What's All This About Japanese Technology Policy?

Gary R. Saxonhouse

The specter of what appears to be the successful promotion by the Japanese government of high-technology industries haunts the leaders of advanced industrialized economies elsewhere. Just how this successful promotion is accomplished, however, remains something of a mystery—even, it seems, to policymakers in the Japanese government. The fear that Japan, through government action, may be acquiring for itself the best high-tech tickets to prosperity in the twenty-first century, combined with a paucity of knowledge as to what Japan has actually done, has led to an extraordinary range of policies being considered in other advanced industrialized economies in supposed emulation of Japanese practice.

Technology Policy as Fiscal Support

While vast new government subsidies for technology promotion are often proposed to meet the challenge of Japanese competition, it is striking just how little the Japanese government actually spends on this objective. As seen in Figure 1, there is little difference between Japan, Germany, and the United States in research and development (R&D) spending as a proportion of gross national product (GNP). At the same time, it's clear from Figure 2 that the Japanese *government* is unique among the governments of such countries in how little it spends as a proportion of GNP on R&D. This is not just the consequence of extremely large American and Western European expenditures on defense R&D, as is often alleged. As can also be seen from Figure 2, even when these expenditures are removed, the Japanese government's spending on R&D as a proportion of GNP still remains well below the spending of all the other advanced industrialized economies save the United Kingdom.

Only a very small proportion of what little spending the Japanese government does is directly related to industrial development. In 1989, the last year for which such data are available, the Japanese government spent no more than 0.03 percent of GNP on R&D whose objective was to promote industrial development. By contrast, the Japanese government spent nearly five times as much promoting the development of alternative energy sources. It may be recalled that a decade and a half ago the U.S. government was heavily—and ultimately unsuccessfully—engaged in that same area.

Since Japanese R&D spending is comparatively large as a percentage of GNP, while Japanese government support of R&D is com-

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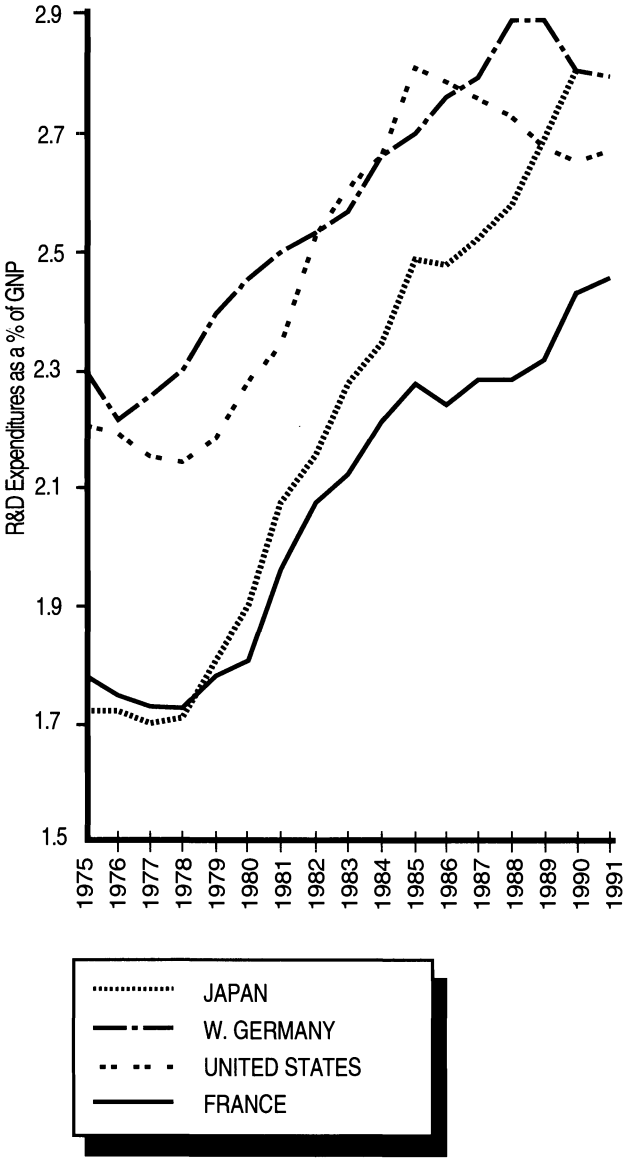
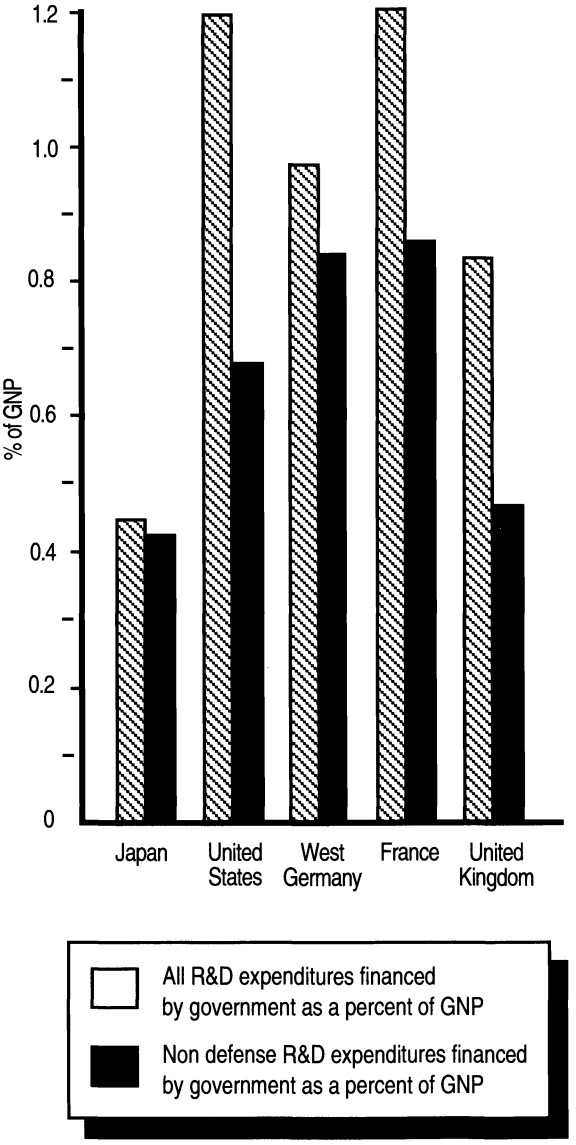
FIGURE 1: R&D EXPENDITURES AS A PERCENT OF GNP



