CHAPTER 10

# National Industrial Policies

# Contents



## List of Tables

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## Overview

Government policies directly and indirectly affect the international competitiveness of industrial sectors. The impacts can be positive or negative, tangible or intangible; they may fall on domestic firms or foreign enterprises. The American electronics industry has claimed that the policies of the U.S. Government sometimes damage its competitiveness, while foreign industrial policies—particularly those of Japan–also place it at a disadvantage. This is a familiar argument: many U.S. business leaders assert, on the one hand, that U.S. policies are counterproductive and that they would be better off without Government interference, and on the opposite hand, that in other countries government polices, far from being counterproductive, give their competitors powerful advantages in international trade. Such questions turn on the general tenor of relations among government, business, and other interest groups (consumers, organized labor) as well as the details of policy.

As the importance of electronics became obvious and competition intensified, foreign governments sought policies that would promote the growth and development of their own industries. These trends seem bound to continue, not only in industrialized nations like Japan but in developing economies. Questions of central concern for American policy makers include: How do industrial policies differ among nations? To what extent can the effectiveness of these policies be evaluated? Do actions taken by foreign governments give the electronics industries of these countries significant competitive advantages? Can industrial policies ''create' comparative advantage? These are hard questions. The monetary value of subsidies can seldom be approximated accurately. Even where this is possible, it does not tell whether the money was well spent or wasted. More important, the industrial policies of countries like Japan work in large part through intangibles. When counting the yen does not suffice, how does the United States countervails subsidies?

This chapter treats industrial policy in comparative fashion, with special attention to institutional context and the evolution of industrial policymaking, as well as the place of electronics in strategies for economic development. Policies in the United States are covered only briefly; the next chapter treats U.S. trade policies in greater detail, while chapter 12 examines policy alternatives for this country.

Industrial policy means different things to different people. To some, the term brings to mind government programs for supporting and promoting targeted industries, typified by the French "plans" or Japan's government-funded research and development projects—sector-specific attempts to assist industry. Beyond sectoral measures, a vast array of public policies—dealing with taxation, trade, human resources, science and technology, antitrust, labor markets and economic adjustment, government procurement—also influence the development and viability of industries like electronics. OTA prefers to view industrial policy broadly, as encompassing both sectoral targeting and the many policy measures with aggregate rather than sector-specific aims that often have less direct effects on private firms.[1]

International competitiveness, at root, depends on the efforts of private firms—this is as true in countries like Japan with relatively comprehensive and well-developed industrial policies as in the United States—but public policies help shape the environment within which corporations operate and managers

[1] *U.S. industrial Competitiveness: A Comparison of Steel, Automobiles, and Electronics* (Washington, D, C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-135, July 1981], p. 151.



99-111 O - 83 - 25

make decisions. The decisions of government officials are important too. Nations have approached industrial policy differently; government intervention is more common and viewed more positively in France or Japan than in West Germany or the United States. Sometimes public policies are clearly defined and consciously developed, sometimes they evolve in ad hoc fashion—the traditional pattern here.

Still, such generalities can mislead: in all major industrial nations, policies toward the electronics industry have changed over time; in several, debates over new approaches are underway. Furthermore, policies often differ across an industry. More than 20 years ago, Japan began a series of programs intended to foster the growth of an indigenous computer industry—but the government did little by comparison to directly promote consumer electronics. In the United States, public policies toward the automobile industry have centered on regulations, while trade issues have been stressed in the context of steel. U.S. agricultural policy has been much more highly developed than policies toward manufacturing.

Why then have some nations—France, Japan, Taiwan, for examples—moved toward well-defined and rather comprehensive policies directed at electronics, while countries like the United States have not? There is no simple answer, but historical and institutional factors as well as stages of economic development and the exigencies of day-to-day politics play a part,

Where government has for years promoted industrial development—France rather than Britain—public sector involvement in the economy is more widely accepted as legitimate. In such countries, policies directed at a single industry such as electronics have usually reflected overall economic objectives. Institutional mechanisms that facilitate coordinated policymaking—central banks or development banks, respected planning councils, centralization of responsibility within one or a few bureaucratic ministries–enhance the ability of government officials to implement industrial policies. These features are lacking in the United States. During the greater part of the postwar period—when American industries such as electronics and aircraft were clear leaders in world competition—public policies here were directed, not at economic development, but at regulation.

As this chapter demonstrates, industrial policies will be a prominent feature of the international competitive environment for the foreseeable future. While other countries are busy developing them, the United States is still groping for a response.

# The Context for Industrial Policy

Public policies directed at electronics should be viewed in light of a nation's overall economic development strategy. Table 77 gives in summary form a number of indicators of economic position and industrial policy for five countries, Electronics and other high-technology industries grow more important as manufacturing and services displace agriculture, In Japan, agriculture accounted for more than 20 percent of the gross domestic product (GDP) in 1955, when the electronics industry was insignificant by international standards; by the end of the 1970's, the agricultural sector had receded to less than 5 percent of GDP, From 1976 to 1980 alone, the share of Japan's exports accounted for by electronics went from 9 to 14 percent.[2]

Such shifts, the results of complex economic currents, form part of the policy context. Major changes have also been occurring within electronics. Continuing the example of Japan, con-

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"*Trends in the Electronics Industry in 1980* (Tokyo: Electronic Industries Association of Japan, 1981), p. 49; "Industrial Review of Japan—1981 ," Japan Economic Journal, p. 33.

**Table 77.—Economic and Industrial Policy Indicators**

| | United States | Japan | West Germany | United Kingdom | Taiwan |
|---|---|---|---|---|---|
| 1. Services as a proportion of gross domestic product (GDP). . . . . . . . | 63°/0 (1980) | 550/0 (1 979) | 49 "/0 (1979) | 630/o (1980) | 380/o (1979) |
| 2. R&D expenditures as a percentage of GDP . . . . . . . . . . . . . . . . . . . . | 2.39°/0 (1981) | 1 .970/0 (1 979) | 2.320/o (1980) | 2.11 (1978) | 0.650/o (1981) |
| 3. Government as a source of R&D funds . . . . . . . . . . . . . . . . . . . . | 47.20/, (1982) | 27.40/o (1980) | 49 "/0 (1 979) | 550/0 (1979) | 43%[a] (1980) |
| 4. Civilian (rather than military) R&D as a percentage of total R&D | 70.0% (1981) | 97.40/0 (1977) | 92.40/o (1979) | 69.70/o (1978) | NA |
| 5. Electronics R&D as a percentage of total R&D (1975) . . . . . . . . . . . . | 22°/0 | 28.40/o (1979) | 30 "/0 | 26 | NA |
| 6A. Government R&D spending on electronics as a percentage of total government R&D spending (1975) . . . . . . . . . . . . . . . . . . . . | 30°/0 | 320/o | 31 % | 340/0 | NA |
| 6B. Industry R&D spending on electronics as a percentage of total industry R&D spending (1975). . . . . . . . . . . . . . . . . . . . . . . . . . . | 21 °/o | 260/o | 30 % | 2170 | NA |
| 7. Percentage of 1978 government R&D funds going to: | | | | | |
| Economic development . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 9°/0 | 220/0 | 15% | 13 % | NA |
| Defense . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 49°/0 | 2% | 12 % | 52 | NA |
| 8. Organization of industrial policymaking system . . . . . . . . . . . . . . . . . . | Fragmented | Centralized | Decentralized | Fragmented | Centralized |
| 9. Government-business relations . . . . . . . . . . . . . . . . . . . . . . . . . . . | Adversarial | Cooperative | Structured representation of business and labor views | Semi adversarial | Cooperative |
| 10. Patents granted (1981) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 65,770 | 50,904 | 13,429 | 22,924 | NA |
| 11. Balance of trade in electronics with the United States (1981) (millions of dollars) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | +$4,235[b] | - $5,878' | + $1,592 | + $1,696 | -$1 ,635' |
| 12. Overall policy and strategy . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | Ad hoc | Leapfrog: indigenous technology development | Adaptive: stresses technology development | Adaptive: stresses commercial applications | Catch-up |

NA not available
[a]Excludes expenditures for military R&D
[b]United States with all nations
[c]Negative sign denotes exports to the United States exceeding imports from the Un ited States

SOURCES Ten Year Economic Development Plan for Taiwan, Republic of China, ' Taiwan Council for Economic Planning and Development March 1980
*Technical Change and Economic Policy* (Paris Organization for Economic Cooperation and Development, 1980) p 31
*Denshi Sangyo no Kokusaika no Hoko to sono Eikyo ni Kansuru Chosa Hokoku* (Survey Report on Trends in the International ization of the Electronics Industry and Their Influence Part II on East and Southeast Asia) (Tokyo Nihon Denshi Kikai Kogyokai (Electronic Industries Association of Japan), March 1981), p 121
K Schott, *Industrial Innovation in the United Kingdom, Canada and the United States* (London Contemprint July 1981) p 9
J Baranson and H B Malmgren,' Technology and Trade Policy Issues and An Agenda for Act Ion " report prepared for Department of Labor and Off Ice of the U S Trade Representative. October 1981 p 158
'Survey of R&D Activities in the Year 1980 Republic of China, " National Science Council, Republic of China 1981
*Science Indicators—1980* (Washington D C National Science Board National Science Foundation 1981), pp 210-214
*Electronics* Jan 13, 1982
C J Mosbacher Will R&D Funds Be More Than $77 Billion in 82 *Industrial Research & Development* January 1982 p 106
*National Patterns of Science and Technology Resources— 1982* (Washington D C National Science Foundation 1982) p 33
*World Development Report 1982* (New York Oxford University Press 1982) p 114
*Outlook* for *Science* and Technology, National Research Council (San Francisco W H Freeman, 1982), p 519
*Electronic Market Data Book 1982* (Washington D C Electronics I ndustries Association 1982) p 111
Information from U S Patent Off Ice Embassy of Japan, Science Division Coordination Council for North American Affairs Republic of China

sumer products declined from two-thirds of that country's exports of electronics in 1971 to about half by the end of the decade, while semiconductor and computer exports increased. Many of Japan's consumer electronics shipments to the United States have been displaced by products from other Asian nations, partly a result of rapid industrialization in countries like Hong Kong and Korea.[3]

These changes in the composition of Japan's exports reflect shifts in the international division of labor—developing economies are now producing more consumer electronic goods, while advanced nations concentrate on higher technology products. Industrial policies can be viewed as responses to such structural changes; they may attempt to modify or resist them, to smooth adaptation to change, to complement or even induce it. "Success" is most likely when policies work to accommodate or reinforce rather than impede changes in industrial structure—provided the policies are based on sound judgments concerning the strengths and weaknesses of a country's industries, both domestically and in the international marketplace. This is no easy task; still, policies toward electronics in other countries, if not the United States, should be viewed in these terms—as components of national economic strategies based at least in part on perceptions and projections of structural shifts in the world economy.

International economic conditions now favor American corporations less than in the earlier postwar years; this is one reason for the growing interest in industrial policy for the United States. This country, along with the rest of the industrialized West, has experienced low rates of economic growth, rising inflation, and high unemployment over the past decade. Competition has intensified among firms here and abroad, all seeking to maintain or enhance their positions in markets that maybe growing only slowly. Under these conditions, governments have turned to industrial policy as a way out of persistent economic problems, Moreover, aggressive industrial policies in one country breed responses elsewhere. The turn toward industrial policies, particularly in nations lacking a tradition of government involvement in economic affairs, is partly a reaction to these new circumstances; in other countries, industrial policy is nothing new, just a continuation of past practices under a different name.

## Policy Orientations

As part of a nation's overall development strategy, industrial policies can be directed at catching up, leapfrogging, or staying ahead in worldwide competition (table 77), Absence of a clearly defined industrial policy may indicate general satisfaction with the situation, the case in the United States until recently; lack of a well-defined industrial policy could also reflect a belief that it is improper for government to concern itself with such issues—a widespread attitude here. In contrast, during the 1960's the French and Japanese began supporting and defending their computer industries against what they viewed as an American challenge.

In many countries and at many times, *defensive industrial policies* have been devised—intended to preserve existing economic structures, maintain employment, and protect beleagured firms and industries.[4] Often defended as temporary (ch. 11), protective measures frequently turn out to be persistent if not permanent.

*Adaptive industrial policies* seek to encourage structural change by facilitating shifts of resources to growing and productive industries—those in the process of becoming more competitive. In contrast to the defensive approach, adaptive industrial policies begin with the assumption that some sectors will eventually decline in size and importance. In practice the boundaries between various sorts of industrial policies are vague; for instance, subsidies or protection for a given sector may be rationalized as a means of encouraging adap-

[3] *White Paper on International Trade-1980* (Tokyo: Ministry of International Trade and Industry, September 1980), p. 32. As discussed elsewhere, Orderly Marketing Agreements have also contributed to this shift.

