement	Technical information including know-how, etc., data regarding economical phase, and samples or marketable products necessary for feasibility study
Third stage License agreement	All information necessary for practical application of technologies

Procedures for granting licensing of state-owned patents abroad are basically identical to those in Japan. The first stage, as shown in Table 2, is to cope with clients when they seek more detailed information and samples to be furnished so as to determine the industrial value concerning the nature of the technologies. In such case, if necessary, a secrecy agreement is concluded before providing them.

The second stage is for coping with cases where further concrete information beyond the first stage is sought by the clients such as information about economical feasibility, information concerning marketing and technical information to determine the industrial applicability of the technologies, as well as providing samples on a commercial basis, etc. Usually in this stage, information is furnished under an option agreement on the assumption that technologies involved will be applied for industrial purposes.

The third stage is the execution of technology transfer under a license agreement in which the contract discloses all technical information necessary for the application of technologies and the nature of the patents.

For the Future

Japan is a small country in terms of natural resources, energy, and food, but is substantially rich in intellectual resources. Using these resources, the country has accumulated industrial property and other technology assets since the end of the last war, making itself one of the leading technology-oriented countries in the world. Such intellectual assets will continue to serve as a bargaining power for Japan.

However, today's accumulation of technology assets has resulted from the introduction of technologies from advanced countries in Europe and America, and efforts for creative technology development. Moreover, in the background of facilitating Japan's introduction of technologies from European and American countries is the sense of trust when Japan was furnished technologies, being accustomed to assessing fair value of new, superior technologies which furthered the understanding of patent protection.

Meanwhile, Japan has been strongly criticized by various countries in Europe and America for its huge trade surplus stemming from expanding exports of manufactured products. Of course, free world prosperity lies in orderly exports and imports under the free trading system. However, Japan's export of its abundant intellectual resources, resulting in a surplus in the technology trade balance, would not create trade friction, but would rather contribute to the development and revitalization of the world economy. The conditions to smoothly transfer technologies overseas are as stated above. The three issues of relations of trust, mutual benefit, and patent protection have been proposed. However, these problems in the case of NIC's and developing nations are such that environments are yet to be sufficiently regulated. It is extremely important that Japan mutually cooperate in resolving these problems for future international cooperation.

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gy, and we can come together as a nation to do what makes sense and what is necessary to advance our national self-interest.

We do not have to wait until there is a consensus at the Federal level about how we can be helpful in enhancing competitiveness. The State and local governments are not waiting for the Federal Government to address the challenge of competitiveness. They know not to expect action from this administration.

STATE AND LOCAL GOVERNMENT INITIATIVES

On the issue of competitiveness, State and local governments are demonstrating much more creativity than is the Federal Government. They are showing that they understand how serious the competitiveness challenge is for America and they are acting boldly and pragmatically to bring the public and private sector together in a constructive partnership to meet this challenge.

The range of these initiatives is too broad, the programs are changing too quickly, and the Federal Government has too little interest in monitoring these developments for us to have even a complete list, let alone an understanding, of what is happening now at the State and local government level.

We do know enough, however, about these initiatives to know that something exciting is happening at the State and local government level. We know they are experimenting with new approaches to the responsibilities of government, we know they are taking risks, and we know that they are challenging the traditional notions about the relationship between the public and private sector. Clearly, we need to know more and a national clearinghouse is the logical first step in educating ourselves about what already is happening.

RANGE OF STATE AND LOCAL INITIATIVES

The range of State and local initiatives to stimulate productivity, technology and innovation is broad and growing. With all 50 States interested in the issue, many novel programs have been launched and even more are being considered. The absence of Federal Government interest has challenged State and local governments to fill the void and they have done so with little hesitation.

There are programs where the State and local government itself is a partner in developing a new production process, a new technology or a new invention. Some State and local governments have establishing laboratories, experimental manufacturing facilities or education institutions which conduct basic or applied research. Some States have established incubators which provide low-cost physical space, equipment, and technical service to start up businesses. These initiatives are of great interest to the other States and to the Federal Government itself.

One of the best examples of State technology efforts can be found in Arkansas. The Arkansas science and technology authority plays a leading role in Arkansas in identification, development, and application of advanced technologies. It provides funding for basic research and applied research partnerships with industry, which industries in turn are eligible for State research and development tax credits. It stimulates a homegrown economy through the establishment of five business incubators which provide support to new technology-based businesses in Arkansas. It's seed capital investment fund provides the critical initial capitalization for these new ventures. Supplementing the work of ASTA is the center for technology transfer at the University of Arkansas, the quality-productivity task force of the Arkansas Industrial Development Commission, and the Industrial Services Association at Southern Arkansas University all of which are working with existing industries in Arkansas to find ways to increase productivity and promote the concept of quality management.

Many States are establishing programs which integrate universities in the search for more productive processes, new technology, and greater economic growth. Universities no longer are the ivory towers that some have thought they should be. "The Higher Education—Economic Development Connection: Emerging Roles for Public Colleges and Universities in a Changing Economy," American Association of Colleges and Universities and SRI International, 1986. Georgia Institute of Technology, the University of Alabama at Tuscaloosa, George Mason University, Michigan State University, and Oregon State University have been leaders in fashioning innovative university/private sector programs. Many other States are involved in similar efforts.

There are at least 10 States which are working on programs to assist small- and medium-sized companies in financing export sales. In California a government agency will guarantee 85 percent repayment on loans which banks give to businesses to finance working capital or receivables related to exports. "States Launch Efforts to Make Small Firms Better Exporters," the Wall Street Journal, February 2, 1987.

STATES ARE MORE PRAGMATIC

It should not be surprising that State and local governments are taking the lead on the competitiveness issue. State and local governments have intimate knowledge of what the decline in competitiveness means to the workers and managers in their region. They know what happens when a firm cannot compete in the international marketplace or when it determines it must relocate its firm overseas to take advantage of lower wage costs. They can see businesses struggling to adjust to changed markets and new technology. They see entrepreneurs with an idea who cannot obtain capital or who need assistance in commercializing an invention.

State and local governments know that under the current administration and with the huge Federal budget deficits, they cannot wait for Washington to formulate or implement a competitiveness strategy for the country. They know that their only alternative is to act on their own, using their own resources and relying on their own good judgment about what role government can play.

State and local governments are in much healthier fiscal shape than is the Federal Government. State and local governments taken as a whole are running a budget surplus, which contrasts starkly with the abysmal deficits we are running at the Federal level. Because of the irresponsible fiscal policies of this administration, at the Federal level we simply do not have the funds to appropriate for new initiatives, or even to provide adequate funding for existing programs in the areas of education, trade adjustment assistance, and export promotion. Our national economic well-being is threatened and we have been left with insufficient resources to make the investments which are necessary to meet this threat.

Most important, State and local governments are finding that they can play a constructive role in stimulating productivity, technology, and innovation. They do not have a rigid ideological suspicion of everything that comes from Government as does the administration in Washington. They're not concerned about ideological purity; they're just trying to solve problems. They don't throw around slogans about "Government Being the Problem." They see a problem and they go to work.

State and local governments know that it is simplistic and counterproductive to assert that Government "Is the Problem." Government certainly can create problems just as can a private business when it is poorly managed. We at the Federal level have made major mistakes in setting macroeconomic policy. But for good or bad, governments are here to stay and the issue is how well they are managed and how constructive the role is that they play. Government can be a partner or a meddler, but it is always a factor.

State and local governments are taking risks with these innovative programs. They are conducting experiments and we must understand that some of these experiments will fail. Some public money may not be invested wisely in searching for effective ways to stimulate productivity, technology, and innovation. Some of these programs already are subject to controversy and there is always controversy when taxpayers' funds are not invested with a maximum return. But,

Government institutions need to take risks just as do corporations. New products introduced into the marketplace by corporations fail, indeed most new product introductions fail. This doesn't lead corporations to stop introducing new products. If Government refuses to take risks and refuses to try innovative approaches to pressing national problems, it may well become more of the problem than the solution.

With a national clearinghouse we all can learn more from experiments which others already are willing to undertake. The clearinghouse itself is itself a modest experiment given the willingness of State and local governments to fund and conduct—and take the heat for—experiments in enhancing competitiveness. In seeking to determine which experiments are succeeding and which are not, hopefully we all can avoid repeatedly making the same mistakes.

With a clearinghouse we are acknowledging that the Federal Government is not the only, and indeed it is not even the major, actor in enhancing the competitiveness of our business sector. There are 50 State governments, thousands of city and county governments, thousands of universities, thousands of foundations, thousands of nonprofit institutions, and thousands of private corporations which can take the lead. We need all of them to play a constructive role and we at the Federal level need to do all that we can to stimulate diverse approaches to the competitiveness challenge. It would be folly and unwise to pursue one single, national, and federally mandated strategy.

NEED FOR A CLEARINGHOUSE

What my legislation would do is create a center on State and local initiatives on productivity, technology, and innovation. The center would be located in the Commerce Department and its principle function is to serve as a clearinghouse on the competitiveness initiatives of State and local governments, regional organizations, university and private sector cooperation, and joint public-private sector partnerships.

The President's Commission on Industrial Competitiveness studied the efforts of State and local governments to boost competitiveness. In a report to the Commission prepared for the Task Force on State and Local Initiatives by SRI International and the Chemical Bank, it is recommended that "A national resource center should be established to identify State innovations, assess their effectiveness and promote action by States and industry." "Innovations in Industrial Competitiveness at the State level," report to the President's Commission, SRI International, December 1984, at 70.