Source: OECD.

FIGURE 2: R&D EXPENDITURES FINANCED BY GOVERNMENT



Source: OECD; Japanese, U.S. and French data are for 1989; United Kingdom data are for 1990.

paratively small, it's not much of a surprise that the Japanese government's direct support of private enterprise R&D is small by comparison with the private enterprise support given by the governments of other advanced industrialized economies. Indeed, virtually all private enterprise R&D is financed by the private sector in Japan. Less than 2 percent is financed by the Japanese government. By marked contrast, as much as 28.4 percent of total private enterprise R&D in the United States and 22.3 percent of non-defense private enterprise R&D is financed by the U.S. government. The American experience is not unusual. In no other major industrialized country is the government as fiscally uninvolved in the support of private enterprise

R&D as in Japan.

What's true for Japanese government spending policy also is true for Japanese government tax policy. For the better part of two decades, Japan's tax policy has been more concerned with removing distortions between sectors than with giving help to any particular sector. The effective corporate income tax rate across Japanese sectors is remarkably uniform. While during the 1950s and 1960s tax-free reserves and expanded accelerated depreciation were widely used by the Japanese government to promote industrial development, by 1982 their role was clearly marginal. Indeed, to the extent that those fiscal devices were used at all, in the 1980s they were used not to differentiate tax rates across sectors, but to harmonize them. Today there is only minor variation in the effective tax rates across Japanese manufacturing sectors.

Notwithstanding an increasingly passive tax policy, high-technology sectors do benefit from a variety of tax credits and special depreciation allowances in the Japanese tax code. Those incentives, however, appear to be modest by comparison with the incentives given to stimulate high-technology sectors in other major industrialized economies, particularly the United States. For example, both the United States and Japanese tax codes maintain a tax credit for encouraging increased private sector R&D expenditures. The U.S. tax credit, however, appears more generous than its Japanese counterpart. The U.S. R&D tax credit is both absolutely larger and larger as a percentage of R&D expenditures than its Japanese counterpart. With $2.3 billion in tax credits on $153 billion in R&D expenditures, the U.S. tax credit is better than double the Japanese tax credit in absolute terms and 45 percent larger as a proportion of R&D expenditures.