[4] See W. Diebold, Jr., *Industrial Policy as an International Issue (New* York: McGraw-Hill, 1980), pp. 7-8, for an outline of types of industrial policies.

tation, while in practice they function as defenses against decline.

More ambitious than adaptive policies are those that attempt to induce change, This implies moving beyond a response to economic forces—here government takes the lead in *initiating industrial change,* with the object of improving the competitiveness of some sectors of the economy. Both this approach and the adaptive strategy tend to be associated with notions of dynamic comparative advantage and the belief that governments can anticipate and plan for shifts in the structure of advantage,

As pointed out in chapter 5, the competitiveness of all sectors of an economy cannot improve at once. To pursue a positive development strategy, a nation must begin with at least the implicit acknowledgment that some of its industries will likely decline. Common ground concerning the prospects for industry is easier to find in economies with simple structures. Nations that are still attempting to catch up have an easier time in formulating policy; they face fewer choices, fewer possibilities,

## The Tools of Industrial Policy

In market economies, governments bring a more or less standard set of policies to bear on industrial development—measures used for purposes ranging from improving competitiveness to encouraging regional development or strengthening the national defense, Regardless of whether a country is attempting to pursue an integrated policy, a wide variety of government actions will inevitably affect the industrial portion of its economy.

In the case of electronics, many countries have instituted policies affecting costs and supplies of capital—for R&D as well as for investment in plant and equipment. R&D *supports* can take the form of low interest loans, direct subsidies, or government contracts. In West Germany, government funding supports basic research as well as projects aimed at commercialization carried out by the laboratories of the Fraunhofer Gesellschaft; the German Ministry of Science and Technology also subsidizes contract research undertaken by smaller enterprises, along with cooperative R&D in industrial research associations. The Very High-Speed Integrated Circuit program of the U.S. Department of Defense is aimed at integrated circuits (ICs) for military applications, but will have commercial spinoffs. The Economic Recovery Tax Act of 1981 included a tax credit for R&D spending, as well as accelerated depreciation of equipment used in research, Japan also offers tax credits to firms that increase their spending for R&D over past levels. Beyond this, the Japanese Government directly supports projects aimed at commercial microelectronics and computer technologies.

Many countries assist regions, small businesses, perhaps entire industries through *investment grants and subsidies.* The United Kingdom's National Enterprise Board provided 50 million pounds to capitalize the semiconductor firm Inmos. In the United States, the Small Business Administration loans money at favorable interest rates and with lengthy repayment periods. Regional development loans have stimulated investment by American and Japanese semiconductor firms in Ireland and Scotland. National banks, particularly industrial development banks, have been important vehicles in many countries for channeling funds to particular sectors.

*Government procurement* is widely used to support national firms. Military procurement has been much more important in the United States, France, and Great Britain than in countries like West Germany. The "Buy Japanese" policies of public corporations such as Nippon Telegraph and Telephone (NTT) were for years an integral part of Japan's policies in electronics. In 1980, NTT—which purchases sizable amounts of communications and electronics products—agreed, after lengthy negotiations, to open some procurements to foreign bidders. American firms have made only limited progress in selling to NTT, but the attention given the case indicates that government procurement is becoming more subject to international negotiation, perhaps less usable as a tool for the promotion of domestic industries (nontariff barriers to trade, of which this is an example, are discussed more extensively in the next chapter).

Still another category of policy measure includes those bearing on the *regulation of industrial structure*. Nations can influence the structure of their industries by encouraging or discouraging mergers, not to mention nationalizing firms or industries as the Mitterrand government in France has done. American competition policy has emphasized the regulatory side—i.e., antitrust enforcement—while in France and the United Kingdom, governments have steered companies into mergers (e.g., the computer manufacturers CII-Honeywel] Bull in France and ICL in Britain) intended to create "national champions. " Encouraging mergers, often through financial incentives—sometimes referred to in Europe as structural policy—has been a common feature of policies toward electronics in most developed nations.

Some countries use *foreign investment controls* to restrict inward flows of capital, and thus preserve domestic markets for local firms. In years past, such regulations, as well as restrictions on imports and technology from abroad, played a central role in the industrial policies of Japan; several examples in electronics were outlined in chapter 5.[5]

Finally, *tariffs and other varieties of trade policy* are an ever-present force in international competition. Countries erect tariff walls to protect new or old industries; the European Economic Community, for instance, maintains a tariff of 17 percent on ICs to discourage imports and stimulate domestic production. The United States negotiated import quotas on color televisions with Japan, Taiwan, and South Korea during the 1970's in an attempt to deal with the problems of this industry (as discussed in ch. 11). Trading nations all maintain export promotion measures intended to help local firms sell in the world market. In the United States, the Export Trading Company Act (Public Law 97-290) passed in the fall of 1982 is one of the most recent examples; modifications to the Foreign Corrupt Practices Act likewise intended to support U.S. firms in foreign markets passed the Senate but not the House of Representatives in 1981.

Policy measures of the types outlined above have been deployed by governments everywhere in their attempts to influence the development of industry and improve competitiveness. Generally speaking, tariff barriers, controls on foreign investment, and competition policies were the tools of first choice during earlier postwar years; since the late 1960's, as trade liberalization gained momentum and direct trade barriers were dismantled, R&D policies and investment stimuli have come to the fore. In the wake of intensified competition in a wide range of industries, trade negotiations—both bilateral and multilateral—have increasingly centered on subsidies and indirect barriers.

While the typical mix of industrial policy measures has shifted over time, the group of policy tools from which they are chosen has not changed very much. The industrial policies of various nations draw on the same basic ingredients—R&D supports, investment grants and subsidies, public sector procurement, merger policy, controls on foreign investment, tariffs and other trade policies. Nations combine these depending on their assessments of the strengths and weaknesses of their own industries and the objectives of their economic development programs.

The key to effective national policies has lain, not in the individual policy tools but in their combination—in the extent to which the policies chosen complement one another and work toward a more or less consistent set of objectives. The timing of policy initiatives and the receptivity of private firms to government programs are also important, but the success or failure of industrial policies is determined to a large extent by the ability of policy makers to develop and implement a consistent framework and approach, one appropriate to that nation's position in the international economy.

The remainder of the chapter reviews industrial policy in a number of countries, with particular attention to electronics,

[5]See also R. S. Ozaki, *The Control of Imports and Foreign Capital in Japan* (New York: Praeger, 1972).

# Industrial Policies Compared

The failures of industrial policy are much more evident than the successes. How does one weigh the contributions of government policies to economic development—either on a general or a sectoral basis—when a country has been in the "take-off" stage, with many forces working more or less in concert to speed industrialization? This was the pattern in the Japanese steel, shipbuilding, and petrochemical industries in earlier years, when a skilled labor force and rapidly expanding markets were aided by the government's push. It is now the case in other nations that have begun to experience rapid economic growth.

## Developing Countries

The past decade has seen a striking rise in the electronics industries of a number of newly industrializing countries (NICs), most of them in Asia. Many of these nations—Taiwan, South Korea, Brazil—have chosen paths of government-guided economic development, albeit with many gradations in the extent of government involvement. With the exception of China, which has emphasized "self-sufficiency," the Asian nations have relied heavily on imported technology while capitalizing on cheap labor. In countries like Singapore, Hong Kong, and Taiwan, economic development policies have relied more heavily on encouraging diversified exports of manufactured goods than protecting local industries against import competition. The typical attitude toward foreign electronics firms has been pragmatic, with American and Japanese involvements tolerated or encouraged because of benefits in technology transfer and infrastructural development.

In years past, the electronics industries in most NICs centered on relatively simple consumer products—radios and black-and-white TVs, pocket calculators, electronic watches, toys and games. Now, policy pronouncements from these countries are calling for shifts toward more sophisticated goods, In Taiwan, which has perhaps the most ambitious government programs, the stated aim is a more knowledge-intensive industrial structure, much as in Japan. Chinese planners, also reconsidering their traditional approach, have become more open to technology exchanges and business ventures involving foreign firms. While the industries in countries like Taiwan and South Korea have already become major producers of middle-range products like color TVs, simpler microelectronic devices, and computer peripherals, it is far from certain that such nations can succeed in advanced electronics technologies. Manpower limitations are the most severe constraint.

### South Korea

The Korean Government has consistently sought rapid industrialization; the public sector presence has perhaps been more pervasive than in any of the other NICs. Policy instruments have ranged from money to guidance: rebates of indirect taxes, raw materials subsidies and loans to exporters, target figures for exports, funds for R&D. Korea's export financing programs have also been unusually comprehensive compared to other NICs.[6]

For many years the Korean economy expanded at a high rate, with annual increases in gross national product (GNP) averaging 10 percent over the period from the early 1960's into the mid-1970's. Labor-intensive manufactured goods provided the foundation for this growth; exports have become much more important to South Korea's economy over the past decade, growing from 12 percent of GNP to 35 percent.[7] Electronics has been an export leader, the most rapidly growing sector. Korea's electronics industry is still small compared to Japan's, but it accounts for more than 10 percent of Korean exports.

More recently, South Korea's economic miracle has fallen on the same hard times that have

[6]"Korea's Eximbank Provides Incentives To Diversify Export Mix, Destination, " *IMF Survey*, Nov. 26, 1979, p. 366.

[7]P. Hasan and D. C. Rao, *Korea, Policy Issues for Long-Term Development* (Baltimore: Johns Hopkins University Press, 1979), p. 20.

afflicted the rest of the world. The slump was sudden: whereas Korea's output of electronic products grew at the astounding rate of 40 percent per year during the 1970's, production actually fell in 1980, although rebounding strongly in 1981,[8] South Korea's Government considers continued growth in electronics necessary for recovery, and the industry remains a focal point of development strategy. Korea's fourth economic plan (1977-81) concluded that long-term export viability would depend on structural changes in manufacturing. The plan called for rapid increases in exports of electronic products.[9] Korea's Government assumes that other developing economies will provide stiff competition in sectors like textiles and apparel, where Korean industry has in the past been strong; thus, the country needs to continue moving into durable manufactures for export. The government also intends to deemphasize petrochemicals and heavy industries like steel—sectors that helped lead Korean economic growth in past years. The fifth and latest plan released by South Korea's Economic Planning Board proposes dramatic cuts in investments in these portions of the economy, with expenditures on electronics boosted substantially.[10] Table 78 summarizes projections by the Korean Government; electronics exports are expected to climb to $14.5 billion in 1991. The most rapid growth is projected in industrial electronics products, including computers and communications equipment, with a heavy emphasis on microelectronics. The share of total electronics output accounted for by consumer products is expected to begin shrinking by the latter part of the decade, with a pronounced move away from the less sophisticated components that are currently a staple

**Table 78.— Korean Electronics Production**

| | Output (millions of dollars) | |
|---|---|---|
| | 1981 | 1986[a] |
| Consumer | $1,600 | $5,800 |
| Industrial[b] | 490 | 2,700 |
| Components | 1,710 | 4,800 |
| | $3,800 | $13,300 |
| Total electronics exports | $2,200 | $7,000 |

[a]Proiected
[b]Includes computers and telecommunications equipment

SOURCE A Spaeth, "Korea's Electronics Industry Making Rapid Gains in Shift to HighTechnology Products," Asian *Wall Street Journal Week/y,* Dec *20, 1982,* p. 1 The projections come from South Korea's Ministry of Commerce and Industry

of the Korean industry, Such a reorientation will entail shifts in R&D emphasis, with increases in funding for both product and process technologies. To this end, the Ministry of Commerce and Industry has begun channeling funds to Korean electronics firms for developments in semiconductors and computers.[11]

To help focus research efforts, the Korean Institute of Electronics Technology—established with government support in Gumi, the country's Silicon Valley—is to be built into a centerpiece for research in electronics. The institute has been installing production lines for very large-scale ICs; the equipment will be used for commercial production as well as engineering development.[12] While the staff of the $62 million institute remains small, planners hope that it will eventually house more than a thousand research workers.[13]

In addition to R&D assistance, the South Korean Government has provided investment funds to electronics firms and supported them through procurements, For instance, Gold Star Semiconductor—a joint Korean-U.S. venture—will receive a loan of more than $40 million from both foreign and domestic sources, including the Korea Development Bank, to manufacture telephone switching equipment which

[8]*Denshi Sangyo no Kokusaika no Hoko to sono Eikyo ni Kansuru Chosa Hokoku* (Survey Report on Trends in the Internationalization of the Electronics Industry and Their Influence, Part II on East and Southeast Asia) (Tokyo: Nihon Denshi Kikai Kogyokai (Electronic Industries Association of Japan), March 1981), p. 103; A. Spaeth, "Korea's Electronics Industry Making Rapid Gains in Shift to High-Technology Products," *Asian Wall Street Journal Weekly,* Dec. 20, 1982, p. 1.