This report found that "States, industry, and the Federal Government all need better information on which of the strategies attempting to promote industrial competitiveness at the State level are working." It found that only a "limited amount of systematic effort" had been made to "document and assess what has been happening." The recommended "National Resource Center" could "serve as a national clearinghouse, a neutral forum for discussions among sectors and a resource for technical assistance for States or industry interested in developing new strategies."

Similarly, the Congressional Office of Technology Assessment found that to provide direct or indirect assistance to State or regional high technology development, it would be helpful for the Federal Government to establish an information clearinghouse "containing a comprehensive and up-to-date list of State and local initiatives" that support high technology development. "Technology, Innovation, and Regional Economic Development," Office of Technology Assessment, July 1984. The report found that the most helpful type of information the clearinghouse could assemble would be a "project bank" such as that established by the White House Task Force on Private Sector Initiatives.

COMPETITION AMONG THE STATES

We all know that States and local communities compete among themselves to entice firms to locate or relocate their plants and headquarters. In this competition, one town may offer tax incentives, it may upgrade the local infrastructure or it may lease available land at a below-market rate.

Obviously, this type of competition has an impact on the economics of the firms which benefit from these incentives. Tax breaks, improved infrastructure and below-market rate leases will lower the firm's costs and that improves the firm's productivity.

But, this type of government assistance is more like a government grant than a bold experiment. It is not directed at changing the management approach of the firm, the manufacturing process, or the employee training at the firm. It is not directed at stimulating the development of new technology or the creativity of the firm's scientists. It does not encourage basic or applied research by the firm or investments in new equipment. And, as a result, it should be of much less interest to the center.

Let me be clear. The economic development efforts of State and local governments are valuable and important. They lead to economic growth and increased employment, but in many cases the result of these efforts is more to shift the growth and employment from one city or town to another, not to stimulate a net increase in the Nation's growth or employment. These efforts may amount to a zero sum game for the Nation's economy even though they provide valuable benefits to individual businesses.

It is not clear that the competition among the States always is healthy or fair. It is certainly difficult for a rural or "economically" disadvantaged community to compete with a relatively well-to-do town. Often the rich get richer and the poor get poorer in this competition. Poor States are forced to compete by offering more special tax breaks or other incentives, which they can ill afford to provide. One recent study by corporation for enterprise development found that "many Sun Belt States that cut taxes and services to attract industry are paying the price with lackluster economies . . ." ("Study Finds Sun Belt Suffers From Steps to Draw Industry," Washington Post, March 19, 1987).

This competition among State and local jurisdictions, however, is a fixture in our market economy. States are part of that market and the Federal Government should not attempt to arbitrate this competition. It certainly has no way to prevent it. At best we can try to shift this competition to more constructive approaches, approaches which stimulate productivity of firms which already are located in the area or which stimulate the creation of new firms there and the center may help in this respect to reduce the type of competition among the States which has not proven to be constructive.

To ensure that the center does not become enbroiled in the intense competition among State and local governments, the clearinghouse I propose here is specifically prohibited from assisting one State or local government in encouraging a private business to relocate any facility from one State or local jurisdiction to another or to locate any new facility in one State or local jurisdiction rather than another. (Section 5A. (i)(1)(C).) The Federal Government has no legitimate role to play in favoring one State over another when a private firm is determining whether or not to relocate or where to relocate. The center could never establish a relationship of confidence with State and local governments if it became a partisan in disputes among the States.

Similarly, the bill would bar the center from providing any financial assistance to support a State and local government to stimulate economic development through the conduct of public works or the repair or replacement of infrastructure. (Section 5A. (i)(1)(B).) Again, these activities are important functions of Government and private businesses need the assistance of Government on these initiatives. But, these initiatives are routine functions of government, not bold experiments of interest to the Federal Government and other State and local governments.

Similarly, the center is barred from providing direct financial assistance to fund State and local development initiatives. (Section 5A. (i)(1)(A).) Funding for these initiatives might well be available from other Federal agencies and the center may perform a service

by compiling inventories on Federal funds which might be available. But, the center must not become involved in providing the funding itself or intervening as partisan in the competition for scarce Federal resources.

Finally, the center is barred from considering any issued "included in a specific labor-management agreement without the consent and cooperation of all parties to the agreement." (Section 5A (i)(1)(D).) This prohibition has a similar intent to those just described. The center should not serve as an arbitrator of disputes. It should provide information and monitor developments. Once it becomes a player in these disputes, it will lose credibility with any parties with an adverse economic or political interest.

STATE INITIATIVES OF NATIONAL INTEREST

The purpose of the clearinghouse is to focus on State and local initiatives which provide a benefit to the Nation as a whole, which stimulate productivity for an entire industry, which develop a new technology which creates a new industry, and which lead to new discoveries about materials, products or processes. It is these initiatives which are of greatest interest to other State and local governments and to the Federal Government.

It is relatively easy for a State or local government to build a new road to service a new factory. However, State and local government initiatives which target productivity, technology, and innovation require much more sophistication. These initiatives are much more difficult to fashion and they are much more controversial. The success of these initiatives is much harder to measure. Initiatives of this type are experiments. When they succeed, however, these initiatives are the ones which are the most significant in our effort to enhance the competitiveness of the Nation as a whole.

The lessons about productivity which are learned by a firm in one State or city can be helpful to a firm in another State or city. One cannot pick up a new road and transfer it somewhere else, but we can easily transport an idea, a new process, or a new material from one State to another.

Under my legislation, the clearinghouse is directed to focus its efforts on those initiatives which are directed at enhancing productivity, technology and innovation. It is these initiatives which are most important to the Nation as a whole and it is these initiatives which are of greatest value to the efforts of the other States. There is great value in learning about how firms increase productivity, how they develop technology and how they enhance the inventiveness of a firm's employees.

COMPETITION FOR PRODUCTIVITY

What we want to encourage is competition among the States to increase the productivity of the firms in their area, not to compete with other States in offering economic incentives to firms to relocate. When States undertake experiments in government-private partnerships, they may do so partly to compete with other States which have launched similar programs. But, this type of competition is healthy; it's precisely the type of competition we want to encourage.

Indeed, if we find that State and local governments can help to stimulate productivity of the firms already located in their area, they may find it much less necessary to entice other firms to choose their town as the location for a new facility. The center can help the States find other basis for competition than forgoing the collection of taxes or providing special and costly services that are not normally available. If States have no ways to compete other than ways that may be shortsighted, they may nonetheless feel compelled to compete.

Some argue than the State and local governments need to be saved from themselves in this competition. Proposals have been circulated that the States agree among themselves to compete in a more positive, less self-destructive way. Such an agreement might take the form of a "disarmament" treaty in which States agree, for example, not to provide special reductions in property or other taxes to entice firms to locate or relocate their facilities in a State. But, until State and local governments voluntarily limit the competition among themselves, the best we can do may be to encourage competition on the basis of constructive partnerships in enhancing productivity, technology and innovation.

EVALUATING STATE AND LOCAL INITIATIVES

One area where State and local governments may need direct financial assistance is in evaluating the initiatives they have undertaken. Typically, evaluation is the hardest and most underfunded aspect of a program.

In some cases, there may be a reluctance to evaluate a program for fear that it will be found wanting. I say this knowing that this same reluctance is common in private businesses, especially for programs where success and failure is not measured simply by a reference to profit and loss.

To be fair, however, it is very hard to determine when an initiative of a Government agency has made the difference in increasing the productivity of a firm. Productivity itself is a concept that is hard to pin down. It is hard to know why some firms are more inventive than others. It is hard to say why one scientist discovers a new technology and another does not. There is controversy about how to evaluate a program just as there is in designing a program in the first place.

In addition to serving as a clearinghouse, therefore, the legislation I am here introducing authorizes the center to provide grants to help State and local governments evaluate their initiatives. (Section 5A.(C)(2).) These grants could be given to the local agency or to a third party, whichever is most appropriate. The legislation bars the center from providing financial assistance for the initiative itself, but it is quite appropriate for the center to provide such assistance for evaluation because only with proper evaluation can the center determine the effectiveness of the initiative.

The issue of evaluations is sure to be a sensitive one as well as an important one. State and local governments which are undertaking experimental programs have no interest whatever in the Federal Government—which has shown little willingness to undertake any initiatives on competitiveness—criticizing their efforts. If the Federal Governments chooses to be inactive on competitiveness issues, it has no right to make life more difficult for State and local governments which are taking up the slack. This is an issue of sovereignty as well as tact. But, the center will find that it cannot hope to establish a relationship of trust with State and local governments if it simply criticizes their efforts from "on high."

To ensure that the center does not trample on the prerogatives of State and local governments, the bill explicitly provides that the center may not evaluate a State or local initiative or disseminate information regarding such evaluations unless the State or local government carrying out the initiative "consents to and cooperates with such evaluation." (Section 5A (C)(2).) This limitation will ensure that when the center does conduct an evaluation, it will be fully informed of the nature and terms of the local initiative. It cannot hope to have all the information it needs if the State and local government is unwilling to provide it. But, it needs more than access to data. It needs to discuss the initiative with the State and local government officials involved to learn from their views and their experience.

There is a need for the center to fund generic research in how any governmental agency can measure the effectiveness of its competitiveness initiatives. The bill I am introducing permits the center to award some grants for this purpose. (Section 5A.(F).) While the center may fund this research, it must be very careful in commissioning such research.