If *keiretsu* members are supposed to be conspiring with one another, they have to know the identity of their fellow conspirators. This may not be easy. Definitions of *keiretsu* vary so widely it is often difficult to know who is inside and who is outside.

The provisions of the Japanese tax code helpful to particular high-tech industries convey benefits that are extremely modest. For example, for many years much has been made of a provision in the Japanese tax code that encourages Japanese computer manufacturers to sell their computers to a government-sponsored leasing company with the proviso that those computers be repurchased at some later date. To facilitate this arrangement, computer manufacturers are allowed to anticipate losses in revenue from repurchases and to deduct them from current tax liabilities. At their maximum fiscal impact, however, in the mid-1980s, tax write-offs for the repurchase of computers were equal to no more than 0.66 percent of the revenue from computer sales by Japanese firms.

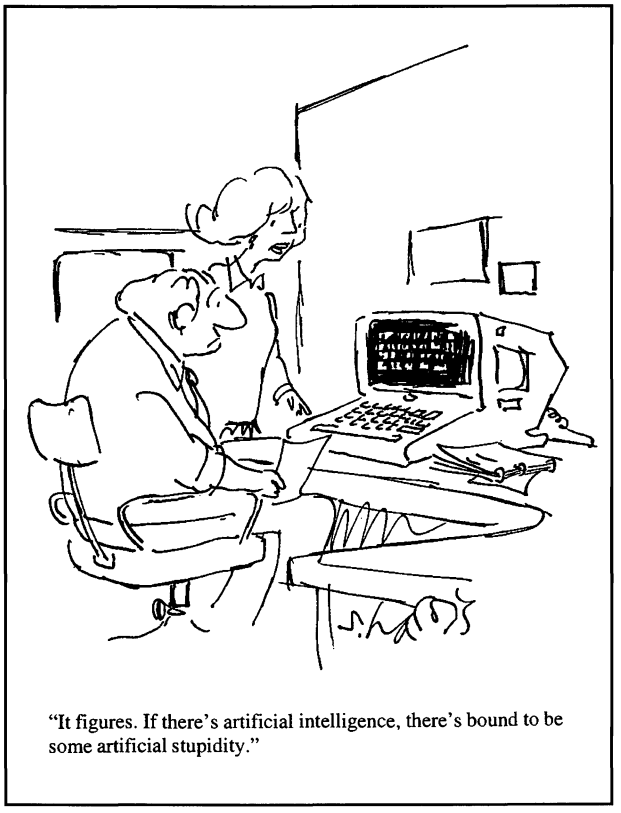
Technology Policy as Trade Policy

It is possible that a policy instrument by policy instrument survey of the pecuniary incentives provided by the Japanese government for technology promotion may miss the forest for the trees. For example, it may be that it is the Japanese government's trade policy that is really important for promoting technological development. Protecting Japanese companies from foreign competition, and not direct fiscal help, might be the way the Japanese government grows new industries. Note, however, that while agriculture is largely exempt from the Japanese government's regime of negligible tariffs and quotas, Japan's high-tech industries are not so favored. Tariffs and quotas for such industries, where they existed, were largely phased out decades ago. Given Japan's industrial and business structure, however, it is widely suggested that the Japanese government can afford Japan's high-tech industry protection through other means. In particular, Japan's firm group or *keiretsu* economic structure may give the Japanese government the means to informally grant protection to promising new industries even while observing the letter of its commitments under the General Agreement on Tariffs and Trade (GATT). Widespread horizontal and vertical long-term relationships among Japanese banks, firms, and distributors, when combined with a heavily regulated distribution industry that makes entry difficult, may facilitate the kind of collusion that could keep out high-tech imports.