[9]*Denshi Sangyo no Kokusaika no Hoko to sono Eikyo ni Kansuru Chosa Hokoku,* op. cit., p. 56,

[10]N. Thorpe, "South Korea's Economic Program Reduces Expansion of Several Major Industries, " *Wall Street Journal,* July 24, 1981, p. 24.

[11]One report states that $800 million has already been invested by the government–''Fourth Five-Year Plan," *Electronics Weekly,* Apr. 25, 1979, p. 19.

[12]"Korea's Electronics Industry Making Rapid Gains in Shift to High-Technology Products, " op. cit. Eventually, the institute expects to sell the production facility to a private firm.

[13]"South Korea Seeks Electronics Rebound," New *York Times,* Mar, 24, 1981, p. D5.

will be purchased by the Ministry of Communications.[14] A second major Korean electronics firm—Samsung, also partly U.S.-owned—is involved in the project as well. When the government decided to begin color TV broadcasting in 1980, Samsung won loans to aid in the production of color receivers. Foreign firms have also benefited from investment incentives, although South Korea's electronics industry has been less dependent on overseas capital than most others in Asia. Foreign-owned companies are exempt from Korean income, property, and corporate taxes during the first 5 years of operation .15

Government generosity has not prevented bottlenecks such as rising labor costs and skill shortages among the 180,000 employees of Asia's third largest electronics industry. The recent push toward indigenous technological capability implies heavy R&D commitments, but most South Korean firms have only limited human and financial resources to devote to these ends. Furthermore, other countries are likely to be cautious in transferring electronics technology to Korea now that the country's competitiveness is apparent. Japanese firms have refused repeated requests for licenses covering video cassette recorder (VCR) technology.[16] Korean producers have already demonstrated their ability to compete in the color TV market, but if they cannot get foreign technology in other areas their progress in electronics will be slowed.

In view of these obstacles, does South Korea's development strategy seem feasible? There is no question that Korean firms are well placed to expand their shipments of products like color TVs, passive components, discrete transistors, and small-scale ICs to more advanced countries. Korea is already the world's biggest producer of black-and-white TVs, and Korean firms have been among the leaders as Asian nations have taken over much of the world's production of consumer electronics products—table 79. But developing the capability for designing and developing new products based on domestic technology and resources is a more ambitious and less certain undertaking than manufacturing commodity-like products using standardized, well-understood techniques.

## Taiwan

The Taiwanese electronics industry runs a close second in sales to Korea (ch. 4), and employs more people. Both governments have followed the Japanese pattern in emphasizing electronics. At the center of Taiwan's current 10-year economic plan (1980-89) is the development of the machinery, electronics, and information industries—favored because of high value-added, modest demands for energy, and comparatively high technology content. Taiwan has the best trained corps of engineers and scientists in the Far East outside of Japan, mak-

[14] "Gold Star Semiconductor Raising Loan for Move Into Advanced Electronics, " *Asian Wall Street Journal Weekly*, Apr. 13, 1981, p. 8. The company is owned 44 percent by Western Electric and 56 percent by the Korean Lucky Group.

[15] C. Webb, "South Korea, " *Electronics Weekly*, Apr. 25, 1979, p. 19.

[16] M. Inaba, "Koreans Press Japan To Share Video Cassette Profits, " *Electronic News*, Nov. 30, 1980, p. F. Nonetheless, several Korean firms already produce VCRs of their own design,

**Table 79.— Market Shares in Consumer Electronics for Japan and Other Asian Nations**

| | Share of total world market, 1979 | | |
|---|---|---|---|
| | Japan | All other Asian nations | Total Asian share |
| Video cassette recorders | 93.2°/0 | 0 | 93.20/o |
| Color TVs | 27.7 | 3.8 | 31.5 |
| Monochrome TVs | 16.3 | 49,6 | 65.9 |
| Radios | 5.2 | 71.8 | 77.0 |
| Audio tape recorders | 38.2 | 52.8 | 91.0 |
| Auto radios and tape players | 48.6 | 18.7 | 67.3 |
| Other home audio equipment, stereos | 40.1 | 12.1 | 52.2 |

SOURCE *Denshi Sangyo no Kokusaika no Hoko to sono Eikyo ni Kansuru Chosa Hokoku* (Survey Report on Trends in the International ization of the Electronics Industry and Their Influence, Part II on East and Southeast Asia) (Tokyo Nihon Denshi Kikai Kogyokai (Electronic Industries Association of Japan), March 1981), p 2 ing the more technology-intensive sectors natural targets. The country's development plans encompass ICs, computers and peripherals, and high-end consumer products such as VCRs. The Taiwanese, like the South Koreans, are not satisfied with their image as manufacturers and assemblers of components, producers of cheap TVs and consumer goods. According to the current government plan, electronics output is to double over the decade.[17]

For some time, the Government of Taiwan has been encouraging shifts from labor- to knowledge-intensive industries. One vehicle has been the Electronics Research and Service Organization (ERSO), which gets about 40 percent of its funding from public sources, ERSO, established in 1974, is one of four divisions of the Industry Technology Research Institute (ITRI); projects have included computerized industrial control systems, Chinese language computers, and semiconductor development. The organization also negotiated the technology transfer agreement with RCA that helped Taiwanese firms produce c-MOS ICs for the country's watch industry.[18] ERSO is engaged in manufacturing as well as R&D, and has helped introduce improved quality control procedures in Taiwan's electronics industry,

Wage increases have rendered Taiwan's labor-intensive industries increasingly vulnerable to competition from other developing countries, an important motive for the government's stress on knowledge-intensive sectors and another parallel with Korea. Policy pronouncements call for greater use of computer-based automation to increase productivity and export competitiveness. ITRI leaders hope that Taiwan will be able to independently develop small computers and the associated software for both domestic and export markets. Government planners believe that Taiwan will have the best chance of success if, instead of attempting to challenge IBM or the Japanese, the country's efforts are concentrated on special-purpose machines compatible with the Chinese language, along with minicomputers, peripherals, and software.[19] Examples of the initiatives being discussed include joint ventures with Western firms in which government-sponsored training efforts would provide skilled workers for software development.[20]

Along with other Asian electronics industries, Taiwan depends heavily on exports (table 19, ch. 4; Taiwan exported 80 percent of its electronics production in 1979, South Korea 70 percent), with the bulk of these shipments going to U.S. markets. Taiwanese firms such as Tatung and Sampo have already set up color TV production facilities in the United States. With an economy that has been growing at an annual rate of about 8 percent, unemployment at less than 2 percent, and a persistent trade surplus with the United States, Taiwan's electronics industry is well positioned for further expansion. But Taiwan faces many of the same problems policy makers in Korea are grappling with. The country will need greater numbers of well-trained technicians and engineers, higher levels of spending on R&D, and continued improvements in labor productivity—the latter of growing significance as wages rise.

As for South Korea, Taiwan may not have the financial and human resources needed for rapid development in electronics based on indigenous technology, And again, foreign patent holders fearful of new competitors appear reluctant to negotiate agreements with Taiwanese companies, particularly in more advanced products such as VCRs, Some leaders within the Japanese electronics industry have urged "accommodation" with emerging Asian economies—meaning that Japan should concentrate on leading-edge technologies while importing less sophisticated goods from elsewhere in Asia; but if Taiwan's government is

[17]" Ten-Year Economic Development Plan for Taiwan, Republic of China, " Taiwan Council for Economic Planning and Development, March 1980, p. 39.

[18]R. Neff, "Taiwan pushes High Technology, *Electronics,* May 8, 1980, p. 100,

[19]D. Ying, "Taiwan is Counting on Its Computer Industry to Boost Exports and Bolster the Economy," *Asian Wall Street Journal Weekly,* Oct. 20, 1980, p. 1; "Upgrade or Perish: Electronics Makers Get the Message, " *Trade Winds,* October 1980, p. 11.

[20]"Hewlett-Packard Weighs Software Center in Taiwan, " *Asian Wall Street Journal Weekly,* Mar. 15, 1982, p. 4.

serious about its commitment to high technology, such an accommodation would probably not be acceptable.[21]

## China

More strongly committed to self-sufficiency than other industrializing economies, China's progress in electronics and other industries has been uneven—in part because of longstanding conflicts between the development of science and technology and the quest for revolutionary social change, China's desire for self-sufficiency has also created obstacles to efficient mass production; as a case in point, components are still soldered into circuit boards by hand, while in the West wave soldering has been employed for more than 20 years. This is not to say that the country's electronics industry is unrelievedly primitive: the People's Republic of China (PRC) builds mainframe computers as well as ICs roughly comparable to mid-1970's U.S. products, Nonetheless, until recently most of the computers were one-of-a-kind machines, lacking even transportable software.[22]

The picture has changed in the last half-dozen years as a new consensus on the importance of science and technology—one of the "four modernizations" advocated at the Fourth National People's Congress in 1975-emerged among China's leaders.[23] In the National Plan for Development of Science and Technology, announced at a nationwide science conference in 1978, eight technical areas were singled out for special emphasis, among them computers. In calling for the development of China's capability in a wide range of electronics technologies, including large-scale ICs, microcomputers, peripherals, software, and computer networks, the plan termed computer science and technology "a conspicuous hallmark of the level of modernization of a country. " The reestablishment of the Science and Technology Commission, a central agency for policymaking and implementation, is a further indication of the government's new direction.

Ten factories in China now produce computers, ranging from microcomputers to machines similar to PDP-11s and IBM 360s.[24] The State Administration of Computer Industry (SACI) has programs underway to utilize the nation's existing computing capability more efficiently, and intends to move toward smaller machines rather than relying on large mainframes. As one route to such objectives, SAC I is establishing joint ventures with foreign concerns. In 1981, the China Technical Services Corp. and the Japanese firm NEC (Nippon Electric Co,) signed an agreement for a computer center in Beijing. NEC will provide a medium-sized machine free of charge, and an annual 4-month training course for 30 to 40 Chinese software specialists. The Chinese will supply other facilities, along with the center's staff, including interpreters. A similar agreement has been signed with Sperry Univac, while negotiations have taken place with other U.S. firms, including Wang Laboratories and Honeywell.[25] Both Japanese and Western firms hope to establish themselves in the potentially lucrative PRC market.

As such ventures indicate, China is putting a good deal of effort into training computer specialists as a basis for more effective utilization of information processing technologies. Electronics and computer technicians will study at an Information Processing and Training Center, established in 1979 with funding from the United Nations. Among the plans for the center, to be equipped with a Burroughs mainframe, as well as five Hewlett-Packard 3000 series minicomputers, are development of a world patent index, collection of information on food supplies, a data base on power generation and distribution for the Electric Power Ministry, studies of urban traffic flows, and macroeconomic modeling.[26] Such endeav-

[21]See the summary of the Electronic Industry Association of Japan's report on Asian electronics in *Asian Wall Street Journal Weekly*, June 8, 1981.

[22]K. Berney, "Computer Sales to China, " *China Business Review*, September-October 1980, p. 25.

[23]R. P, Suttmeier, *Science, Technology and China Drive for Modernization* (Stanford, Calif.: Hoover Institution Press, 1980),

[24]D. Burstein, "Chinese Foment Another Revolution, " *Electronics*, Jan, 13, 1983, p. 115.

[25]K. Berney, "China's Computer Resolution, " *China Business Review*, November-December 1981, p. 14.

[26]" U.N. Aid for China's Computer Modernization, " *China Business Review*, September-October 1980, pp. 33-34.

ors imply that China—at least at present—may be more interested in applications than in building production capacity, not only in computer equipment but in electronics more generally,

## Other NICs

Rapid growth in the Asian electronics industry extends well beyond Taiwan and South Korea. Hong Kong's companies, which have been basically assembly-oriented suppliers of products like watches and calculators, accounted for 13 percent of the colony's exports in 1980.[27] In Singapore, which has also been a major assembly site, the government has introduced policies intended to encourage semiconductor manufacturing, as well as production of computer hardware and software; the government, for example, owns 25 percent of Tata Elxsi, a joint venture involving U.S. and Indian interests formed to make mainframe processors.[28] Government policy in Hong Kong has been less intrusive than in Singapore, but the electronics industry there has also been moving toward high technology.