The interest of the center in assisting State and local governments to evaluate their initiatives is, in part, a selfish interest. The center is just as interested in the results of these evaluations as are those involved in the initiative. The center is interested in disseminating information on the most successful initiatives and in disseminating information on how each initiative compares to others and it needs as much data as it can assemble on the impact of these programs.

COMMERCE DEPARTMENT AND OPTI

In my bill, the new center is to be located in the Office of Productivity,

technology and innovation (OPTI) in the Department of Commerce. OPTI is an agency that I have long supported and on several occasions I have made sure that the administration's efforts to slash its budget have not been successful. Indeed, at one point the administration argued that OPTI should be abolished because its mission had been "completed." In fact, OPTI is a bright light in this administration as an agency which is trying to make government work, not simply to avoid dealing with real problems.

To a very limited extent, the functions of the center are performed already by the OPTI. Because OPTI does monitor developments at the State and local level and serve to a limited extent as a clearinghouse, the bill places the center within OPTI. By establishing the center by statute, however, we can give it visibility, ensure it has enough resources, and lend it the credibility of the Congress.

The center belongs in OPTI and its existence will enhance everything that OPTI already does to stimulate the competitiveness of the country. OPTI is one of the only current Federal agencies which can understand and appreciate the initiatives of State and local governments.

THE CHALLENGE WE FACE

It may be said that this proposal is not dramatic enough or massive enough. Some would argue that we need to spend huge new sums on some programs on competitiveness. Others would argue that we need to erect barriers to the imports which are flooding our markets. But I think the competitiveness problem is more complex than that and that we need to undertake many different initiatives to have an impact.

We cannot pursue any single strategy. Our economy and the world economy are too complex for any level of government—Federal, State, or local—to have a major impact on the competitiveness of the private sector. The resources of government can help but the private sector has many times the resources available to it.

Indeed, in many ways government cannot affect the competitiveness of private business. The competitiveness of a firm depends in large part to the foresight of its management and the creativity of its technical people. These are qualities that cannot be legislated.

But, the Government may be able to serve as a partner. The State or local government may be a more sensitive and more constructive partner than can be the Federal Government. The Government can provide some leadership. It can encourage risk taking and it can provide information.

What this proposal says is that we need a decentralized strategy which draws on the creativity and innovation of many sectors, public and private, nonprofit and commercial, education and training.

By pursuing a broad-based and multifaceted strategy, we are more likely to enjoy success. Vast new Federal programs have a potential for doing harm as well as good, especially if they impede our efforts to control the budget deficit.

Given the constraints on funding any new Federal Government programs, the Federal Government can start by working constructively with State and local agencies which are taking the lead in stimulating productivity, technology, and innovation. It can at least help us all to learn about the complex challenge we face from international competition.

We can all benefit from the initiatives of State and local governments if we share information about their successes and failures. The clearinghouse can bring us together with information, which can help to bring us together for action.

The center speaks of risk taking, partnerships, and long-term efforts. It is not a panacea. It does not overpromise. It does not underestimate the complexities of the challenge. It's a modest proposal but therein lies its virtue. It will help, it is constructive, it is pragmatic, and it is something we can come together to do now while we debate grander and more controversial proposals.

This bill is not printed here but will be forwarded to members and any interested parties upon request.●

By Mr. BUMPERS:

S. 931. A bill to amend the Internal Revenue Code of 1986 to provide preferential treatment for capital gains on small business stock held for more than 4 years, and for other purposes; to the Committee on Finance.

INCENTIVES FOR LONG-TERM INVESTMENTS IN AMERICA

● Mr. BUMPERS. Mr. President, I am introducing a bill to encourage investors to make long-term investments in growth-oriented small business ventures. By encouraging these investments, we encourage investments in the future prosperity and competitiveness of America. Indeed, without these investments, our Nation's economic strength is sure to decline.

The bill I am introducing would provide a modest tax incentive to encourage investors to provide long-term capital to growth-oriented, small businesses. This incentive is available to entrepreneurs who risk their own capital in establishing these business ventures, to outside investors who buy stock issued by the entrepreneur, and to employees who purchase stock in the company under incentive stock options or similar plans.

It is crucial to the prosperity of our capitalist economic system that entrepreneurs, investors, and employees take risks by founding, investing in, and working for startup small businesses. These startup ventures are the hope for both economic growth and competitiveness for our country. However, these ventures frequently need capital to grow and often are unable to attract capital because there are safer investment options available.

ECONOMIC IMPACT OF SMALL BUSINESS

The tax incentive I propose is targeted at startup ventures and other small businesses because we know that they have the greatest potential for creating jobs, for innovation in products and services, and for enabling the United States to remain competitive in international markets. Despite this fact, these businesses have the greatest difficulty in obtaining the capital needed to become larger businesses because so many of these ventures fail.

Employment growth in small business-dominated industries, at 5.1 percent, far outpaced that of large business-dominated industries, at 0.7 percent. "The State of Small Business," report of the President, 1986, at XIII. Small firms generated most of the net new jobs during the economic downturns from 1979 to 1983 and they continue to be the major employer of younger and older workers, women and veterans.

It is quite clear that the small firms which thrive on venture capital investments make a major contribution to the economic growth of the country. In one study of 72 firms in which venture capitalists had invested only $209 million during the 1970's, the firms had combined annual sales in 1979 of $6 billion and had created 130,000 jobs. "Government-Industry Cooperation Can Enhance the Venture Capital Process," General Accounting Office, August 1982, appendix II, page 9.

CAPITAL NEEDS OF SMALL BUSINESS

What these startup ventures and other small businesses need most is patient capital, capital which is invested for a substantial period of time while the firm grows, innovates, and penetrates or creates new markets. Unfortunately, small businesses have difficulty in obtaining sufficient capital because it is much less risky for investors to make short-term investments, to seek returns based on next quarter's profit-and-loss statement, or to rely on a steady stream of dividend income.

The reason why small businesses have difficulty in obtaining capital is that they may never generate any profits and dividends for the investor. A study of 10 venture capital funds through 1983 found that roughly 26 percent of the investments lost money and consumed 34 percent of the capital invested. Another 25 percent of the investments produced only a return of the original capital after many years of waiting for a return. Almost another 40 percent returned less than 5 times the original investment and only 5 percent returned more than 10 times the original investment. Unpublished study of Horsley, Keogh & Associates, cited in "Tax Policy Influence on Venture Capital," Burton J. McMurtrey, Technology Venture Investors, 1985.

COVER STORY

PART 1

A National Interest in Global Markets

SUMMARY: This much has not changed: The Pentagon keeps a short leash on those who wish to export technology, and measures are being directed at keeping U.S. companies competitive with foreign firms. Yet advances in high technology are increasingly being made through cooperative international efforts. The United States is finding a major challenge in balancing two essential, oft-conflicting interests: selling U.S. products abroad while maintaining national security.



EIJI MIYAZAWA / BLACK STAR

Workers from the United States (left and center) are trained at a compact disc factory in Kawasaki, Japan.

The first shot in the superconductor revolution was fired by two European scientists working for a U.S.-owned multinational firm in Switzerland. Sometime, somewhere, someone might sort out the tangled genealogy of that first discovery — and the dozens of breakthroughs all over the world that have followed it in the past few months. But right now it seems pointless. Americans, at the present moment — at Paul Chu's laboratories at the University of Houston, at Wayne State University in Detroit, at IBM's research facility near New York — hold sway in the superconductivity race.

But in a few months' time the pendulum might well swing toward Japan, where two special superconductor committees have already been set up by the government's Science and Technology Agency. Or perhaps it will swing to Western Europe, where scientists and engineers have been as consumed by the promise of superconductivity as their counterparts elsewhere.

There is little geographic logic to the pace of scientific discovery. New breakthroughs flow quickly and easily through national and political barriers, with endless and confusing permutations. The next frontier in superconductivity could be explored by a Japanese graduate student working for a U.S.-funded lab at a European university. This is a world only science can conjure, a world without borders.

When the new realities of superconductivity pass from research laboratories to private industry in the next few years, there is little doubt that the United States and Japan will lead the rest of the world in commercial exploitation. But separating the efforts of the two, and defining precisely what their leadership actually entails, may prove as difficult then as it is now. The U.S. chemical giant Du Pont Co. employs 180 scientists at a lab in Yokohama, Japan. International Business Machines Corp. has thousands of researchers at facilities in Tokyo and Yamato City. On the flip side, Japan has thousands of graduate students in U.S. universities, sponsors millions of dollars' worth of research at them and puts up still more millions in



SHAHN KERMANI / GAMMA - LIAISON



CHARLIE COLE / PICTURE GROUP

Products of borderless venture capital: First U.S.-made Toyota, under deal with General Motors; IBM Pavilion in Japan

venture capital for American high-tech companies.

New cross-licensing and joint venture agreements between Japanese and U.S. firms are reached at a dizzying pace. General Motors Corp. and Toyota Motor Corp. make cars together in California. Texas Instruments Inc. makes advanced microchips in Japan. U.S. electronics giant Motorola Inc. swapped secrets with Toshiba Corp. late last year.

As more and more high-tech firms implement such strategic alliances," Lenny Siegel, editor of Global Electronics newsletter, says, "competition . . . will be less between the U.S. and Japan and more between transpacific corporate alliances, each containing one or more American and Japanese firms." What's the likeliest scenario for superconducting microchips? Try a mixture of Silicon Valley technology, Japanese manufacturing know-how and international venture capital.