Does such government-tolerated collusion in the interest of high-technology protection actually take place? Novels such as the notorious *Rising Sun* by Michael Crichton which place Japanese *keiretsu* at the center of vast conspiracies misunderstand the role such groups play within the Japanese economy. If *keiretsu* members are supposed to be conspiring with one another, they have to know the identity of their fellow conspirators. This may not be easy. Definitions of *keiretsu* vary so widely it is often difficult to know who is inside and who is outside. For example, depending on which definition is used, anywhere from 9.4 percent to 79 percent of all manufacturing firms listed on the Tokyo Stock Exchange are *keiretsu*-affiliated. Similarly, estimates of sales volume by *keiretsu* members can be as low as 40 percent of the sales volume by firms on the Tokyo Stock Exchange by one definition, or as high as 94 percent by another. More generally, with one exception, none of the most common definitions of *keiretsu* result in membership lists that correlate with each other at a rate of more than 32 percent. Quite apart from arbitrary classification, Japanese firms do change whatever affiliation they may have far more than is generally believed. Surprisingly, between the mid-1970s and the early 1980s no less than 25 percent of all the firms listed with the Tokyo Stock Exchange changed their main bank affiliation.

Even if *keiretsu* affiliations were crystal clear, what evidence is there that high-technology imports are being unfairly kept out of the Japanese domestic market? There is certainly no shortage of complaints regarding access to the Japanese market. Note, however, that the tales of Japan's unfair trade practices are not necessarily random drawings from the universe of foreign experience in Japan. Indeed, there is every reason to suspect that many of these anecdotes are non-randomly selected from what may be an entirely normal distribution of foreign experience. As James Bovard has shown in his book *The Fair Trade Fraud*, an endless store of anecdotes about unfair trade practices can be told about many countries, not the least of which is the United States. The non-Japan stock of such stories is just beginning to be mined.

Persistent complaints of unfair treatment can best be corroborated with aggregate evidence. American high-tech industries argue that their products have only a small share of the Japanese market despite their global competitiveness. For example, despite the recent upsurge in Japanese purchases of foreign manufactured semiconductors, U.S. trade officials continue to argue that the Japanese semiconductor market is closed because the 80 percent share of the domestic market held by Japanese manufacturers is well above their 40 percent share of the global market. This argument has been applied not just to the semiconductor industry, but to many other high-tech industries where foreign businessmen feel they have been unfairly treated.

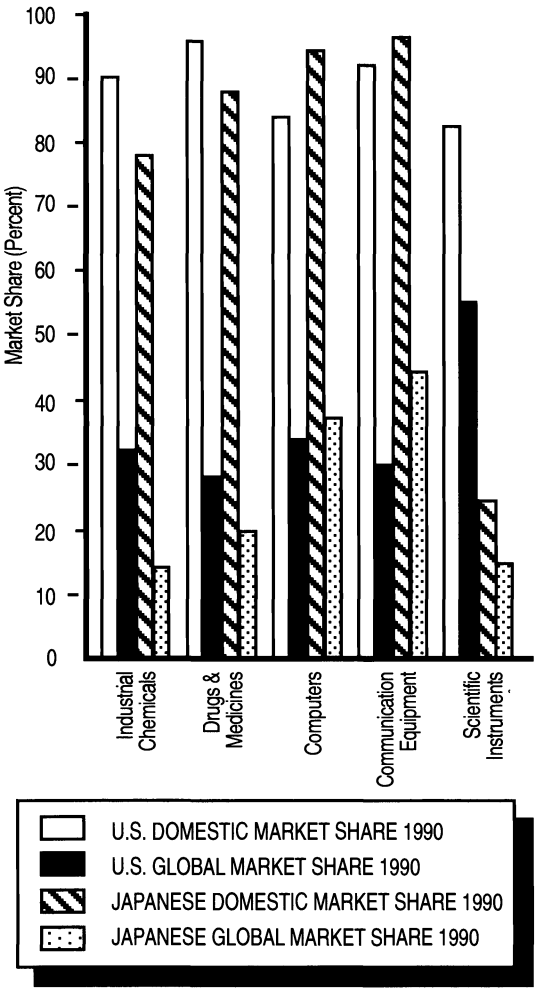


"It figures. If there's artificial intelligence, there's bound to be some artificial stupidity."

If a wide disparity between domestic market share and global market share is evidence of a closed Japanese semiconductor market, then it appears the American semiconductor market is also closed.