Clearly the Asian NICs are all, in one way or another, attempting to learn from and emulate Japan's approach to industrial policy, In the earlier postwar years, Japanese companies imported technology, while government decisions favored heavy industries; newly in*dustrializing nations in Asia have already abandoned this approach for one more like Japan current industrial policy*. The question is whether South Korea, Taiwan, and other NICs have, at this juncture, the resources to support technological self-sufficiency. But even if their progress in developing home-grown technologies proves slow, these countries will be increasingly competitive in world markets for less sophisticated electronics products, well able to challenge manufacturers anywhere that fail to maintain a technological edge,

The discussion above does no more than sketch in a few of the outlines of industrial policy toward electronics in developing Asian economies (Japan is treated in some detail below). Outside Asia, governments in countries like Brazil and Mexico have also nurtured rapidly expanding electronics industries. Brazil, for instance, has used access to its rapidly growing market as the carrot for acquiring U.S. minicomputer technology.[29] In all these countries, foreign investments by American and/or Japanese firms have been one of the starting points for indigenous development. Today, these nations are aggressively attempting to strengthen their own capability and reduce their dependence on more advanced countries. None of the policies employed—the establishment of government-supported R&D facilities, tax breaks and financial subsidies for local firms, preferential procurement, government encouragement of or participation in joint ventures with foreign firms—are unique or even unusual. Such measures are part of the standard list. Still, government planners in NICs have often pursued them more consistently and forcefully—South Korea is especially striking in this regard–than have developed economies. This is partly because the paths are well marked for NICs in comparison to advanced nations with complex industrial structures. The explicit focus on strengthening domestic technical know-how—a recent shift in emphasis —has led to increased demands for transfers of technology as a condition for sales or investment by foreign firms. Countries making such demands—or alternatively, offering incentives to attract technology inflows-see them as a prerequisite for building their own capabilities. Some multinational electronics firms have accepted these conditions—which at times have been a prerequisite for market entry, a tactic that Japan employed in years past—more readily than others. The draft UNCTAD (United Nations Council on Trade and Development) code on technology transfer

[27] "Says Electronics Could Lead as Hong Kong Export Earner, " *Electronic News*, Oct. **26, 1981,** p. FF.
[28] "See CPU, Software Mfg. Leading Singapore's Future, " *Electronic News*, Dec. **7, 1981, p. Q.**

[29] J. Baranson and H. B. Malmgren, "Technology and Trade Policy: Issues and an Agenda for Action, " report prepared for Department of Labor and Office of the U.S. Trade Representative, October 1981, pp. 125-126.

illustrates the strong desire among developing nations everywhere for technology acquisition on more favorable terms.

A problem that the developing Asian economies all share—some more so than others—is expanding their pools of engineers and technicians. Countries like India, Taiwan, and Korea have labor forces containing substantial numbers of engineers and scientists, many of them educated in the West. Nevertheless, while some of these nations have managed to mobilize their human resources more effectively than others, none of the NICs have enough skilled people to move rapidly into high-technology electronics production. They do have one advantage: their engineers are not paid nearly as well as in the advanced countries. With salaries perhaps one-quarter those in the United States, the industrializing Asian economies are striving to capitalize on lower R&D costs as they earlier did with unskilled labor.[30] While it is unlikely that any of these countries will quickly bridge the commercial and technological gaps separating them from Japan and the West, and while their approaches to industrial policy differ in style of government intervention and reliance on market mechanisms, all seem committed to some variety of coordinated industrial policy as a means of supporting local electronics manufacturers in both domestic and world markets.

## United States

The U.S. Government has not developed a consistent, systematic set of policies directed at industry—a task that, even if judged desirable, would be much more difficult for the world's most complex economy than one that was still industrializing. It has become a commonplace to note that, while numerous public policies exert direct or indirect effects on firms and industries, the American approach is ad hoc. In this sense, then, U.S. industrial policy also differs from that in Japan or many of the European nations, While the Federal Government has paid more attention to some industries than others, this has most often been a result of political pressures, as in the case of textiles, or national security considerations. And not even in the Department of Defense could one find anything like an "electronics industry policy. " Following World War II, U.S. foreign economic policy centered on an ambitious recovery program in Western Europe and Japan–the Marshall Plan. But despite this embrace of economic planning for other parts of the world, domestic economic policies have revolved around macroeconomics and regulation. The United States has avoided promotion, planning, and targeting—the common tools in other countries.

In electronics, microlevel involvements, leaving aside national defense, have generally had regulatory thrusts—witness the lengthy antitrust prosecution of IBM. One reason the U.S. Government has been willing to endorse economic planning overseas but not at home lies in the unrivaled strength of American corporations during most of the postwar period. In light of the success of American firms such as Boeing, IBM, or General Electric in world markets, the focus of policy makers here on free-market competition is quite understandable; for the Federal Government to consider policies that would promote "national champions''—as the French did—when these champions already existed, would have seemed superfluous if not counterproductive.

Public policies have, nonetheless, exerted considerable influence on the American electronics industry. Military procurements stimulated developments in computers and semiconductors. Since the 1960's, trade policy has been a persistent concern in consumer electronics. Taxation, regulations of many kinds (particularly in the telecommunications sector), patents, protection of computer software–all have been debated in various contexts. But in total, the Federal Government's policies have been a patchwork, often based on objectives quite different from those motivating the industrial policies of other countries. Antitrust enforcement stands out especially.

'A, Spaeth, "Asian 'NICs' Rely on Cheap Brainpower To Plan Output of More Advanced Goods, " *Wall Street Journal*, Jan. 5, 1983, p. 25.

## Antitrust

Where competition policies in other countries have been vehicles for mergers, joint ventures, and consolidation, notably in the computer industry—the rationale being to create companies big enough to compete effectively—antitrust enforcement in the United States has aimed at breaking up large enterprises.[31] Despite the common association of bigness with badness, American law does not prohibit oligopoly (industries dominated by a small number of firms), but limits predatory or exclusionary tactics. Therefore, antitrust violations tend to be difficult to prove, cases lengthy and expensive .32

How has antitrust enforcement influenced the international competitiveness of American electronics firms? As has been the case so often with U.S. industrial policy, the side effects may have had the greatest impact—in this instance, uncertainty over the intentions of the Department of Justice and the Federal Trade Commission. Business and industry in the United States claim—perhaps with justification—that antitrust enforcement is ambiguous and threatening, that Government officials, knowing the line to be vague, try to keep companies far back. Instances in which enforcement intentions have been known to actually stop mergers, joint ventures, or acquisitions in electronics are few. One case arose at the end of the 1970's, when GE and Hitachi proposed a joint venture to manufacture TVs in the United States. The two companies suspended their negotiations after the Justice Department threatened to sue under provisions of the Clayton Act.[33] More frequently, the possibility—even if remote—of costly and protracted litigation seems to have caused American firms to steer clear of cooperation in R&D.[34] While much of the complaining by the business community over antitrust reflects no more than the usual antagonism toward Government regulation, it does appear that companies have been little inclined to explore the bounds of the permissible, simply because the risks have been seen as far greater than the rewards. Largely as a result of repeated expressions of concern, the Department of Justice issued a set of written guidelines covering joint R&D ventures, but a good deal of ambiguity nevertheless persists.[35] Even where no single project has great import, a general discouragement of joint R&D efforts could eventually have a large cumulative impact. Moreover, if joint international research projects proliferate, American antitrust law—in the absence of more concrete guidance—may present an obstacle to participation by U.S. firms .38

## Trade and Foreign Economic Policies

If antitrust has recently been at the forefront of U.S. industrial policies as they have affected

[31] On U.S. antitrust law and enforcement, see *U.S. Industrial Competitiveness: A Comparison of Steel, Electronics, and Automobiles,* op. cit., pp. 184-185. Also ch. 12 of the present report; J. W. McKie, "Government Intervention in the Economy of the United States," *Government Intervention in the Developed Economy, P.* Maunder (cd. ) (London: Croom Helm, 1979), p. 75; and M. Keller, "Regulation of Large Enterprise: The United States Experience in Comparative Perspective, " *Managerial Hierarchies: Comparative Perspectives on the Rise of the Modern Industrial Enterprise,* A. D. Chandler, Jr., and H. Daems (eds.) (Cambridge, Mass.: Harvard University Press, 1980), p. 161.

[32] The Department of Justice initiated its suit against IBM in 1969, with the trial beginning in 1975. A decision—which would certainly have been appealed regardless of the verdict—was still well in the future when the case was dropped by the Government in January 1982. At the same time, the Justice Department resolved a 7-year antitrust suit asking that AT&T divest itself of Western Electric, the communications company's manufacturing arm. On the settlements, see "Statement of William F. Baxter, Assistant Attorney General, Antitrust Division, on Recent Actions of the Department of Justice in U.S. v. AT&T and U.S. v. IBM, Before the Committee on the Judiciary, U.S. Senate, " Jan. 25, 1982.

[33] J. Crudele and J. Hataye, "Fear for TV Jobs as Justice Blocks GE-Hitachi Venture," *Electronic News,* Dec. 4, 1978, sec. I, p. 1.

[34] See, for example, D. H, Ginsburg, "Antitrust, Uncertainty, and Technological Innovation, " *Antitrust Bulletin,* winter 1979, p. 635.

[35] *Antitrust Guide Concerning Research Joint Ventures* (Washington, D. C,: Department of Justice, November 1980). At the end of 1982, the Justice Department announced that it would not seek to bar the formation of Microelectronics & Computer Technology Corp., the joint venture involving a dozen U.S. firms intended to pursue R&D in advanced electronics technologies (ch. 5].

[36] For a proposal that foreign enterprises be allowed to participate equally in the government-sponsored R&D efforts of all nations, see *Report of the U.S.-Japan Economic Relations Group,* January 1981, p. 80. Japan has recently agreed to open its fifth-generation computer project, and others like it, to Japanese subsidiaries of U.S. companies. See U. C. Lehner, "U. S., Japan Pact Would Bolster Joint Research," *Wall Street Journal, Nov.* 1, 1982, p. 35.

the computer industry—via the IBM case—trade policies concerned with dumping and other unfair practices have been central in consumer electronics, Trade policies and their effects are treated in detail in chapter 11; the point here is simply to note their significance as part of U.S. industrial policy. After years of litigation, the competitive battle in color TV is still proceeding in the courtroom as well as the marketplace. A legalistic thrust analogous to that in computers has dominated public policy impacts.

To take a somewhat broader perspective, as world competition in electronics has increased, U.S. policy makers have renewed their attempts to reduce overseas trade barriers. Nontariff and indirect barriers restricting the entry of American products into foreign markets have been particular targets. A new flurry of activity came in 1982; the many bills introduced in Congress that could be loosely grouped as dealing with trade reciprocity illustrate the depth of concern. Progress on such questions will be slow; since most countries view subsidies and other tools of industrial policy as internal matters, they are difficult to address via international negotiations.

## Procurement and R&D

In contrast to the antitrust and trade orientations visible in computers and consumer electronics, American semiconductor firms have seldom, since the 1960's, been directly affected by public policies. Through the 1950's and 1960's, the Federal Government stimulated developments in microelectronics by purchasing semiconductors for military and space programs, as well as by supporting R&D (much the same was true for the computer industry in its early years). During this period, the Government purchased a large fraction of U.S. semiconductor output—e.g., for the Minuteman II missile. In 1965 the Department of Defense accounted for about 70 percent of U.S. IC sales, while by the end of the 1970's, the figure had dropped to around 7 percent, s'

Because the military market is now so small compared to commercial sales, specialized contractors do much of the work on devices for defense systems. Largely in response to the slow rate of introduction of advanced microelectronics technologies into military hardware, the Department of Defense initiated an R&D program directed at very high-speed integrated circuits (VHSIC) beginning in fiscal 1979. With an initial 6-year budget of more than $200 million–since expanded substantially–the VHSIC program is intended to speed the development of ICs that meet military needs. Involving all three services, VHSIC has been structured around bidding by firms and groups of firms for contracts covering a variety of well-defined R&D tasks. Although the ICs themselves will be tailored to military applications, research results in areas such as processing technology, computer-aided circuit design, and system architectures will find their way into the commercial efforts of U.S. merchant firms. While most of the VHSIC contracts are closer to development than basic research, the Defense Department has also initiated a program entitled Ultrasmall Electronics Research intended to support R&D that will pay off 10 or 20 years in the future.[38]

Even with the increases stemming from the VHSIC program, Federal support of R&D in semiconductor-related technologies remains a much smaller fraction of total U.S. semiconductor R&D than in the 1960's. While the comparisons are less than straightforward because allocations of spending to R&D categories tend to be rather arbitrary, and disaggregated data seldom available, an idea of the current significance of Federal funding can be pieced together.

For 1980, the latest year for which data is available, total U.S. R&D spending by the "electronic components" sector—which is considerably larger than microelectronics alone—has been put at $1.354 billion.[39] For the same

[37] *An Assessment of the Impact of the Department of Defense Very-High-Speed integrated Circuit Program,* National Materials Advisory Board Report NMAB-382 [Washington, E). C.: National Research Council, January 1982), p.6. Also see ch. 4.

[38] *The 5- Year Outlook on Science and Technology 1981* (Washington, D.C.: National Science Foundation NSF 81-40, 1981], p. 33.