Twenty and 30 years ago it was true that if a government made an investment in research and development, or in the country's scientific base, it could be reasonably sure of reaping the benefits itself. That is no longer true. But this does not mean that in today's global environment individual governments have given up on high-tech policies. In fact — and this is the paradox of the internationalization of science and technology — the demands of the new world economy have made the countries of the developed world pursue their national strategies more aggressively than ever before. Not all of these nationalist strategies will work. Some will simply be the product of reflexive protectionism or of nativistic fears. But there remain, even in a globalized economic environment, legitimate areas of individual government action. Finding those, and striking a balance between national interest and international competitiveness, may well be the principal political challenge of the 1990s.

Why has Tokyo stepped in to coordinate research and commercial activity surrounding the superconductor race? "We are working to assure that all this will not be just a fad," explained Mitsuig Chiba of Japan's Science and Technology Agency. "We want it to be a solid, feet-on-the-ground campaign." Officials in Washington publicly shy away from advocating so bold an exercise in government management. "We have a secret weapon that will overwhelm [the Japanese] process," said William Graham, head of the White House Office of Science and Technology Policy. "We call it the free market. It's far better to let industry make the investment decisions for profits and to let government devote its resources to the basic research and underpinnings."

But Graham's words belie a federal effort as pragmatic and interventionist, in many ways, as Japan's. The U.S. government has $29 million earmarked for superconductor research this year, with much of that going to federal labs and Defense Department offshoots — such as the Defense Advanced Research Projects Agency — which have always worked closely with private industry. In the air in Congress is talk of a special superagency to coordinate industry activity in certain high-tech areas and dole out research money. Frank Press, president of the National Academy of Sciences, expresses a common nationalistic sentiment: "Superconductivity has become the test case of whether the United States has a technological future. That future depends on our ability to commercialize our scientific discoveries. If we lose this battle, it will wound our national morale."

This idea of an affirmative national policy — what Harvard economist Robert Reich calls "technonationalism" — does not always sit easily with the realities of the modern world economy. Reich says that many of the measures suggested and implemented in the past year in behalf of U.S. "competitiveness" actually are unworkable or even absurd in the light of the worldwide diffusion of science and technology.

Suggestions have been made in Congress, for example, to increase federal research and development funding for various scientific and industrial endeavors on the condition that those resources be limited to U.S. engineers, scientists and companies. But what, in the age of the strategic alliance, is an American company? What if a U.S. citizen is working for a Japanese company? In 1984, roughly 2,000 scientists and engineers immigrated to the United States from the developed world. Some of them are in the States only on temporary visas; most are not yet U.S. citizens. Would they qualify?

It makes little sense to base public policy on technonationalism, Reich argues, when our institutions are organized on a global model. Nor is it in America's long-term interest to bar foreigners from the fruits of its research and development. Technology is not a "scarce commodity," Reich says. "Rather than guard our technological breakthroughs, we should learn how better to make use of breakthroughs wherever they occur around the globe."

He has a point, but the fact is that in many cases the United States has little choice but to follow technonationalistic policies. As William Schneider Jr., under secretary of state for security assistance, science and technology, has put it, trade policies "cannot be divorced from our broad political security objectives. . . . Our economic policies must support our key objectives of deterring Soviet adventurism, redressing the military balance between the

West and the Warsaw Pact and strengthening the Western Alliance."

The cost of the U.S. position as the military leader of the West has always been a need to sacrifice economic goals to strategic or national security considerations. Not surprisingly it is the Pentagon, not protectionist businessmen, that has been behind much of Reich's technonationalism. In January the Defense Science Board, a Pentagon task force, released a report titled "Defense Semiconductor Dependency," a worried look at the U.S. semiconductor industry. The task force saw the globalization of the electronics industry as a serious military problem, in that dependence on outside suppliers could threaten Pentagon access to leading-edge technology.

This was not so much of an issue in the early 1960s, for example, when the United States imported only about 5 percent of its gross national product and exported only about 9 percent. But in 1984 those figures were 30 percent and 25 percent respectively, and the Pentagon finds itself dealing with a world technology market increasingly beyond its control. Forty percent of the electronics in U.S. weapons systems comes from Japan, and by the early 1990s, according to some analysts, that figure will top 50 percent. "Ten years from now Japan will have a separate industrial base, one perfectly capable of carrying on without the United States," says Michael Borrus of the Roundtable on the International Economy, a research group at the University of California at Berkeley. "At that point reliance on Japanese technology may not be the best idea for the United States."



CHARLIE COLE / PICTURE GROUP

RICHARD HOWARD / BLACK STAR

Reich says United States should use breakthroughs "wherever they occur."



KEVIN T. GILBERT / INSIGHT

Graham: Benefits of a free market

The Pentagon does not want a global economy that puts U.S. interests at the mercy of its allies' trading policies. The Defense Science Board recommended that the Reagan administration put up $2 billion over five years to prop up certain key areas of the U.S. semiconductor industry. The Strategic Defense Initiative, in addition to its stated goals, also represents a multibillion-dollar attempt by the Defense Department to develop cutting-edge technologies in aerospace and electronics.

But building up a healthy domestic high-tech base is not the only concern of the Defense Department. The task force worried not just about promoting U.S. technology but also making sure such expertise stayed in the country. Why? Because the globalization of high technology makes it easier for the Soviets to obtain products and know-how. And when that happens, the report warned, "The U.S. could lose the considerable margin of advantage it holds over the U.S.S.R. in this critical area of technology — and upon which it relies to offset quantitative military advantages."

Restricting the flow of American expertise overseas, however, is not easy, and after 6½ difficult years the Reagan administration still has not struck a clear balance between national security and technology trade. Take the touchy issue of scientific freedom. Not long ago, the Defense Department seemed to know what it wanted. If scientists engaged in strategically important research or took Defense Department money, they would have to submit to department controls. In April 1985 the Society of Photo-Optical Instrumentation Engineers received word from the Pentagon that 43 of the 219 papers scheduled to be presented at a conference could not be given in open sessions. Three years before that the Defense Department ordered restrictions prompting the withdrawal of 100 papers from a similar conference in San Diego and intimated that more restrictions might be forthcoming. The actions caused a surge of outrage among scientists.

Today the issue has died down somewhat, with the Pentagon apparently respecting the desire of the scientific community that no controls be attached to either basic research or research conducted on a university campus. But the matter is far from settled. "DOD is pretty two-headed on this issue," says Stephen Gould, a project director of the Committee on Scientific Freedom and Responsibility at the American Association for the Advancement of Science in Washington. He points up the distinction in the Pentagon between those whose jobs are concerned with national security policy and those who are charged with advancing scientific and technological programs.

Insiders paint a picture of a Pentagon that talks tough on research controls but shies away from implementing regulations as aggressively as the language would allow. That may represent a victory for the scientists, but its impermanence leaves some of them nervous. And in the meantime the gap between rhetoric and reality has made it difficult for the Pentagon to articulate a position on what many scientists see as the next critical issue: whether, in the name of national security, it is even worth placing restrictions on applied research. One of the inventors of the atom bomb, Edward Teller, for example, has argued that all that is needed to keep U.S. science ahead of the Eastern bloc is to control the opportunity of Soviet scientists and engineers to work side by side with U.S. scientists. Any other method of technology transfer — scientific conferences, academic papers — Teller has said, is of little value to countries playing catch-up.

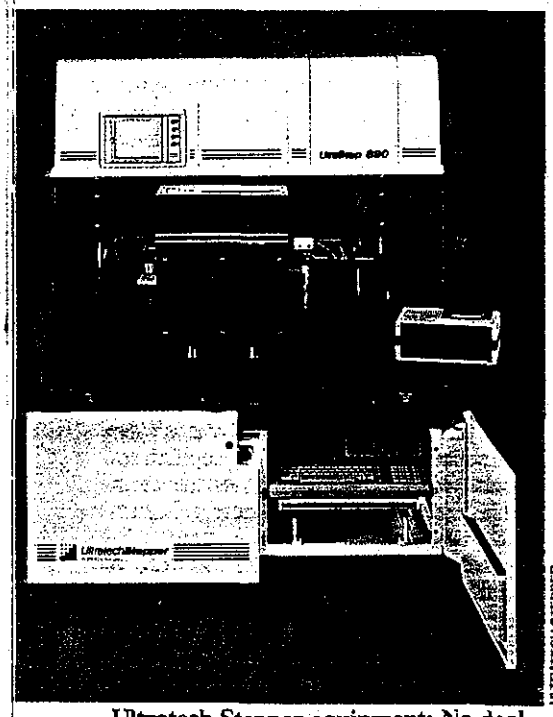


CHUCK NACKE / PICTURE GROUP / FOR INSIGHT

Perrone's company was stymied in sale of semiconductor technology to China.

More serious is the Reagan administration's attempt to control the export of what it deems militarily and strategically significant products and technology. Here the administrative framework is more convoluted. It revolves around two acts of Congress and has been disfigured by a turf war between the departments of Commerce and Defense. Also involved is a clumsy and largely ignored agreement among the major nations of the Western alliance to limit exports to the Eastern bloc.

The economic costs of restrictions are high. In 1985, according to the National Academy of Sciences, in the name of national security, these controls cost the most dynamic high-tech sectors of the U.S. economy some $9 billion in lost sales and 200,000 jobs. The administration wants to inhibit Soviet access to high technology, but there is a growing body of criticism that says the existing export control system in the United States just doesn't work.