Such market share evidence is far less compelling than might be glibly assumed. Exactly like their Japanese counterparts, American semiconductor manufacturers also have 80 percent of their domestic market but only 40 percent of the global market. If a wide disparity between domestic mar-

FIGURE 3: DOMESTIC MARKET SHARE AND GLOBAL MARKET SHARE FOR HI-TECH INDUSTRIES



Source: NSF.

ket share and global market share is evidence of a closed Japanese semiconductor market, then it appears the American semiconductor market is also closed. As seen from Figure 3, this is true not just for semiconductors but for all America's leading high-tech industries. There is a rather similar wide disparity between domestic market share and global market share for high-technology industries in both the United States and Japan. If there is aggregate evidence that the Japanese market for high-tech industries is distinctively closed, it remains to be found. Differences between domestic market share and global market share are hardly conclusive evidence for the existence of significant import trade barriers. Such differences can be explained on many other grounds, not the least of which might be discriminatory barriers against Japanese products in overseas markets.

Technology Policy as Signaling

It's possible that the Japanese government encourages high-tech industries not by protecting them from foreign competition but by signaling Japan's financial system that particular areas are unusually promising and worthy of support. Perhaps it is not the total amount and terms of government aid that is important, but rather that such aid is given at all.

Why might Japan's private financial system respond to such a signal from the government? Indeed, how is it that the government has the information to do any sort of signaling at all? For the Japan of the 1950s, 1960s, and even the 1970s, such questions are easily answered. A signal from the government compensated for the information that might otherwise be provided by freely functioning capital markets. With Japan's financial system highly concentrated and heavily regulated, its equity markets played too marginal a role in the allocation of resources to serve as the ultimate arbiter of future prospects.

High concentration and heavy regulation, particularly of entry, provided a framework within which the Japanese government, through the financial system, could influence the allocation of resources. High concentration of capital made a government presence not only possible, but necessary. Moreover, as long as Japan was far from the global economy's technological frontier, fathoming what structural change the Japanese economy required was not difficult. At the same time, however, the complicated pressures of intra-*keiretsu* or bank group politics often meant that in the absence of government pressure, a socially suboptimal allocation of resources might easily result. Without government pressure, it was too easy for established industries to divert badly needed resources from emerging industries.

The institutions of Japan of the 1950s, 1960s, and 1970s which allowed the Japanese government to work through Japan's private financial system to shape Japan's industrial structure no longer exist today. Since the late 1970s, continu-

ing financial deregulation has allowed Japanese firms to draw on far more diverse sources of finance, both domestic and overseas, than had once been the case. Between the late 1970s and the late 1980s the sources of Japanese corporate finance changed markedly. Once bank loans had dominated all other forms of external finance. By the late 1980s, however, equity and equity-linked corporate bonds had surged to such an extent that bank loans were reduced to a secondary role. Small wonder that the bank *keiretsu* of today seem loosely organized or even amorphous.

Today's Japanese firms seeking to promote new industries no longer need the Japanese government as an ally to force a main bank to turn on its financial spigot. The problems that Japan's equity market have faced in the 1990s notwithstanding, sources of finance remain so varied that a Japanese company seeking help may not look to its nominal main bank at all. The same deregulation that removes the need for the government to intervene removes the means by which the government *might* intervene. The Japanese banking system, now forced to compete with many other financial institutions both at home and abroad and burdened with a staggering overhang of loans gone bad, is no longer fit to shape Japan's industrial structure.

Technology Policy as Coordination

Cues from the government may also be taken less seriously by the private sector than before because of the highly uncertain environment within which the Japanese economy now operates. With Japan at the technological frontier, unlike the 1950s, 1960s, and 1970s, the precise direction structural change should follow is by no means clear. And there's certainly little reason to believe that the government might be better informed on which way to go than the private sector.

The best illustration of the difficulties the government has faced is the various R&D consortia organized by the Ministry of International Trade and Industry (MITI) in the 1980s and 1990s. Such consortia were once seen as a crucial instrument of government policy. At the peak of their importance and influence, projects such as MITI's celebrated Very Large Scale Integration (VLSI) semiconductor consortia were viewed as playing a critical role in helping diverse Japanese companies coordinate their research. It was said that duplication of effort was avoided and information that might otherwise have been considered proprietary was shared. Once again, such critical government intervention was accomplished with relatively minor fiscal support. For example, MITI's contribution to the VLSI consortia accounted for no more than 3 percent of electronics and communications R&D expenditures during the years the project was in operation.