[39] *Electronic Market Data Book 1 982* [Washington,D. C.: Electronic Industries Association, 1982), p. 121. The figure, from data collected by the National Science Foundation, is for SIC category 367, which has nine subdivisions. Of these, semiconductors (SIC 3674) is certainly the largest performer of R& Il.

year, tabulations of R&D spending by U.S. merchant semiconductor firms from sources such as annual reports give totals in the range of $800 million. It is more difficult to determine spending on microelectronics by captives, which seldom report such data separately. Allocation of software development costs also leads to ambiguity; as microelectronic devices become more complex and more like complete systems, software becomes a major part of the research, design, and development effort.

In any case, given that IBM—largest of the captive producers—no doubt spends several hundred million dollars annually on microelectronics, total U.S. R&D expenditures on semiconductor-related technologies in 1980 must have been well over $1 billion. How much of this did the Federal Government provide? For fiscal year 1980, Government expenditures for R&D related to ICs have been reported as $61 million, rising to $71 million in fiscal 1981.[40] Evidently, then, the Federal Government contributes something between 5 and 10 percent of the total. This estimate illustrates the continuing decline in the Federal presence; over the period 1958-76, Government spending accounted for about 15 percent of all U.S. semiconductor R&D.[41]

Indeed, it appears that even in the early years, Government purchases were a greater spur to the industry than R&D contracts.[42] By providing a guaranteed market, Government procurement—mostly for military purposes—stimulated the growth of the industry at a critical stage in its development. At the time, semiconductor manufacturing was a far different business than today; it was part of the defense sector of the economy, whereas sales to the Government are now dwarfed by sales to computer manufacturers and other nondefense customers.

## Taxation

The Economic Recovery Tax Act of 1981 (ERTA) was supposed to speed economic growth and build U.S. competitiveness by increasing incentives for saving and investment.

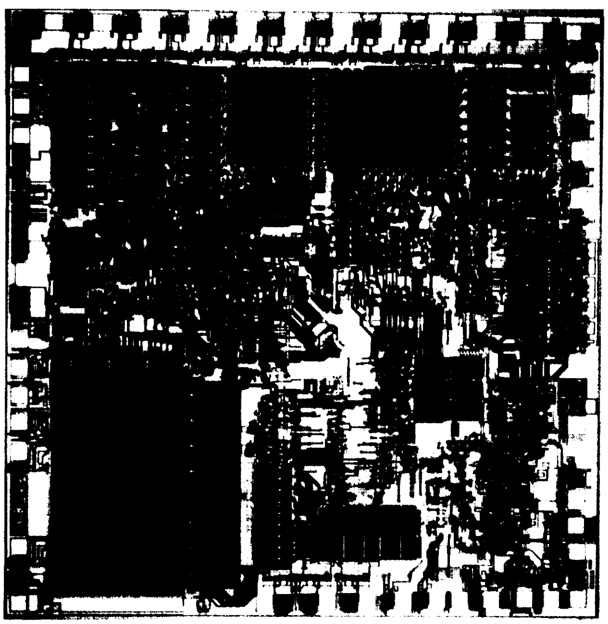

*Photo credit: Intel Corp*

A 16-bit microprocessor

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[40] *An Assessment of the Impact of the Department of Defense Very-High-Speed Integrated Circuit Program,* op. cit., pp. 20-22. For purposes of this rough comparison, R&D related to ICs can be taken as equivalent to R&D related to microelectronics. The Federal contribution includes work performed in Government laboratories, but this accounts for less than 10 percent of the total—the rest being contracts and grants to industry, universities, and independent research laboratories. About 10 percent of the Government money comes from the National Science Foundation (NSF), most of the rest from the Department of Defense, NSF's share of *basic* research support is closer to 30 percent. In fiscal 1980, the VHSIC program accounted for 40 percent of the Government's total spending on microelectronics R&D. As table 77 indicates, overall R&D spending by the U.S. Government is heavily skewed toward military needs compared to countries like Japan or Germany.

IBM spends well over $1 billion annually on R&D; the company's R&D spending on very large-scale ICs has been reported to total about $1 billion over the period 1977-80—G. Gregory, "The U.S. Wages Micro-War, " *Far Eastern Economic Review,* Mar. 16, 1979, p. 124.

[41] *A Report on the U.S. Semiconductor Industry* (Washington, D. C.: Department of Commerce, September 1979), p. 8. The estimates are those of the Semiconductor Industry Association. In 1958, Department of Defense contracts and grants accounted for nearly a quarter of the industry's R&D spending–N. J. Asher and L. D. Strom, "The Role of the Department of Defense in the Development of Integrated Circuits, " Institute for Defense Analyses paper P-1271, May 1977, p. 3, The percentage has thus been falling more or less steadily for many years.

[42] Asher and Strom, op. cit.; J. M. Utterback and A. E. Murray, "The Influence of Defense Procurement and Sponsorship of Research and Development on the Development of the Civilian Electronics Industry," report CPA-77-5, Center for Policy Alternatives, Massachusetts Institute of Technology, June 30, 1977.

The wholesale changes in U.S. tax policy embodied in ERTA have affected all industries; perhaps most significant are the altered depreciation schedules discussed in chapters 7 and 12. ERTA also extends a tax credit—amounting to 25 percent of any increase in R&D spending over a base figure—as part of a package of incentives for research. Although young high-technology companies may not have profits to set against the tax credit, at least some electronics companies will benefit from the R&D provisions more than from accelerated depreciation.

As pointed out elsewhere, the ERTA package has thus far had little perceptible effect on investment. Moreover, it appears that, in comparison with other U.S. industries, the *relative* attractions of investments in electronics may have been diminished, The telling point in the context of U.S. industrial policymaking is this: *such outcomes have been neither intended nor anticipated, instead resulting from the unexamined give-and-take of the political process.*

## Industrial Policymaking

As many of the examples above indicate—from antitrust through taxation (many others could be adduced)—public policies influencing the American electronics industry have lacked a framework and sense of direction, The very notion of objectives or "goals" for policy, in any but the most immediate sense, has been anathema for policy makers here. In contrast, other countries have pursued economic development quite consistently, making use of numerous policy tools. While in the United States there has been no one agency to serve as a focal point for industrial policies, other nations have developed policymaking approaches involving more or less permanent industrial advisory councils, ministries accountable for well-defined policy areas, mechanisms for coordination. Here, many agencies participate in policy development—sometimes on a regular basis, sometimes infrequently.

More often than not, policies affecting electronics have been formulated with little consideration of possible impacts on international competitiveness. National security, antitrust, macroeconomic policy have taken priority—competitiveness and economic efficiency have seldom been at the forefront, or even in view. Trade policy complaints in consumer electronics have come from domestic firms and their employees, with Federal agencies—ill-equipped to take an independent view—reacting to these pressures. Short-term response to political pressures has in fact been the common denominator of U.S. industrial policy.

Yet as competition has intensified—in computers and microelectronics, jet aircraft and telecommunications systems—both Congress and the executive branch have begun to debate the question of a more explicit industrial policy for the United States.[43] In addition, the Department of Defense through VHSIC and other programs, the National Science Foundation, and the Department of Commerce have all studied—even attempted to design, often under rubrics such as innovation—policies that would stimulate basic as well as applied research, and

[43]To give only a few examples, and leaving aside such related topics as innovation or productivity, late in 1980 the Subcommittee on Trade of the House Ways and Means Committee issued the *United States-Japan Trade Report* (Sept. 5, 1980), calling for overall improvement of the economy rather than trade protection as a response to Japan's growing challenge in high-technology industries. A report by J. Gresser—*High Technology and Japanese Industrial Policy: A Strategy for U.S. Policymakers* (Oct. 1, 1980)—recommending a more focused U.S. response was published soon thereafter under the auspices of the same committee, The Subcommittee on Trade's *Report on Trade Mission to the Far East* (Dee. 21, 1981 ) reiterates many of the same themes, More recently, the Joint Economic Committee has released a study by M, Borrus, J. Millstein, and J. Zysman entitled *International Competition in Advanced Industrial Sectors: Trade and Development in the Semiconductor industry* [Feb. 18, 1982) which stresses the importance of electronics for overall economic development.

Dozens of hearings in Congress over the past several years have covered such issues, two examples being *Industrial Policy,* hearing, Joint Economic Committee, Congress of the United States, May 18, 1982; and *U.S. Industrial Strategy,* hearing, Subcommittee on Economic Stabilization, Committee on Banking, Finance and Urban Affairs, House of Representatives, Sept. 22, 1982.

Trade and tax policy debates inside the Reagan administration have dealt at least peripherally with electronics, as has an interagency stud y on high-technology trade—see *An Assessment of U.S. Competitiveness in High-Technology Industries* (Washington, D. C,: Department of Commerce, February 1983). The Commerce Department has begun work on an inventory of industrial policy measures employed by other countries, while the Department of Labor has a long-standing interest in industrial policies, particularly as they deal with adjustment.

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encourage productive investments by the private sector. There is no dearth of concern over policies affecting industries like electronics, but little consensus as yet on the direction that policy initiatives should take.[44]

Chapter 12 addresses policy alternatives for the United States in some detail; here the point is that—in contrast to ongoing debates over industrial policy in other countries, which tend to focus on review and redirection of measures already in place—there is still no consensus in this country on the need for a more coherent industrial policy, much less on the form it might take. In a sense, the United States is *starting off behind in the race to develop effective industrial policies simply because U.S. industries like electronics led the competitive race for so many years.*

## France

Perhaps more than any other advanced Western nation, France has centralized and coordinated its industrial policymaking as one of the primary ingredients in an interventionist approach to economic policy. While the tools and tactics have shifted over time, the policies adopted by the current Socialist Government trace their origins to the planning process adopted by France in the aftermath of World War II. The continuity of the French system, like that of Japan, is one of its salient characteristics.

### The Setting

The French have accepted government involvement in the economy as legitimate and necessary. Industrial policies are part of a context that includes extensive public ownership of both manufacturing organizations and financial institutions; under Mitterrand, the electronics firms CII-Honeywell Bull, Thomson, and CGE (Compagnie Generale d'Electricity) have joined the roster of national enterprises, together with a number of banks. The goal has been not only to increase the financial resources and market power of French corporations, but to create prestigious flagships that can lead the economy. Saving jobs in threatened industries—e.g., steel—has also been an important motive; furthermore, the government's plan for the electronics industry promises to create 80,000 new jobs over the 5-year period 1982-86.[45] "National champion" firms were a capstone of French industrial policy during the 1960's, when France became the first nation to mount a direct challenge to IBM. Aircraft, nuclear power, and telecommunications have been other government favorites. The idea of national champions never really died, and has simply been revived in slightly different form under Mitterrand; electronics—computers, semiconductors, consumer products, communications, office automation—is to be at the core of France's future industrial policy.

Policymaking mechanisms in France—centered on the ministries of Industry and of Economy and Finance—differ greatly from those in the United States, as might be expected in a country where the idea that the state can and should play a role in industrial development has been widely affirmed. In the policymaking system that has evolved, the Ministry of Economy and Finance takes the lead in channeling funds to favored sectors (ch. 7), while the Ministry of Industry is more heavily involved in day-to-day matters, as well as technology and microlevel planning. Within the Ministry of Industry, the Directorate of the Electronics Industries and Data Processing is responsible for efforts such as the Government Program for Development of Electronics, announced late in 1982. Since the Socialists took power in 1980, the Ministry for Research and Technology has taken a larger role in industrial policy—not only the design of policies for high-technology industries like electronics, but

[44] OTA's comparison of U.S. competitiveness in three industries led to the suggestion of a "macroindustrial" policy. The intent would be to provide infrastructural support for American industries, rather than moving toward explicit Government decisions favoring some sectors over others. Examples would be policies directed at labor markets, technological development, human resources, taxation, and economic adjustment. See *U.S. Industrial Competitiveness: A Comparison of Steel, Electronics, and Automobiles,* op. cit., pp. 157-165.

[45] "Government Funding for Electronics Industry Discussed," *West Europe Report, Science and Technology, No. 118,* Joint Publications Research Service JPRS 81678, Aug. 31, 1982, p. 3.

also restructuring elsewhere in the French economy. Broad 5-year economic plans continue to be part of the policymaking process, although they have receded into the background compared to 30 years ago.

The staffs of French ministries tend to share similar educational backgrounds, typically the prestigious grandes ecoles. Not only the public sector, but large industrial enterprises as well, are managed by a small and homogeneous elite; the Socialists placed at the head of nationalized firms by the Mitterrand Government are in most respects indistinguishable from the men they replaced. The closed nature of this system helps the French bureaucracy wield authority more like that granted public officials in Japan than in the United States, Distinguishing features of French industrial policy—an emphasis on sectoral measures, perhaps stronger even than in Japan, and the encouragement of corporate consolidation—reflect not only the power of the bureaucracy but the community of interest binding industry and the state.