ULTRATECH STEPPER

Ultratech Stepper equipment: No deal

"The whole theory of export control is based on a notion that's completely outdated," says Bill Maxwell, director of international issues for the Washington-based Computer and Business Equipment Manufacturers Association. Ten or 15 years ago, forbidding the export of American high tech meant that foreign countries did not get high tech. Today it means they buy it from someone else.

Export controls are supposed to be lifted if it can be proved that the technology in question is readily available elsewhere in the world. But that rarely happens. A blue-ribbon commission appointed by the National Academy of Sciences to study export controls concluded, in a report published earlier this year, that "foreign availability has had virtually no impact on the objective of achieving decontrol." In the past four years, 20 technology areas have been thought to be sufficiently global to be worthy of decontrol. Only three have been dropped from government lists.

This has had a substantial effect on a number of U.S. manufacturers. The Andover, Mass.-based GCA Corp., for example, used to be one of the world leaders in making the sophisticated equipment used in manufacturing semiconductors. But, says economist George Gilder, who is writing a book on the semiconductor industry, "Right at the moment that Nikon and Canon entered the market and Asia became the fastest-growing semiconductor area, GCA was prohibited from selling overseas for national security reasons." The result? The Japanese got a free pass to the world chip equipment market, while GCA was handcuffed. "It was a really unfortunate policy that had no defense justification whatsoever," says Gilder. "The whole thing has been incredibly badly conceived."

The critics of export control do not doubt the national security justification for the program; they just think that the controls are administered unwisely. "Technology moves very rapidly," says Lou Perrone, vice president of the California electronics firm Branson-IPC, "and it's difficult for a government the size and complexity of ours to keep up with it." Perrone's company made a deal to sell a few million dollars' worth of what it felt was obsolete equipment to the People's Republic of China in late 1984. The sale was blocked by the Reagan administration, and Perrone still does not know why.

"If China, or any Eastern bloc country for that matter, came to us for state-of-the-art equipment, I would say forget it. I wouldn't even bother to ask for an export license; I'm not stupid. But here was a logical case of some technology and some capability that had little fundamental use elsewhere in the world, except in parts of the Third World and developing countries." This spring, after more than two years of time-consuming and costly pleading in Washington, parts of the deal were approved.

Ultratech Stepper, another California firm, also made a deal to sell what it thought was obsolete equipment to China two years ago. In its eyes there was no reason to believe that an export license would be denied: U.S. firms had already sold comparable equipment to China; the Chinese could easily get more sophisticated equipment from Hong Kong; and when the Pentagon sent an expert to examine the proposed equipment for export, he agreed that it was obsolete. So why is Ultratech Stepper still waiting for a license? "It's not a technological issue anymore; it's a political issue," says Kay Mascoli, a company spokesman. She charges that the Defense Department did not understand the technological issues and let its national security concerns determine the result.

The experience of Ultratech and Branson-IPC is not typical. The average processing time of an export license in the United States is, according to the Pentagon, one to two months. What does seem to be typical, however, is the role played by the Pentagon in the decision making process. The Export Administration Act of 1979, which governs the export of com-

"Why should we buy controlled American chips that come with all kinds of strings attached when we can buy uncontrolled Japanese chips?"

mercial and military technologies, is supposed to be administered by the Commerce Department. Defense is to act in an advisory capacity.

Richard N. Perle, who was the assistant secretary of defense responsible for the Pentagon's export control policy until he resigned this spring, denies that the Defense Department has encroached on Commerce's authority in this area. He points to a presidential directive, implemented by Defense Secretary Caspar W. Weinberger in 1984, that calls for defense-related technology to be treated as a "valuable limited national security resource, to be husbanded and invested in pursuit of national security objectives."

Jurisdictional issues aside, however, there is little doubt that the effect of Pentagon involvement is to make controls much stricter and the licensing process more complicated than would otherwise be the case. Commerce Secretary Malcolm Baldrige has consistently called for a 30 percent to 40 percent reduction in the number of items on the Pentagon's export control blacklist, which is currently about the size of the Los Angeles phone book. "The whole list needs an overhaul," Baldrige said in March. "It's very easy to add things to that list, but it's very hard to take them off."

The Pentagon's response at the time was firm. "Any loosening at this point would be extremely harmful to national security," explained Stephen D. Bryen, then Perle's deputy. Perle himself has said that the list's comprehensiveness is its strength, not its weakness. As he told Congress in 1984: "We have sought, and believe it makes sense to seek, the greatest possible precision. And precision is attained by having a list that is sometimes excruciating in its detail, because it enables people who have to make judgments on licenses to reference the precise commodity or technology in question. . . . The size of the list, which has frequently been the subject of criticism, is not the relevant measure of effectiveness."

Does the Pentagon really understand the rapidly changing face of American high technology? Boyd McKelvain, who is chairman of the export control blacklist advisory committee, likens the process of defining military criticality to the problem faced by "a Supreme Court justice in defining pornography: 'I can't define it, but I know it when I see it.' "

Commerce and Defense are agreed on basic principles. When former White House science adviser George A. Keyworth III complained that "the Soviets are robbing us blind" on high tech, he spoke for the entire administration. The argument is simply over procedure, and in many ways those problems are being addressed. President Reagan recently directed the National Security Council to study the entire export control system with an eye toward reform. Reform came up again in January's State of the Union address, and the current House omnibus trade bill contains a number of provisions that would liberalize the Export Administration Act. The Pentagon has tried to streamline the licensing process as well. During his tenure at Defense, Perle eliminated the backlog of applications that had piled up in 1981 and beefed up equipment and support staff.

There is no way around the fact that the heightened awareness of national security needs leaves U.S. high technology at a significant disadvantage, however, with respect to Europe and Japan.

Almost all Western nations are supposed to abide by the rules of the Coordinating Committee on Multilateral Export Controls, which governs exports to the Soviet bloc; but, perhaps unsurprisingly, levels of compliance vary widely. The United States takes longer to process licenses, requires more red tape and checks up far more closely than any other major industrialized country.

Says Daryl Hatano, an official at the Semiconductor Industry Association, "Companies are saying, 'Why should we buy controlled American chips that come with all kinds of strings attached, about how they can be used or where the end product can be sold, when we can buy uncontrolled Japanese chips?' " Of the U.S. firms surveyed by the National Academy of Sciences panel, 52 percent reported lost sales because of export controls, 26 percent said they had had deals turned down because of them and 38 percent said existing customers had actually expressed a preference for shifting to non-U.S. sources to avoid controls.

Controls have not been the only sticky wicket in government-industry relations. The government directly funds some 775 research laboratories across the country, employing some 80,000 people (about one-sixth of the nation's scientists and engineers) and gobbling up about half of the annual $123 billion that goes to pure and applied research nationwide. These are the labs that do research on the Strategic Defense Initiative, missile systems, nuclear energy, synthetic fuels or the space program. They lay the scientific groundwork for much of the U.S. public sector's use of advanced technology. But the work they do — publicly funded, much of it unclassified and easily accessible — does almost nothing for the country's broader economic competitiveness. Since the 1950s, only 5



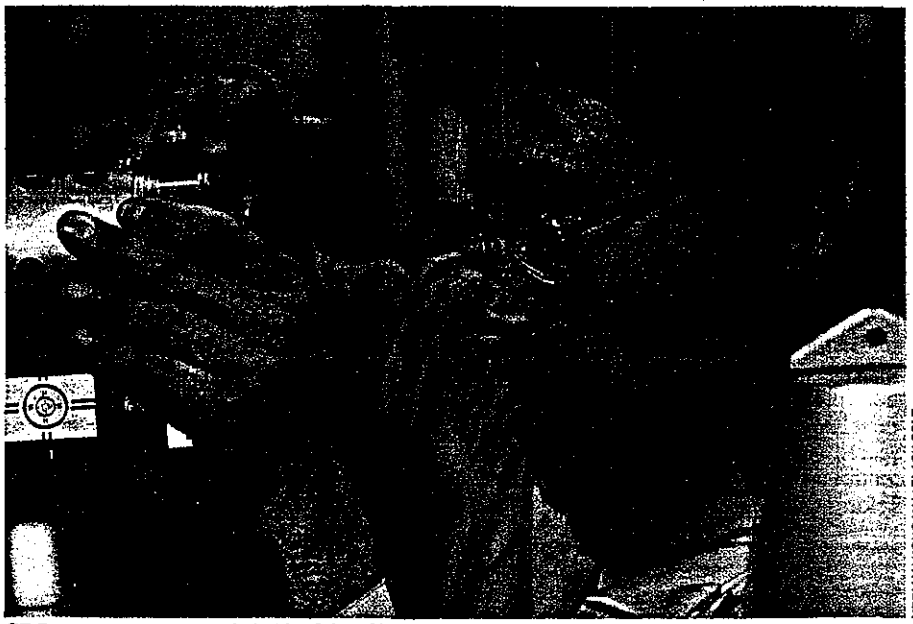
GLEN STUBBE / INSIGHT

Pentagon's Perle kept firm grip on exports, despite objections from Commerce.

Says one observer, "The notion that what government labs do is just all-out wonderful stuff for industry to commercialize on is a pipe dream."

percent of the government's 28,000 patented inventions have been licensed for commercial use.