Whether such projects, even in their heyday, really played a critical role in Japan's technological development is a matter of considerable debate. For example, the VLSI project is one of the very few examples of a government-sponsored joint R&D project that actually had a joint laboratory. In the vast majority of the joint R&D projects, separate laboratories were set up by participating companies and research results merely exchanged. Simply receiving such results was not really of much practical use to participating companies unless they too had research teams working in the same area as the company transmitting the results. Under such circumstances, whether much duplication of effort was avoided by the joint R&D projects is debatable.

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Even in the few cases where joint laboratories were set up, surprisingly little collaborative research among scientists and engineers from different companies actually occurred. For example, in the VLSI projects participating companies refused to allow key elements of the project to be jointly researched in a common laboratory. Toshiba, Hitachi, and Fujitsu each wanted to work separately on the electron beam equipment which writes integrated circuits directly onto a silicon wafer. Each company insisted upon and ultimately got the VLSI project to fund company electron beam equipment laboratories. This pattern was repeated in tech-

nology after technology, so much so that only some 10 to 15 percent of the VLSI project budget was spent on joint laboratories.

Though the VLSI joint laboratories were left to concentrate mostly on basic research, this still did not insure that much cooperation among participating firms actually occurred. Only a small part of the VLSI budget spent supporting the joint laboratories actually supported joint research. Of the patents issued from the VLSI joint laboratories, only some 8 to 12 percent were for research jointly performed by members of different companies. Despite very limited collaboration among researchers from different companies, the record of the VLSI project is actually much better than that of other MITI projects during the 1960s and 1970s. For example, neither the Pattern Information Processing Systems project of the 1970s nor the High Performance Computers project of the 1960s could mount a joint laboratory at all, or produce a single patent based on joint research between different companies.

Whether or not there was much joint research and whether or not much duplication of effort was avoided, at least the R&D consortia of the 1960s and 1970s were associated with, if not absolutely necessary for, successful outcomes. The High Performance Computer project, for example, allowed Japanese manufacturers to make sophisticated computers for the first time. Following the VLSI project, the Japanese were producing world-class VLSI computer chips. In the 1980s and 1990s, however, the MITI-sponsored R&D consortia have fared poorly by almost any standards. In project after project, the government has seriously misread technological trends or has otherwise sponsored activities with unrealistic and overly ambitious goals. Those problems have been compounded by the increasing difficulties MITI has faced in maintaining even a semblance of its role as a coordinator of critically important private sector R&D activities. The companies that MITI wishes to involve in its R&D consortia are invariably large corporations that in the 1980s and 1990s have a global reach not only in their sales, but also in their manufacturing and R&D capabilities. Such companies are still more reluctant than they had been in the past to risk the loss of critical proprietary information that might result from participation in a joint R&D project.

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The Fifth Generation Computer project provides some of the best known examples of the vicissitudes of government-sponsored joint projects of the past decade. Created over the strong objections of Japan's computer manufacturers, the Fifth Generation Computer project sought to change the traditional structure of computer architecture. It was planned that older von Neumann computer architecture that processed information sequentially would be replaced by a new distinctive Japanese approach allowing parallel processing of data. The Fifth Generation project was intended to provide for a great Japanese leap forward not only in computers, but also in computer software. The inference capabilities of this powerful new approach would be harnessed by the development in Japan of a hitherto obscure but powerful French-invented programming language called PROLOG. It was hoped that the great increases in speed permitted by parallel processing when harnessed with the logical calculus and extremely rapid theorem proving capabilities of PROLOG would allow a Japanese breakthrough in Artificial Intelligence. In particular, it was hoped that the Fifth Generation computers would self-generate software for new applications. With one well-targeted stroke, the competitive disadvantage of Japan's software industry might be eliminated.

The reaction of Japan's computer manufacturers to the Fifth Generation project concept was highly negative. If there was to be a MITI-sponsored project, computer manufacturers hoped for something that would support their efforts to develop technologies and products for newly emerging markets in personal computers. Japan's computer manufacturers were loath to have precious human resources siphoned off for years into what was believed to be a largely academic project with a highly uncertain outcome. To be at all successful, the 10-year-old Fifth

Generation project might well require a disproportionate number of Japan's extremely scarce corporate-affiliated computer scientists.

Even if it made sense for MITI to boldly seek a vast step forward in computer technology, the particular approach MITI ultimately authorized was widely criticized in corporate Japan. If the central focus of the Fifth Generation was Artificial Intelligence, the emphasis on great speed in making inferential steps seemed unnecessary. Similarly, while using PROLOG as the programming language for the Fifth Generation project might save on computer scientists, it would do so at the cost of using what basically would be an uncontrollable process of inference making.