## Planning

Much has been written on indicative planning in France, which can be traced to the immediate postwar period and the Monnet Plan for reconstruction. As the term "indicative" suggests, the country's 5-year economic plans have not been imperative, but based on concerted actions mutually agreed on. In earlier years especially, officials in the Planning Commission played key roles in bringing together leaders in government and industry.

A major function of the planning process has simply been to gather information about past progress and future prospects by sectors in the economy. The hard decisions have been made elsewhere, with the role of the Planning Commission largely facilitory. While the rapid postwar recovery of the French economy cannot be attributed solely to planning and industrial policy, the planning exercise has helped crystallize perceptions among the bureaucracy, as well as decisionmakers in private industry, creating a shared referent for government and industry. Business has been able to operate within a fairly predictable context.

## Finance

The French financial system, like the planning mechanism, enhances government influence over economic development. Capital allocations—see chapter 7—are controlled to considerable extent by administrative fiat rather than market forces, A rather small number of financial institutions—closely tied to the bureaucracy whether or not actually nationalized—link government policy makers and companies seeking funds. The Treasury determines interest rates on bonds; through the Ministry of Economy and Finance, as well as a variety of semipublic lenders and the banks, the government can exert considerable leverage over credit decisions. Specialized institutions such as the Institut de Developpement Industriel (IDI), funded from both public and private sources, provide risk capital to medium-sized firms; ID I has also made equity investments in the computer firm Compagnie International pour l'Informatique (CII). Even in light of the French Government's traditional use of financial channels, Mitterrand's investment plans for electronics are extraordinarily ambitious. The industry—which is now roughly half nationalized—is to invest $20 billion over the period 1982-86, with the government providing about 40 percent of the total .[46] It is not clear where the money will come from.

## Le Plan Calcul

French policies as they have affected electronics have been shaped, as elsewhere in Europe, by historical circumstance—i.e., the relative weakness of French industry compared to American corporations. The result during the 1960's was a concerted thrust in computers known as Le Plan Calcul—not unlike what the French are now undertaking in electronics as a whole.

[46] Ibid. The 5-year investment plan calls for the government to provide 55 billion francs of the 140 billion total.

By the early 1960's, the enormous strength of IBM—combined with the comparative weakness of European firms—was perceived as a serious threat to the viability of the French electronics industry. It was the "American challenge''–viewed as a technological lead, but in reality just as much commercial superiority—that stimulated an ambitious effort by the French.[47] The well-known Plan Calcul came in 1966, on the heels of serious difficulties for the French computer industry. In the "Affaire Bull" of 1964, the American firm General Electric had purchased Machines Bull, a faltering French computer manufacturer. At about the same time, the U.S. Department of State refused to grant export licenses for two of Control Data's largest processors. These were to have been used in the development of fusion weapons; the refusal helped convince French policy makers of the need for an independent computer industry. Since then, if not before, the French military, although taking some care to stay in the background, has had a major say in industrial policy decisions affecting electronics and telecommunications.

Le Plan Calcul was intended to build an industry capable of challenging IBM; to do this, the bureaucracy engineered the merger of two existing manufacturers, forming a new public corporation—CII. The government provided capital to the fledging champion, but as the product of a union between two firms which together held no more than 7 percent of the French computer market, the new company had a long way to go.

CII's efforts were directed first and foremost at medium to large mainframes—the rise of the minicomputer was just beginning and had not been widely recognized. CII was to be an export leader, as well as providing for France's own needs, of which national security was at the forefront. Although CII was attacking IBM at the latter's point of greatest strength, French planners hoped—by providing export and other subsidies, encouraging shipments to the Soviet bloc and developing countries, protecting CII against foreign competitors, and guaranteeing domestic procurements for the company's products—to enable the firm to challenge IBM. A related series of measures over the late 1960's and early 1970's comprising Le Plan des Composants (Plan for Components) was to help with the development of semiconductor devices, primarily for computer applications.

Despite the support provided CII, the firm never approached its targets. American companies continued to dominate sales in France, and CII's chief market turned out to be the government, By 1975 Le Plan Calcul had effectively been abandoned, as a variety of factors combined to defeat the best efforts of French policy makers (who now insist that their efforts at least prevented further erosion of the nation's indigenous capabilities), Some critics emphasize the contradictions inherent in a protective strategy within a highly competitive industry, and a policy designed and implemented by technocrats with little experience of commercial realities.[48] Hindsight shows the effort to have been overambitious, an attempt to confront American firms across a broad line of products rather than in selected niches. In this sense, national goals took precedence over sound business strategy. Finally, the money that the French Government pumped into CII—perhaps $350 million between 1966 and 1976—looks rather insignificant next to, say, IBM's resources.[49]

Into the 1970's, then, French policy toward the electronics industry centered on one company—CII. By 1975, when the failure of Le Plan Calcul was clear, the government encouraged CII to merge with Honeywell Bull—the descendant of Machines Bull that emerged from the sale of General Electric's computer business to Honeywell. The new company, CII-Honeywell Bull (CII-HB), was majority French-owned; it quickly received further government

[47] This interpretation of the "challenge" is elaborated by N. Jequier, "Computers," *Big Business and the State,* R. Vernon (cd.) (Cambridge, Mass,: Harvard University Press, 1974), p. 193.

[48] J. Zysman, *Political Strategies for Industrial Order* (Berkeley, Calif.: University of California Press, 1977), p. 99.

[49] The $350 million estimate is from *Technical Change and Industrial Policy: The Electronic Industry* (Paris: Organization for Economic Cooperation and Development, 1980), p. 46. Jequier (op. cit., p. 217) gives a figure of $120 million between 1966 and 1970.

assistance totaling perhaps $700 million, so In 1982, after prolonged discussions, the Mitterand government effectively nationalized CII-HB, which will become a subsidiary of a government-controlled holding company taking up the old name Machines Bull. [51] Machines Bull will be the centerpiece of Mitterrand's computer thrust, discussed below, with CII-HB responsible for mainframes,

## Le Plan des Composants

Recognition that CII-HB needed infusions of semiconductor technology led to a new 5-year components plan in 1977. Military requirements were also a strong motive, Since the 1950's, France had maintained a small but high-quality semiconductor research effort. However, this had never been translated into a commercially viable merchant industry. By the early to mid-1970's, perhaps a hundred French engineers and scientists were engaged in R&D on advanced microelectronic devices; the country did not have the capability for mass-producing ICs. French engineers had little background in microprocessors, nor in MOS (metal oxide semiconductor) ICs, most of their expertise being in bipolar devices for communications and consumer products. Le Plan des Composants—designed by the ministries of Industry and Defense, plus the PTT (responsible for postal services and telecommunications)—was intended to rectify these deficiencies. In contrast to Le Plan Calcul, France did not attempt to keep foreign participants out, but sought to build on American technology, In this way, French planners hoped to move toward self-sufficiency in microelectronics, with the eventual goal of a major share of the European market,

The vehicles included three joint ventures linking American semiconductor firms with French partners. France would get technology, the U.S. participants access to the French market—particularly the lucrative telecommunications sector, well protected by the PTT. These joint ventures, in which the French partners held controlling interests, tied Thomson to Motorola, Saint-Gobain to National Semiconductor (in a firm named Eurotechnique), and Matra to Harris. In addition, the plan supported two more firms: Radiotechnique, a Philips subsidiary in France, and EFCIS, originally owned by the French atomic energy authority (Thomson purchased a majority interest in EFCIS in 1977).

Le Plan des Composants was developed at a time when France's Government was rediscovering market forces, Attempting to learn from Le Plan Calcul, French planners decided to support a number of firms. Rather than funnel the money set aside for the program to a single champion, the five companies would compete with one other. Although an element of competition was thus built in, each participant was assigned certain technologies in which it was to take the lead. Matra-Harris, for example, would specialize in c-MOS since this was Harris' strength; later the joint venture negotiated a further agreement with Intel, largely to gain the latter's n-MOS technology. ICs were new technologies for both Matra and Saint-Gobain, which were picked for the program in part because of their success in other fields–in the case of Matra, its high-technology experience in aerospace was a particular attraction, Saint-Gobain-Pont-a-Mousson, a major producer of glass and chemicals, had decided of its own accord to diversify into electronics; in addition to participating in Le Plan des Composants, the company purchased substantial interests in CII-HB and the Italian computer and office equipment firm Olivetti during this period, More recently, the French have decided that, if one national champion is too few, five are too many; since the Mitterrand government came to power, extensive discussions aimed at consolidation have been underway. Three centers of excellence in microelectronics seem likely to emerge. Both Matra and Saint-Gobain have been nationalized, with Saint-Gobain evidently forced out of elec-

[50] *Technical Change and Industrial Policy: The Electronic Industry*, op. cit., p. 46. Other estimates have ranged as high as $1 billion. Prior to the merger with Honeywell Bull, CII had been a participant with Philips and Siemens in the European consortium, Unidata. The consortium did not prove workable,

[51] "CII-Honeywell Bull Announces Restructuring in Line With French Plans for Computer Firms," *Wall Street Journal*, Dec. 21, 1982, p, 30. Honeywell's interest has been reduced to about 20 percent.

tronics.[52] Eurotechnique has been sold to Thomson, which purchased the shares of both Saint-Gobain and National Semiconductor, while retaining a technology exchange agreement with the American firm.

The R&D portion of Le Plan des Composants, known as Le Plan Circuits Integres, channeled about $150 million in government funds as direct grants and loans to the five companies. The money supported work on very large-scale ICs, ranging from circuit design to the development of processing equipment. Research centers, including the Electronics and Informatics Technology Laboratory of the French Atomic Energy Commission, were strengthened, while Le Plan Circuits Integres also supports microprocessor applications through a new Information Agency.[53]

It is too early to judge the success of Le Plan des Composants in building a viable commercial industry, but in terms of technology French semiconductor firms have made great progress. Eurotechnique manufactured its first ICs at the end of 1980 and has since expanded output at a high rate. EFCIS's production of advanced devices began about the same time. Despite rapid increases in production, however, the French entrants remain small on a world scale (see ch. 4, table 32), suffering from thin product lines and limited distribution networks. Still, the technical know-how they have acquired from American firms places them in advantageous positions compared to other European semiconductor manufacturers.

In recent years, the French bureaucracy has also given a good deal of attention to minicomputers and peripherals through Le Plan Periinformatique. Moreover, the components program has been linked to a major push into telecommunications—including developments such as videotext—that French planners embarked on in the mid-1970's; the PTT's ambitious projections envision 25 million terminals in French homes by 1990, pointing toward a rapidly growing market for semiconductors. As part of its telecommunications policy, the government has forced the sale of two foreign-owned companies (subsidiaries of ITT and Ericsson) to the Thomson group.

## Recent Developments

French industrial policy has been in something of a turmoil since Mitterrand's election. The outlines of the Socialist Government's program remain murky, although the intent is to emphasize electronics. Initiatives in semiconductors, computers, communications, and consumer products are likely to be even more tightly coordinated than in the past, And, while the themes of nationalization and merger policy predate Mitterrand, the Socialists have carried this aspect of French industrial policy still further.

Even before Mitterrand came to power, the Eleventh Five-Year Plan (1981-85) had targeted electronics for special support. The plan singled out six fields for massive government assistance, with electronics—ranking third in French exports of manufactures, after machine tools and chemicals—viewed as a critical sector.[54] Under the plan, total R&D expenditures in France are scheduled to increase to 2.5 percent of GNP by 1985. Currently, France is making a more concerted effort than any other European country to strengthen its technological base and promote high-technology industries, with considerable attention to training greater numbers of engineers and technicians. Le Plan des Composants indicated that the French had learned from the mistakes of Le Plan Calcul—and also from the commercial failings of the Concorde—with French industrial policy as it affects electronics and other high-technology sectors passing into a new stage, one marked by a more sophisticated un-

[52] See "Possible Strategies for Executing Microelectronics Plan," *West Europe Report, Science and Technology, No.* 112, Joint Publications Research Service JPRS 81340, July 22, 1982, p. 18; D. Marsh, "Thomson Absorbs Eurotechnique," *Financial Times*, Jan. 21, 1983, p. 14.

[53] "190 Million Francs in Next Five Years for VLSI Research," *West Europe Report, Science and Technology, No. 89*, Joint Publications Research Service JPRS 80022, Feb. 3, 1982, p. 7; "Le Developpement des Applications de L'informatique," *Lettre 101*, Oct. 7, 1980.

[54] *Rapport de la Commission Industrie*, Commissariats General du Plan, July 1980, p. 48. According to this report, electronics has received about 10 percent of all direct sector-specific aid to French industry in recent years [p. 113).

derstanding of international competition in commercial products and technical developments. This shift began during the 1978-80 period. Under Prime Minister Barre, the government claimed to be "decontrolling" markets, for instance cutting back on price controls. With a reemphasis on planning and national champions, came more stress—at least in official rhetoric—on market forces. Is Mitterrand likely to reverse this trend?