In recent years, in Congress and the executive branch, this underutilization of federal technology has been ascribed to a lack of coordination between private industry and public labs. In 1980, Congress passed the Stevenson-Wydler Technology Act, which requires the government's larger labs to set up special offices to promote technology transfer. Last year, Congress beefed up the act, making special allowances for cooperative research and development efforts between government and private industry, strengthening individual labs' technology transfer offices, formalizing the creation of a federal laboratory transfer consortium and, most critical, providing government inventors with incentives — including royalties and patent rights, which are unheard-of in most corporate laboratories — to make commercial use of their research.



HERMAN KOKOJAN / BLACK STAR

SDI research: A good deal of funding but few commercially exploited patents

The key word in the new technology transfer vocabulary is communication. Officials at federal labs around the country speak of the importance of networking. Argonne National Laboratory in Illinois uses an electronic mail system to relay information and assistance around the country. Critics of practices from the old days have cited the fact that only the United States among the world's leading industrial nations has no centralized government office to coordinate public sector research with private sector needs. Their views struck a nerve: The past six years have seen the creation and refurbishment of, among other organizations, the Commerce Department's Center for the Utilization of Federal Technology; the National Industrial Technology Board; the private Technology Transfer Society; and two directories, the Guide to Federal Technology Resources and the Directory of Federal Technology Transfer Personnel; not to mention technology transfer operations sponsored by the National Bureau of Standards.

At congressional hearings on technology transfer, the air was thick with definitions, explanations, caveats and analogies, all in the new language of competitiveness. A.T. Brix, president of Battelle Technology International Exchange, warned Congress: "Technology isn't like Campbell's soup. It doesn't come in a nice container, properly bar-coded for easy pricing. It cannot be rendered delicious by merely adding two cans of water and simmering it on the stove." What is it then? "Technology transfer can be more realistically likened to going into a supermarket and finding ingredients for soup interspersed with detergents, bakery goods and pots and pans. In short, here are some herbs, potatoes and onions; now make your own soup."

That culinary challenge is intended primarily for U.S. companies. Indeed, the 1986 law makes it clear that, whenever possible, domestic industry should be given preference in licensing agreements. But, one Senate staffer concedes, there is no way to guarantee that Yankee know-how will go to Yankee companies, and the fact is that the Japanese and West Germans have historically been far more interested in the fruits of U.S. government research than have U.S. companies. "There's nothing illegal in what they're doing," the staffer says. "They're just more aggressive. They appreciate the values of tapping into these resources. What we're doing as a Congress is taking a gamble that by trying to speed up the transfer of technology we'll benefit this country. Whether this will work remains to be seen."

A more serious question, however, is whether improved networking and communications is actually the answer to the technology transfer at all. "The notion that what government labs do is just all-out wonderful stuff for industry to commercialize on is a pipe dream," says Richard Nelson, a professor of international political economy at Columbia University. "A lot of folks in Congress have misconceptions about the way technical change proceeds." Commercial labs and federal labs, the argument goes, do different kinds of research for very good reasons: because commercial labs have tested similar waters and found them wanting, or because government research priorities — especially those having to do with defense — are so specialized as to have little commercial use at all. One of the pioneers of Silicon Valley, Robert Noyce, founder and now vice chairman of Intel Corp., has put it bluntly: "There is no work of interest to commercial industry going on in government laboratories."

If he is right, then the enormous resources devoted to federal research — important as that research is, and however much it contributes to the welfare and security of the country — nevertheless represent a net drain on the economy's productive capacity. The efforts of the recent technology transfer brigade to bring considerations of the national interest into step with the demands of the world economy may, ultimately, prove fruitless. The same is true for export controls. It may be possible to ease the economic burden that restricting Soviet access to Western technology places on American high technology, but as long as U.S. foreign policy objectives coexist with economic considerations, there must be some sacrifice. What is good for General Motors is not always what is good for America. That is truer now than it has ever been. The challenge of the modern world economy is to strike the proper balance.

— Malcolm Gladwell

The British Elite in Exodus: 'We're Losing Our Captains'

SUMMARY: Brain drain, the loss of a nation's elite, is usually a problem for developing countries. But in Britain, it is epidemic. Scientists there face relative salary declines, harsh budget cuts and a government that has been ill-disposed to university research. Public funding is rising finally, and scientific special interest and support groups are springing up. But Britain's brain drain is not likely to end.

Some of the best minds in the world come from Britain, and the better they are the faster they come. Over the past few years, the cream of the nation's academia, thousands of its top scientists and engineers, have left to take high-paying jobs in the United States. Twenty-five percent of the fellows of the Royal Society, the United Kingdom's most prestigious scientific organization, work abroad. All of the Royal Society of Chemistry medals for research last year went to British scientists working in America. "We're losing the top four or five in every field," says one professor at Oxford University. "We're losing our captains."

This is far from the first time brain drain has become an international issue. From the time of the biblical exodus to the group of Jewish scientists and intellectuals (including Albert Einstein, Sigmund Freud and a young Henry A. Kissinger) who fled Nazi Germany in the 1930s, the talented have always been the first to migrate in search of better opportunities. But since the end of World War II, brain drain has primarily been an issue between the developed and the developing worlds, wherever the differences of economic climate and personal opportunity have been greatest. In the industrialized world, the pressure to compete internationally and the push toward high technology have made countries more aware than ever of the importance of keeping the best and the brightest at home. Brain drain, in the West, is a nonissue.

Except in Britain.

More scientists leave the United Kingdom every year than leave the rest of Europe combined, and the brain drain has never been worse. The golden age of British science, between 1950 and 1975, when the Nobel Prizes won for England were legion, is but a memory. In comparison to the rest of the world — from the United States, where fostering high-tech research and promoting competitiveness is all the rage; to West Germany, which spends nearly twice as much per capita on civil research and development as Britain; to France, which coddles its scientific community — Great Britain has been markedly less concerned about the fate of its intellectual resources. In the long term, that may mean trouble for the country in an increasingly competitive and technologically dependent world economy.

In 1981, the Conservative government of Prime Minister Margaret Thatcher cut back government funding for university research. "I think that that first round actually did us some good," says Dick Bishop, president of Brunel University in London. "It made us think more seriously about the research that we were doing. But we thought things would level off by 1984, and they didn't. It's been a slow squeeze. The cuts have begun to hurt."

The percentage of gross national income that Britain spends on research and development has remained virtually unchanged over the past 25 years, even as technological needs have intensified and the cost of research has skyrocketed. Last year the government's Science and Engineering Council, which doles out research money, closed up shop for six months because it ran out of funds. The horror stories of what budget cuts have done to British universities are legion: libraries that cannot afford scientific journals, laboratories that cannot afford to hire technicians. The University of Southampton is so strapped for cash it cannot afford to buy a Macintosh computer for the dean of its mathematics department. Right now he is ninth on the school's waiting list.

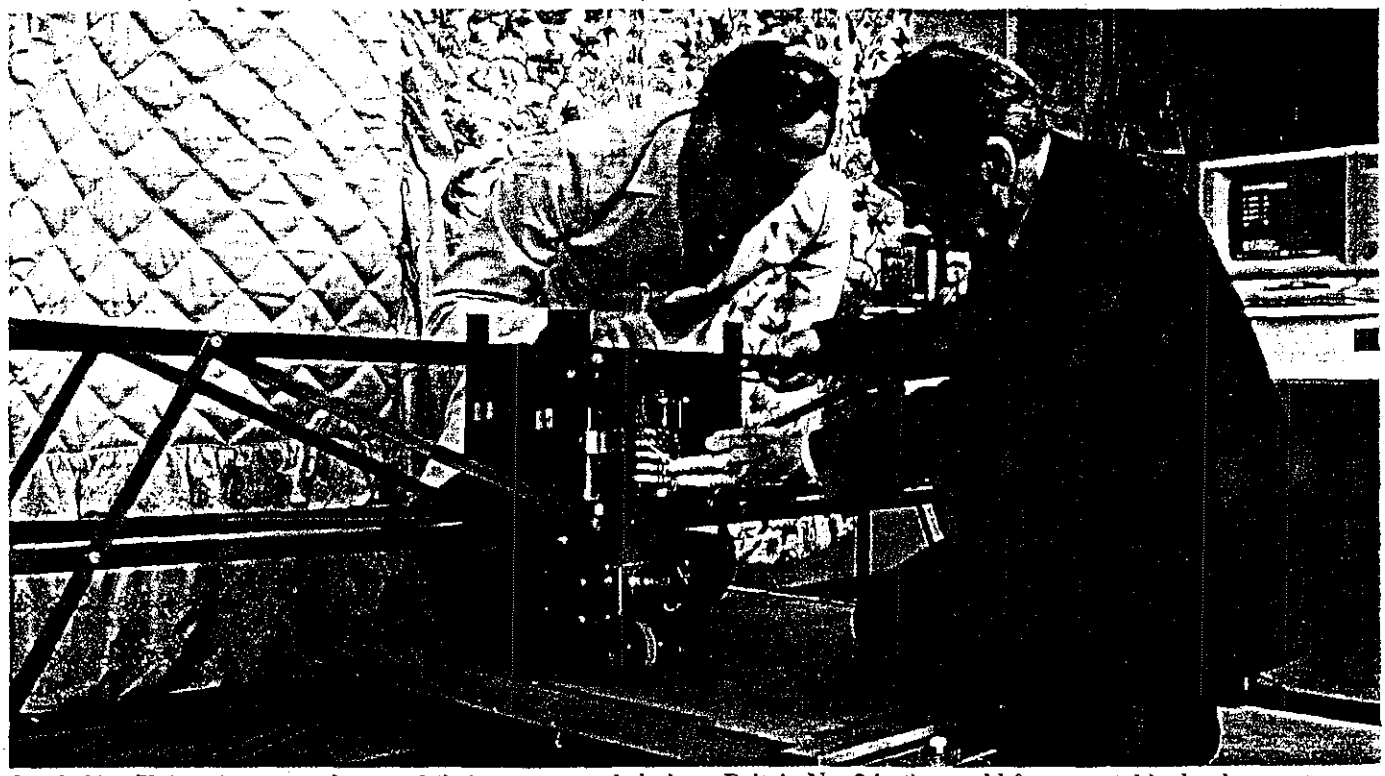
Faced with these frustrations, and salaries that have fallen 12 percent relative to average income since 1980, some of Britain's best are simply going elsewhere. "I don't think I've ever seen the morale of British science so low," says Professor John Ziman, chairman of the recently created Science Policy Support Group.