An Artificial Intelligence with such weak user interface was thought unlikely to have many practical applications. In light of such criticisms, it is hardly surprising that while Japan's major computer manufacturers ultimately succumbed to MITI pressure to participate in this project, unlike the VLSI project, they refused to contribute a single yen to finance it.

The results of the decade-long Fifth Generation project show that Japanese private sector skepticism was well merited. Japan's computer manufacturers had accurately forecast the trends in their industry for the 1980s and 1990s. The leading edge of the computer industry as promoted by American innovation was miniaturization, ease of user interface, and specific dedication. To the extent that Japanese manufacturers were able to keep up with these extraordinary changes in their industry, they did it without the help of MITI.

While a continuing stream of innovation was changing the global computer industry, MITI remained wedded to its original Fifth Generation concepts. In the absence of corporate funding and remote from market pressure, the Fifth Generation project's bureaucratic leaders were too insulated to acknowledge mistakes and dramatically change course. At the end of the decade as at the beginning, the Fifth Generation project was still preoccupied with improving inferential speed and logic programming for Artificial Intelligence. Large numbers of computers embodying the fruits of Fifth Generation research were built, but all were highly experimental in character and provided little the private sector could readily build upon. Even the experimental machines met none of the goals originally professed for the Fifth Generation project. When first announced, MITI's joint project envisioned computers with Artificial Intelligence that could understand human speech about sophisticated subjects and that could translate back and forth between Japanese and English. The Fifth Generation did make some software advances and some minor computer hardware advances, but came nowhere close to achieving what was promised.

The travails of the Fifth Generation project also reflected the continuing difficulties Japanese firms and even Japanese government agencies faced in trying to work on joint R&D projects. From the first, Japanese computer manufacturers derided the Fifth Generation project as something better suited for university professors, yet no Japanese university professor of any stature ever participated directly in the project. In the United States, there is criticism that too often there may be altogether too intimate a relationship between government funding, basic research in universities, and corporate applications (such as in biotechnology). By contrast, in Japan such links are tenuous. The Ministry of Education discourages faculty and researchers at Japan's elite publicly funded institutions from working on projects that it does not fund. This is true both of corporate projects and of projects funded by other Japanese government agencies. Given the great scientific and technological leaps forward envisioned by the Fifth Generation project and the paucity of well-trained computer scientists in Japan, MITI wanted many university professors as key participants in the project. Their efforts were rebuffed by the Ministry of Education. The Ministry of Education's view was similar to that of Japan's computer manufacturers: the Fifth Generation project was an academic endeavor

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that ought to be managed by the Ministry of Education.

That Japanese companies complained about the impractical character of the Fifth Generation project did not mean they could therefore easily participate without fear of giving some advantage to their competitors. For example, while there was cooperation in the Fifth Generation's joint laboratory on some basic research, when it came time to build an experimental computer, each company insisted on building their machines separately. Considerable duplication of effort, which should have been avoided, resulted. Worse still, along with differences in hardware came differences in software. The Fifth Generation project resulted in each participating computer manufacturer having its own experimental machine with its own distinctive software, and the hardware and software were both incompatible across companies. Finally, as in the VLSI project, while there was some cooperation among companies in a joint laboratory setting, there were very few patents resulting from research jointly conducted by scientists and engineers from different companies.

Conclusion

The Fifth Generation project's experience is not atypical for government-sponsored joint research in the 1980s and 1990s. TRON, MITI's effort to leapfrog ahead of Intel and Motorola in microprocessors, and MITI's supercomputer project are just two other examples of government misreading of future technological trends. The Japanese government continues to search for a successful technology policy suitable to the 1980s and 1990s. The Japanese government is no longer, if it ever was, a major source of support for the development of new technologies. Nor is there evidence that it directly protects emerging industries and technologies through its trade policy. Where once the Japanese government signaled the private sector about the direction incremental investment might take, with financial deregulation and technological maturity, this role is no longer either possible or necessary. The same technological maturity that makes signaling to the private sector so difficult has made even a coordinating role for the Japanese government troublesome. The Japanese government's technology policy in the 1980s and 1990s is strewn with failure. Where the government's search for a new role will lead is anyone's guess.

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