A fundamental plank in the Socialist platform had been nationalization of companies like CII-HB. As Mitterrand himself explains the Socialist strategy, the object is first to win back the domestic market in key industries such as steel, machine tools, semiconductors, and small computers.[55] In conjunction with further nationalization in the financial sector, the announced philosophy was "flexible" nationalization—with the government providing considerable support while promising to eschew extensive involvement in business affairs or economic planning at the micro-level. In appearance, this is not a sharp turn from the past; despite the lengthy history of planning in France, nationalized firms—so long as they have performed adequately–have operated relatively free of direct intervention by the bureaucracy.

In R&D and technology development the new government has also moved ahead in bold if seemingly disorganized fashion, Research support has been increased under the current 5-year plan, and is to include a new microelectronics project as a follow-on to Le Plan Circuits Integres, plus more money for computers and data processing, The government expects to put up two-thirds of the $500 million it believes must be invested in microelectronics over the 1982-86 period.[56] As in the past, much of the money will come from the Ministry of Defense. And as also in the past, the new microelectronics plan is but one piece of a much larger effort aimed at strengthening the entire French electronics industry.

While the overall outlines remain vague, the government is promising that investments in electronics—from both public and private sources, and including investments by foreign-owned firms (IBM, Texas Instruments, and Motorola are among the American electronics companies with a major presence in France)—will total $20 billion over the 5-year period 1982-86. The Government Program for Development of Electronics—presented in September 1982 after an extensive study by an Electronics Industry Task Force—is to be coordinated by an Interministerial Committee for Electronics, with representatives from the ministries of Industry and Defense, the Plan, and the PTT.

A primary vehicle will be 9 "national projects," chosen from 14 originally recommended by the Task Force. These national projects, which will get extensive government support, are intended to link private and nationalized firms, as well as the labor and user communities. The nine projects have the following titles:[57]

- consumer electronics;
- information displays;
- local networks;
- cable TV networks;
- very large-scale ICs (fabrication as well as design);
- central processing units for small computers;
- computer-assisted education;
- computer-assisted engineering; and
- computer-assisted translation.

The list is noteworthy for emphasizing computer systems from the perspective of user needs—not only the last three projects, but also that on local networks. All are software-inten-

[55] "Mitterrand: Why Nationalization Will Work," *Wall Street Journal*, Oct. 7, 1981, p. 27.

[56] "Microelectronics Plan: Win Market, Technology Independence," *West Europe Report, Science and Technology, No. 113*, Joint Publications Research Service JPRS 81392, July 29, 1982, p. 10.

[57] See R, T. Gallagher, "$20 Billion for French Electronics," *Electronics*, Sept. 8, 1982, p. 104; "Fourteen Projects," *West Europe Report, Science and Technology, No. 116*, Joint Publications Research Service J PRS 81575, Aug. 18, 1982, p. 14. Among the five that were dropped-not necessarily permanently—was a supercomputer effort.

sive, a field in which France is in a relatively good position. The plan does not neglect consumer products. France hopes to increase its presence in consumer electronics markets throughout Europe, with Thomson moving aggressively into new generations of products like VCRs, electronic toys and games, and home information systems.[58]

The Socialist Government faces severe obstacles in implementing such a vast program. In addition to the $20 billion in planned investments, a considerable increment compared to recent expenditures within the industry, France has an inadequate supply of men and women with training and skills in electronics; the shortfall is reckoned at more than a thousand engineers yearly and at least three times as many technicians. The development plan contemplates an extensive training effort, including the establishment of several new schools, Moreover, foreign firms with investments in France may resist some elements of the program. Joint venture participants, for instance, could prove less willing to transfer technology when the partner is a nationalized concern. But in the end, money will probably be the limiting factor; boosting France's R&D expenditures from 2 percent of GDP in 1982 to 2.5 percent by 1985 is extraordinarily ambitious. And, with nearly three-quarters of R&D carried out in government-controlled institutions, France runs a real risk of stifling innovation and new ideas.

## Future Prospects

While the hallmarks of French industrial policy remain the same—an elite corps of officials, centralized policymaking, and a preference for sectoral policy along with a tradition of state intervention in the affairs of industry—Mitterrand's philosophy does represent a turn away from the market orientation of Giscard d'Estaing. It is too soon to assess the effectiveness of the new avenue, but past results give some insights. Government efforts under Le Plan Calcul must be termed a failure, although CII-HB's troubles had multiple sources. In semiconductors, Le Plan des Composants seems to have functioned much better. Even so, the largest French producer—Thomson—controls only a quarter of the domestic market, with a market share in all of Europe that is perhaps 7 percent. Most of Thomson's sales are in discrete semiconductors; the company has no more than about 2 percent of the European IC market. Although Thomson appears to have benefited considerably from technology-assistance agreements with Motorola, as have Matra and Eurotechnique through their joint venture with American partners, French electronics firms—along with most European manufacturers—remain heavily dependent on foreign sources of MOS and microprocessor technology.

The history of French electronics policy shows that *strong government direction cannot by itself produce a competitive industry,* At the same time, the French seem to be learning how to make their electronics policy function more effectively.

## United Kingdom

In contrast to the French, with their reliance on centralization and government action, Britain's industrial policy has been closer to that of the United States—largely ad hoc, not well coordinated. There is at least one major difference: the United Kingdom during the 1970's began to experiment with a variety of novel measures intended to directly affect the actions of industry. Ranging from programs to encourage applications of microprocessors to government investment in the semiconductor venture Inmos, these initiatives are far different from the arms-length approach to industrial policy of the United States (U.S. policies related to national defense are, as usual, the exception). At the same time, these policies—some of which attracted considerable attention in other parts of the world—were pursued with little sense of direction. Only in its support of International Computers Ltd. (ICL) through procurement practices, R&D funding, and other con-

5a'' First Details Published on Electronics Plan, '' West *Europe Report, Science and Technology, No. 120,* Joint Publications Research Service JPRS 81804, Sept. 20, 1982, p. 7.

ventional policy tools has Britain shown much consistency over the longer term in policies toward electronics.

Measures to aid ICL, in several respects similar to the somewhat earlier French effort to build and strengthen CII-HB, date from the late 1960's. In the latter part of the 1970's, the United Kingdom's electronics policies, as in many countries, turned towards semiconductors; a group of programs were developed to promote IC technology and applications, Even so, neither today nor at any point over the past decade does the British example show much evidence of a coherent view of industrial policy.

## Early Experiments

Certainly Britain has had ample incentive to try new approaches; since the early 1960's, policymakers in the United Kingdom have sought ways of grappling with the nation's lackluster economic performance—by most measures the poorest among industrialized nations. During the 1950's, macroeconomic policies had been assumed sufficient for revival. But continuing inflation, along with persistent wage disputes, convinced the ruling conservatives to move toward a more active government role. The National Economic Development Council (NEDC) was established in the early 1960's as a forum where business, labor, and government could air their ideas about the future direction of the economy.[59] Inspired by the prestigious French Commissariats du Plan, NEDC was empowered to produce 5-year plans intended to reduce uncertainty about the directions of government economic policy. Planning responsibility fell mainly on a National Economic Development Office attached to the NEDC.

The Labor Government which came to power later in the decade continued this general orientation, and picked up the pace by establishing a number of Economic Development Committees to deal with specific industries. The Electronic Development Committee, set up in 1964, produced a series of reports that identified problems and proposed strategies for overcoming them. But by the end of the decade, the planning experiment had run afoul of persistent conflicts with the macroeconomic policies that Britain's leaders were determined to pursue; economic planning came to be viewed as a failure, and the visibility and influence of the Economic Development Committees waned.[60]

## The More Recent Context

Since the beginning of the 1970's, U.K. industrial policy has been a hedge-podge. As in the United States, consistency has been found mostly in the area of national defense. A host of government offices, themselves subject to periodic reorganization and changes in direction, have been involved in policies affecting Britain's electronics industry. The National Research Development Council, set up as early as 1948 to provide financial support for joint research ventures under the Ministry of Technology, is one example. The Ministry of Technology also had jurisdiction over the Industrial Reorganization Corp. (IRC), established in 1966 to aid industrial restructuring. Under the authority of the Industrial Expansion Act, the Ministry of Technology engineered the mergers creating the computer firm ICL, as discussed in more detail below. The IRC likewise provided financial backing and other encouragements for a series of mergers that enlarged GEC, the British General Electric Co. But the interventionist IRC was abolished in 1971, about the time the Ministry of Technology became part of the larger Department of Trade and Industry—which has since again been di-

[59] For an outline of the origin and role of the NE IX, see T. Smith, "The United Kingdom," *Big Business and the State*, op. cit., pp. 88ff. Most of the discussion on the earlier years of Britain's industrial policy is drawn from this source. Also see S. Blank, "Britain: The Politics of Foreign Economic Policy, the Domestic Economy, and the Problem of Pluralistic Stagnation," *Between Power and Plenty: Foreign Economic Policies of Advanced Industrial States*, P. J. Katzenstein (cd.) (Madison, Wis.: [University of Wisconsin Press, 1 978), pp. 1 14ff.

[60] They still exist, however. The committee for electronics recently issued a report urging a comprehensive sectoral policy for the industry. See "Prescription for Electronics," *Financial Times*, Apr. 30, 1982, p. 16.

vialed, leaving a Department of Industry and a Department of Trade.

Among other agencies active in industrial policymaking, the National Enterprise Board (NEB) has had considerable leverage because of its ability to provide direct financing to British firms. Established in 1975, NEB has concentrated on startups such as the semiconductor manufacturer Inmos, to which it gave about $90 million in equity capital (ch. 7). In quite different realms, the Science Research Council and the Advisory Council for Applied Research and Development, set up in 1976, are intended to supply policy guidance on such topics as applications of new technologies and the education and training of engineers,

The number of government bodies involved in Britain's industrial policy provides one explanation for the random approach to programs in electronics. In France, relatively clear lines of authority link the various parts of the bureaucracy dealing with electronics; certain agencies have the lead role in certain areas. By comparison, the British approach is uncoordinated. In further contrast to the situation in France, Britain has never been very comfortable with government intervention in the affairs of business–rather surprising considering the size of the public sector. Not only do government plus the nationalized firms employ about a quarter of the British labor force, but publicly owned enterprises account for more than 10 percent of the country's industrial output and in recent years about a quarter of total capital investment.[61] Nationalized firms in industries like steel and automobiles have received more attention from British policymakers than electronics. Still, the United Kingdom's approach to the electronics industry does reflect a belief that government can strengthen existing firms as well as create new ones,

## ICL

The formation of ICL was preceded by much less rhetoric concerning the need to create national champions than in France, but the emergence of ICL in 1968 was similar to that of CII-HB. ICL benefited not only from government financing, but from aid for R&D and the promise of public sector purchases of its products, Britain's Government encouraged the series of mergers by which the company was formed, and supplied about $12 million a year until 1976 to stimulate its growth.[62] Despite this, ICL never emerged as a viable competitor in the world computer industry. Although still holding more than a third of the U.K. market—largely the result of government procurements coupled with "Buy British" persuasion aimed at private firms—ICL has had little success outside the United Kingdom. Within Britain, the Central Computer Agency, responsible for government purchases, gave perhaps 90 percent of its orders to ICL during the early 1970's.[63] This is a major reason why the United Kingdom joins Japan as one of only two countries where American computer manufacturers and their subsidiaries do not have at least half the installed base.

ICL is known for its software, but—like most computer manufacturers outside the United States—missed the shift toward small systems. The company has also been handicapped by the lack of a strong local semiconductor industry. Since the latest government initiative—a package of loan guarantees totaling nearly half a billion dollars, and the installation of a new management team headed by a long-time executive of Texas Instruments' U.K. subsidiary—there have been signs of revival.[64]

Not long before jumping back into try to save ICL—in part because mergers or takeovers involving American companies were rumored—

[61] P. Maunder, "Government Intervention in the Economy of the United Kingdom, " *Government Intervention in the Developed Economy,* op. cit., pp. 131-137,

[62] "Technology and Trade Policy: Issues and an Agenda for Action, " op. cit., p. 58.

[63] G. de Carmoy, "Subsidy Policies in Britain, France, and West Germany: An Overview, " *International Trade and Industrial Policies,* S. J. Warnecke (cd.) (New York: Holmes& Meier, 1978), p. 38.

[64] E. Bailey, "Britain's Role at Ailing ICL, " *New York Times,* May *18, 1981,* p. Dl; S. Love, "New Talent Spurs Britain's ICL, " *Wall Street Journal,* Mar. *1, 1982,* p. 27.

the Thatcher government had sold off the publicly held 25 percent of the company's stock. ICL's checkered past thus illustrates the "stop-go" quality of industrial policy in the United Kingdom. The uneasy relationship between Inmos and the government has followed a similar pattern, one in which Inmos faced considerable uncertainty over whether the Thatcher administration would provide the second installment of capital—another 25 million pounds—that the company was counting on.