Those scientists who do not leave face a research climate of increasing uncertainty. Oxford Professor Denis Noble, who heads Save British Science, a recently formed lobby of distinguished scientists and Royal Society fellows, says that what



D. HUDSON / SYGMA

Still in London, hospital scientists study acquired immunodeficiency syndrome.



STUPROCK / NETWORK / JB PICTURES

Cambridge University researchers and their robot may help keep Britain No. 2 in the world for patentable developments.

he calls internal brain drain is as bad as the external kind. He compared U.S. and British grant requests and found that, as a rule, researchers in the United States receive three times as much money from their science council as their British counterparts. "Those that stay have their own intellectual resources drained by a continual process of keeping their research going. In the U.S. the top people are far better-off. It's inconceivable that the equivalent of a Royal Society fellow would find himself in the position of scrambling for money. Yet that's the case in England."

Much first-class work is still being done. The Royal Society recently compared Britain's performance in basic scientific research with that of the rest of the world and found that while the country had slipped from second to fourth in theoretical and experimental physics over the past 10 years, it still led everyone outside the United States in biomedical research and genetics. And the Thatcher government has not been been deaf to the pleas of the scientific community. In February the government agreed to raise academic salaries 24 percent over the next few years. Also, as part of the Tories' preelection promise to raise public spending 1.5 percent this year, the Department of Education and Science is slated to get a 7 percent budget increase and universities an additional $80 million.

But some wonder if these measures will actually solve Britain's problems. The salary increases still leave the nation's universities at a substantial disadvantage when it comes to competing with the $70,000 to $100,000 positions often offered by U.S. schools, and Save British Science estimates that nothing short of a flat-out $180 million research increase will ensure that all worthy projects are adequately funded. Indeed, even if the government has loosened the purse strings somewhat, it continues to defend the original premise behind the spending freeze of the last six years.

Thatcher still says that much of university research is wasteful, supporting what one of her ministers calls scientific "white elephants." The government has long argued that scientific prowess is not necessarily related to economic success. In recent hearings in the House of Lords, Treasury officials cited the fact that Britain's postwar scientific brilliance coincided with the period of the country's greatest economic decline.

By the same token, with science in apparent decline, the economic outlook now is rosier than it has been in years. Economic growth is expected to reach 3 percent this year, higher than most industrialized nations. London's financial markets are the most important in Europe, drawing banks and investors from around the world. After the lean early years of Thatcher's economic program — which saw unemployment triple to 3 million and whole sectors of manufacturing, particularly traditional smokestack industries of northern England and Scotland, collapse — Britain has made impressive strides in developing new, internationally competitive high-tech industries. California has Silicon Valley; England has a silicon crown around London.

Does Britain really need a strong, publicly funded research base? And even if it does, does it matter that that base is moving overseas? "People who migrate from a country don't necessarily disappear from view," points out Jagdish Bhagwati, a trade economist and brain drain expert at the World Bank. "That was the tendency in early brain drain literature. Today we tend to look at a diaspora model. People keep their ethnicity. Communication and return to the home country is much easier now. Smart developing countries also have been facilitating increased participation in their own scientific work of people who have settled abroad." Losing scientists does not necessarily mean losing the fruits of their work.

Even so, commercial high tech in the developed world, and particularly in the United States, historically has tended to grow in clusters around such prominent universities as Stanford in California and the Massachusetts Institute of Technology and Harvard in Cambridge. The proximity of scientists and businesspeople seems to count for something in the chemistry of entrepreneurship. Nor does it follow from the apparent lack of correlation between British scientific achievement and economic success that science should be cut back. "It's a non sequitur," says Ziman. According to the National Science Foundation in Washington, British science trails only the United States in developing patentable technologies. British science isn't wasteful; it's wasted by a commercial industry that, as George Walden, minister responsible for science, readily admits, "is at the top of the league in pay raises and bottom in research."

So why use science as a scapegoat? "I think that our Treasury doesn't have any great sympathy for or understanding of science," says Ziman. "It's part of the two cultures in this country. There are no scientists in the Treasury."

"A top-ranking researcher might enthuse another 30. If you lose people like that you lose the stimulus that others get from interacting with him."

His theme is echoed by other academics, who insist that science has never been properly respected or represented in the United Kingdom. Noble recruited 2,000 prominent British academics for Save British Science because, he says, "there came a point when people began to wonder that what was wrong was that we didn't have what people in America have: a political lobby capable of putting political pressure on the government." The House of Commons has nothing like the U.S. Office of Technology Assessment to keep it abreast of developments in science nor even a standing committee dealing with science and technology. Scientists are conspicuous only by their absence on corporate boards and in positions of political responsibility.

To some extent this is the fault of scientists themselves.

"Bound up in their own self-congratulatory elitism and academic self-importance," says Ros Herman, a prominent British science writer, "scientists have largely lost touch with the rest of society." A recent Royal Society report worrying about the image of science in Britain prompted the formation of an ad hoc Committee on the Public Understanding of Science, drawing from all of Britain's major scientific organizations. Planned are a $750,000 investigation into the way science and technology are perceived by the public and a massive "scientific literacy" campaign in the media next year. Will it work? Nature, Britain's most influential scientific magazine, does not think so. The journal described the report's analysis as "overflattering to the scientific community everywhere" because it refused to address "the convention of self-certitude that has been taken up by academics."

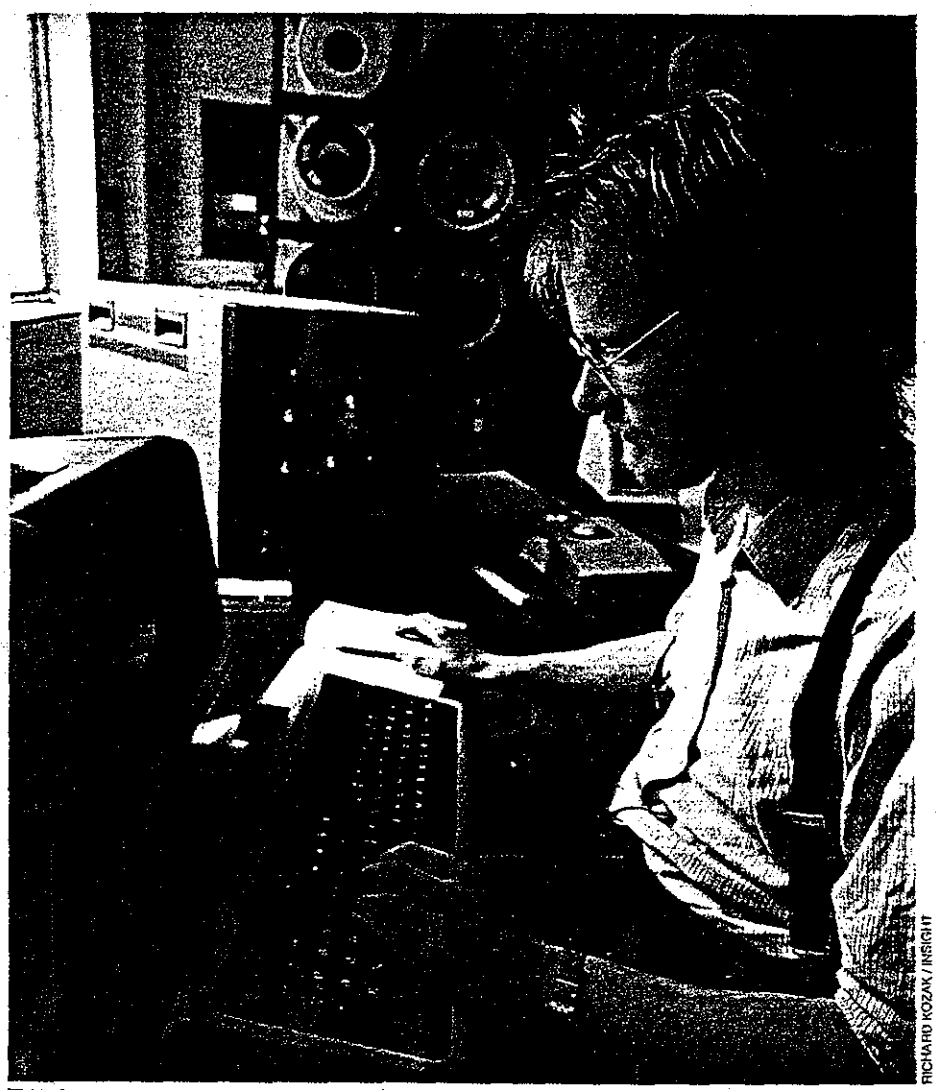
Ultimately, though, the ball is in the government's court, and more support is now its stated goal. For example, Thatcher has said that she would like to see the portion of university research supported by industry rise from its present 2 percent to somewhere in the vicinity of 30 percent. But policies may be lagging behind proclamations. Corporate donations to universities are not tax deductible. Nor has the prime minister changed the tax code to encourage increased commercial research: There are no tax credits for industrial research and development, which most of the country's competitors allow. Even on the critical question of encouraging companies to exploit new technologies, Thatcher's policy has been indifferent. Technology transfer may be a big issue in the United States, but in the United Kingdom the Technology Exchange Center just went bankrupt.

Brain drain is the price that Britain is paying for this. One thousand of its finest leave every year, and although that figure is small compared with the 50,000-odd new scientists and engineers who join the work force in that time, it is the quality of those leaving that counts. "A top-ranking researcher might enthuse another 30," says one professor. "And they in turn might enthuse a few hundred of their students. If you lose people like that you lose the stimulus that others get from interacting with him."

"We are moving from economies that basically deal with materials — iron, steel, coal — to economies driven by information," says Carver A. Mead, one of the prime movers behind the modern microchip. For the U.S. scientist, the intellectual component in any product is increasingly becoming more important than the actual manufacturing process or materials involved. Brains count for more in the high-tech age. Last year Texas Instruments Inc. renegotiated all its patent agreements with Japanese electronics manufacturers, raising the cost of licenses by millions of dollars. "More important than the immediate financial impact of these settlements," company President Jerry R. Junkins said at the time, "may be the general recognition by our industry that intellectual property has considerably greater value than has been recognized in the past."

If he is right, that may mean trouble for Great Britain. "Somehow," says Brunel's Bishop, "the excitement seems to be gone from British science."

— Malcolm Gladwell in London



RICHARD KOZAK / INSIGHT

Edinburgh observatory: Britain slipped internationally in experimental physics.

Williams
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Japanese Launch Bid to Lead the World in Pure Science

But Skeptics Say They Are Too Wedded to Product-Oriented Research

By Stephen Kreider Yoder
Staff Reporter of The Wall Street Journal

KYOTO, Japan—Yoko Naya has it good running a laboratory for Japan's biggest whiskey distiller. Her 26 young researchers, several of them foreigners, enjoy a fat budget and the latest lab equipment in a spotless building nestled in a bamboo grove.

They never have to touch a drop of liquor. "Application isn't our work," Ms. Naya says.

Instead, they do research on such topics as why certain fish are attracted to each other, or how barley roots extract iron from soil and on insects' sex lives. At the Suntory Institute for Bioorganic Research, Ms. Naya says the projects "aren't something that will pay off commercially."



The Suntory Ltd. lab represents the new gospel of creativity in corporate Japan. Japan feels it has caught up in applied research—where researchers have a commercial product or process in mind—and desperately wants to take a lead in pure science. Dozens of companies, from electronics giants to steelmakers to food companies, are staking millions of dollars to set up basic-research labs. The government, too, has pitched in with showy programs to encourage basic research.

'Seeding' Future Industries

The call to science stems not from curiosity about nature but from a deep and growing fear that Japanese industry will run out of steam without its own scientific "seeds" to feed future industries. Genya Chiba, a manager at the government's Research Development Corp. of Japan, says Japanese companies have mastered research aimed at creating commercial products and now "discover they are at the end of the road."

Government and industry leaders voice growing anxiety over where the ideas for Japan's next bonanza industries will come from. Not only is the West refusing to give away its best technologies as freely as before, they say, there are fewer of those technologies to draw from.

"America has been our pacemaker," says Hisatoshi Goshima, an executive manager at Nippon Telegraph & Telephone Corp., or NTT, Japan's largest company. "That pacemaker is harder and harder to see."

The solution: "If we train more researchers and inject more money, we will decisively leapfrog into a top world position," says Prime Minister Yasuhiro Nakasone in his party newspaper. At the Venice summit next week, Mr. Nakasone will plug a multibillion-dollar Japanese biotechnology-research program.

Grave Doubts Remain

But while prophets trumpet a new age of creativity in which Japan becomes the world's supplier of basic science, grave doubts remain that Japan can make the leap. The boom is a passing fad, skeptics say, doomed by risk-shy managers and economic factors such as the strong yen. And much basic research in Japan is stifled by a calcified bureaucracy, poorly equipped universities and a conservative education system that hampers free-thinkers.

"There is still a major gap in the mentality between our researchers" and those in the West, says Hisashi Shinto, president of NTT. The Japanese "move on others' findings so that they won't make mistakes. They've fallen into a trap."

Research managers like Eiichi Maruyama want to change that. Mr. Maruyama oversees Hitachi Ltd.'s Advanced Research Laboratory, opened in 1985 in a wooded oasis outside Tokyo.

In a room full of tubes and beakers, a geneticist pores over thousands of tiny plants in glass vials. Down the hall, a researcher is developing a computer model of human thinking, a task he expects will take decades. Soon they and 80 others will move to a new seven billion-yen ($50 million) lab in a quiet suburb far from Hitachi headquarters. The lab doesn't take orders from product planners; researchers choose their own themes. "We want to value the individual researcher's personality to let him be creative," says Mr. Maruyama.

Until now, Japan dismissed basic research as too risky and too expensive. For every promising scientific discovery, thousands more don't make it out of the lab. But Western industrialists say Japan has come too far on borrowed science. "Japan isn't performing its fair share of the basic, scientific research which adds to the world's store of knowledge," says William C. Norris, chairman-emeritus of Control Data Corp.

Research Risks

Hitachi's Mr. Maruyama agrees. "Now we're rich, and we have to take the responsibility of being rich," he says. "That means not simply making products but contributing to science. We have to take on the risks of investing in research that has uncertain results."

That mood has been growing since the early 1980s, when creativity became a catchword among Japanese opinion leaders. NEC Corp. has set up a basic-research lab where newly hired scientists study, among other things, the nervous system of microscopic worms. Toshiba Corp. plans to boost basic-research spending to 20% of its research budget within five years, up from 10% now and nearly zero in 1983.

Kobe Steel Ltd. has a new biotechnology lab. Toyota Motor Corp. does biomedical studies at its research subsidiary. Ajinomoto Co., a food-products company, opened a basic research lab in February. By one estimate, more than 30 major companies have set up basic-research labs in the past five years.

A recent survey indicates that corporate research expenditures in the life sciences jumped 16% to 429 billion yen ($3.05 billion) in 1985, the largest rise in the survey's history. And manufacturers are starting to woo more theorists. One-fourth of the doctoral-degree graduates in theoretical physics at the University of Tokyo between 1981 and 1985 took posts in corporate labs. "In 1970, no one would touch them," says Steve Yamamoto, a physics professor at the university.

Government bureaucrats have eagerly joined the fray. The Ministry of International Trade and Industry, or MITI, started promoting basic research in 1984. The education ministry boasts a new high-energy particle accelerator. The science agency gives $10 million grants to senior researchers.

Nakasone's Pet Project

Then there is Mr. Nakasone's pet project, the Human Frontiers Science Program. The plan is to bring together the world's scientists to unlock the secrets of biology—to determine how organisms convert energy into motion, for example, or the mechanisms behind such mental functions as creativity, memory and recognition. MITI officials have spent the past year garnering international support for the program, which, by an early MITI estimate, will cost one trillion yen over 20 years.

Japan is indebted to the West, says Mr. Nakasone. "We now need to repay the favor."

But Japanese companies still must tap the West for research talent. Some, like Ohtsuka Pharmaceutical Co., have opened research institutes in the U.S. Others give huge grants to U.S. universities to tap into their research.

Still others import Western-educated scientists. A law passed last year lets government labs hire foreigners. Hitachi plans to hire foreign scientists for 20% of the 250 posts its lab will have by 1990.

When Suntory's managing director, Teruhisa Noguchi, shifted the Suntory bioorganic lab from liquor-related research in 1979, he hired as the lab's manager Koji Nakanishi, a professor at New York's Columbia University. Eight foreign researchers now work there. To staff a new biomedical lab next door, Mr. Noguchi pulled 10 researchers from overseas labs.

Japan Moves to Hasten Public-Works Spending

A Wall Street Journal News Roundup

The Japanese government, as part of its effort to spur economic growth, decided at a cabinet meeting yesterday to initiate in the fiscal first half 80.1% of the public-works budget for the year that began April 1.

Yesterday's decision, which had been expected, followed last Friday's approval by the government of a package of spending, largely for public works, and tax cuts totaling six trillion yen ($42 billion).

The yen's strength has made Japanese products more expensive on overseas markets, hurting the country's export-driven economy. Japan also has been under pressure from its trading partners, particularly the U.S., to stimulate its economy in order to encourage the purchase of imports and narrow its trade surplus.

Japan's trading partners also have been pushing for greater access to the country's markets. Yesterday, British Chancellor of the Exchequer Nigel Lawson said "satisfactory progress has been made" in talks with Japan on trade in financial services.

Mr. Lawson said a review of the talks in Japan shortly "is likely to lead to the outcome we wish," namely, that three British investment banks will gain membership on the Tokyo Stock Exchange. Formal notice of the decision to admit those firms is expected by the end of the year, and the firms should become members when the exchange expands in 1988.

Officials of the major industrialized nations will meet at an economic summit that begins Monday.

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