## Research and Development

Beyond support of ICL, the U.K. computer industry benefited during the late 1960's and early 1970's from R&D funding provided through the Advanced Computer Technology Project, which provided up to half the costs of projects dealing with hardware or software. The British have also attempted to aid their electronics industry through efforts like a preproduction order program, in which the government purchases newly developed products and leases them to users—or "clients. " After a trial period, the client prepares a report on the new product and then must either buy or return it. Other programs have supported software development and marketing, as well as microelectronics. In addition to contracted basic research, paid for by both civilian and defense agencies, commercial product development has been financed through government contracts, particularly to ICL.

Nonetheless, the United Kingdom has been a poor performer in R&D—more precisely, in development, Although British scientists continue to do excellent basic research, industry has been reluctant to invest heavily in R&D directed at commercial products and processes; between 1967 and 1975, real R&D expenditures by industry declined. Furthermore, sectors like electronics have suffered from a lack of capable engineers. While government R&D expenditures have been heavily concentrated on electronics and aerospace—in 1975, 30 percent went to electronics and communications alone —this spending, largely motivated by military needs (table 77, ch. 10), has had little perceptible effect on the competitiveness of British firms. Tellingly, electronics and communications manufacturers have spent less of their own money on R&D than the government has contributed; in 1975, private firms spent 113 million pounds on R&D, publicly held corporations 36 million pounds, and the government 130 million.[65] In the United States, the impacts of military spending on electronics have been far overshadowed by the vigor of the commercial industry; the British case has been vastly different.

## Other Policies Toward Electronics

Among the more intriguing programs of the U.K. Government have been those aimed at utilization of microelectronics. In the midst of a lengthy debate on the question of whether the country needed an indigenous capability to design and manufacture advanced ICs, the Microprocessor Applications Project (MAP) was established to encourage companies in any industry that could to incorporate these devices in their products, MAP, which began in 1978 and has been somewhat reluctantly continued by the Thatcher government, funds up to 25 percent of the costs of product development. Increased support is provided for microelectronics-related programs in schools and colleges, principally teacher training. A third element consisted of a consciousness-raising campaign aimed at 50,000 managers in private industry, with MAP funds supporting seminars to educate corporate decisionmakers on the virtues of the new technology. Government spending through MAP totaled nearly $100 million over a 3-year period .88

A related program known as MISP—the Microelectronic Industry Support Programme, also started in 1978—aids firms in developing and manufacturing ICs. MISP was stimulated by a report prepared for the NEDC which stressed the importance of design and processing expertise; a central goal was mass produc-

[65]K. Schott, *Industrial Innovation in the United Kingdom, Canada and the United States* (London: Contemprint, July 1981), p. 12.

"''Microelectronics, The New Technology, " Department of Industry, London, 1981, p. 23.

tion capability in standard devices.[67] Among the steps taken were the establishment of a joint venture between the British firm GEC and Fairchild, then still American-owned, to manufacture a broad-based line of ICs. More ambitious was the decision to establish a greenfield firm, Inmos.

NEB's announcement in June 1978 that Inmos would receive equity funding from the government to design and manufacture n-channel MOS circuits, starting with memory chips, generated a good deal of controversy within Great Britain (NEB has considerable independence in making such decisions). The attempt to replicate a merchant semiconductor firm on the American model—complete with executives experienced in U.S. companies and a design center in Colorado Springs—was a move directly into the central arena of worldwide competition, The risks were high. Inmos was to begin production of 64K RAMs in 1981—a target which slipped, but as it turned out, no more than those of a number of well-known American firms.

Inmos is a unique experiment; the government committed 50 million pounds, split into two installments, with the hope not only of creating a first-rank semiconductor company, but also of luring talented British engineers back from employment with foreign firms (one reason for the Colorado Springs location), Stimulating end-users in Britain was another major objective, While there are still many doubters, Inmos appears to have had reasonable success in developing its first products. The company has plans for a new family of microprocessors, as well as a broad line of memory chips. Becoming profitable may be more difficult.

Since the election of the conservative Thatcher government in 1979, efforts such as MAP and MISP have been scaled back. The conservatives' review of the Inmos venture revived public debate over the company's prospects. After a considerable period of uncertainty, during which it appeared that NEB's holdings in the firm might be sold, and following a decision by Inmos executives to locate a production facility in the depressed area of South Wales, funding was continued. In late 1981, NEB reported $22 million in pretax losses, more than half accruing from its holdings in Inmos; losses are to be expected during the early years of such an enterprise, and it is still too early to judge the success of this recent entry into the world semiconductor industry, but the qualms of the conservative government are not surprising.

## Has Britain's Approach Worked?

The answer, implicit in much of the discussion above, is that it has not. While some of the initiatives in electronics may eventually have positive results, U.K. industrial policy as a whole has suffered from lack of consistency—even during periods when the same party has been in power–and from a rather odd, if not chaotic, mixture of policy instruments. Even the direct beneficiaries, British electronics companies, have not been very enthusiastic about the government's support efforts, viewing them as favors likely to be withdrawn on short notice.[68] Some executives in British industry could be described as not only skeptical but cynical about their government's policies. Nothing like the symbiotic relationship between business and government in Japan, or even France, has emerged in the United Kingdom.

The grab-bag character of U.K. policies toward electronics has stemmed in part from the inconclusive nature of debate over the need for a continuing British presence in semiconductor *manufacturing*. Many took the position that, so long as British industry *applied* ICs in its products, there was no need to have home-grown design and production capability. Others held that, lacking an IC design and production base, applications would always lag those in other countries, Rather than coming

[67]See *Microelectronics Into the 1980's* (Luton, England: Mackintosh Publications Limited, 1979], p. 27, for a summary of the Sector Working Party report to NE DC.

[68]See D. Imberg and J. Northcott, *Industrial Policy and Investment Decisions* (London: Policy Studies Insitute, 1981), pp. 72-73. Also J. Northcott and P. Rogers, *Microelectronics In Industry: What's Happening in Britain*, No. 603 (London: Policy Studies Institute, March 1982], especially ch. 8.

to a decision, the British have tried to have it both ways—supporting Inmos, though never whole-heartedly, while also pursuing applications and technology diffusion through MAP and MISP. Similar patterns, over a longer time period, have characterized the government's dealings with ICL; after many years of public support, the Thatcher government withdrew, only to find itself forced to the rescue of the faltering computer manufacturer. Industries like steel and automobiles show similar oscillations in government attitude.

The fact is that foreign firms have already captured major shares of most British electronics markets, except where the government itself is the customer—e.g., the defense sector. Outside the government market, ICL presents little challenge to its American and Japanese competitors, just as British firms now hold only a small share of U.K. semiconductor sales. Thus, ICL's agreement with Fujitsu, entailing marketing of Japanese-built mainframes in England, also involves purchases of Fujitsu semiconductors. While ICL has also negotiated for rights to U.S. and Canadian technology, Britain does not seem as well-placed as France to make use of foreign know-how, and may find that it is already too late for technological independence.

In sum, many of Britain's industrial policy efforts in electronics seem to have been too little and too late. The formation of Inmos and the creation of MAP and MISP came at the close of the 1970's, by which time American and Japanese suppliers were firmly established in the U.K. market.

Industrial policy has been doubly difficult because of the stagnant British economy. As economic troubles continued, the government cut back its R&D support, making progress in industries like electronics still less likely. Recently, the Thatcher administration has tried to streamline industrial policymaking by merging the National Research Development Corp. and the NEB into a "British Technology Group. " One goal has been to temper the activist policies of the NEB, which enjoyed considerable autonomy in the past. There is no indication yet that this will produce positive results. To be fair, industrial policies—of whatever stripe—are a limited tool when the overall economic situation has been as grim as Britain 's. While U.K. industrial policies may seem neither efficient nor effective, they have perhaps been asked to do the impossible.

## West Germany

Industrial policy in the Federal Republic of Germany (FRG) has been distinguished by reliance on the market. Objectives have been allowed to remain vague beyond the level of macroeconomic policy, where stability has been paramount. But if private sector actions have been central, this does not mean the role of the public sector has been negligible, Following a "social market philosophy, " the West German Government has helped reconcile national, regional, and interest group concerns. The Act for the Promotion of Stability and Economic Growth (Gesetz zur Forderung der Stabilitat und des Wachstums der Wirtschaft) provides a set of tools to coordinate economic policymaking among government, management, and labor aimed at ''macroeconomic equilibrium." While avoiding extensive planning, policymakers have paid consistent attention to structural adjustment; since the mid-1960's and the tenure of economics minister Karl Schiller, it has been widely accepted that policy instruments could be deployed to "rationalize" markets and ease structural change. Especially since the mid-1970's, the FRG has also provided considerable support for R&D. Although proponents of an avowedly sectoral approach to industrial policy have become more vocal, it is still true that industrial policies are market-oriented, with limited reliance on public ownership compared to a number of other Western European nations, and a strong commitment to open international trade. Nevertheless, the German Government has sometimes taken strong and direct action on the sectoral level when economic problems have arisen.

### The Institutional Setting

Economic and industrial policymaking in the FRG combines elements of decentralized decisionmaking with representation by major interest groups, including labor. The ministries of Finance, Economics, Labor and Social Affairs, and Research and Technology are among the more influential in terms of policies affecting industry. Macroeconomic policies are developed and implemented by a number of agencies. The Ministry of Finance submits 5-year plans. Since the early 1960's, a five-person Council of Economic Advisers–comprised of academics not otherwise attached to the government—has been responsible for macroeconomic forecasting. The Council also prepares annual reports on the health of the West German economy. Money supply is the responsibility of the Deutsche Bundesbank—legally independent of the government, though closely tied to it. Policies and analysis related to economic and industrial development are centered in the Ministry of Economics. The Lander (state) governments help formulate economic as well as regional development policies. A joint Federal-Lander planning committee, for instance, draws up regional action programs identifying growth points (schwerpunktorte) to be promoted via investment grants, West Germany has emphasized regional development perhaps more heavily than any other Western industrial nation, with the Lander Governments central to these efforts.[69]

As chapter 7 pointed out, financial institutions have a special place in the West German policymaking structure—as they do in France and Japan. Executives of the central Bundesbank keep in close contact with public officials, and normally act in support of the government's economic policy, The Bundesbank's control of the money supply gives it direct influence over the value of the deutsche mark, During the years of rapid economic expansion, particularly the early 1960's, the bank helped maintain an undervalued currency—a strategy that strengthened the export competitiveness of German goods but earned a good deal of criticism from the country's trading partners.

The Federal Government also holds majority shares in five banks, while cities and states have their own financial institutions. One of the nationalized banks, the Kreditanstalt fur Wiederaufbau, is a development bank that provides funds to commercial lenders. TO While the financial communities are major seats of influence over industrial policy in both West Germany and France, they function quite differently in the two countries: rather than selective credit for favored firms and industries as in France, German banks have supported fiscal and monetary policies oriented toward aggregate growth.

If economic and industrial policymaking in West Germany is less centralized than in France, the lines of responsibility are more clearly drawn than in Great Britain. While the Research and Technology Ministry (BMFT), say, tends to approach industrial policy with a perspective quite different from that of the Economics Ministry, the division of authority is more or less predictable and consistent. Germany's parliamentary system has seen few changes in government since 1949; when a different party has come to power, overall objectives such as maintaining the country's export strength while controlling inflation have been retained.

## Policymaking Processes

A distinctive feature of the German system is the broad representation of interests, the effort made to integrate diverse points of view. The Stability and Growth Act empowers the Federal Government to provide "orientation data" for policy measures to be "simultaneously and mutually agreed upon" by Lander and local governments, labor unions, and employers' associations, In the late 1960's, "concerted action" incomes policies were developed, aimed at consistency in approach among government bodies and socioeconomic groups on budgetary matters as well as wages and prices. Concerted action was not an attempt to sup-

[69] G. de Carmoy, "Subsidy Policies in Britain, France and West Germany: An Overview, " *International Trade and Industrial Policies*, S. J. Warnecke (cd.) (New York: Holmes & Meier, 1978), p. 52.

[70] E. Owen-Smith, "Government Intervention in the Economy of the Federal Republic of Germany, " *Government Intervention in the Developed Economy*, op. cit., p. 176.

plant the monetary and fiscal policies of the Federal Government, but was intended as an adjunct and complement to these, the basic objective again being the creation of an environment conducive to economic growth. Like codetermination—which ensures labor a voice in plant operations—concerted action sought to integrate labor and other interest groups into the mainstream of policy formulation. Today, concerted action has fallen into disuse, but speculation on its revival regularly surfaces; if nothing else, this indicates the persistence of the view in Germany that sound economic and industrial policies depend on broadly based consensus-building.

Indeed, institutionalized participation by major social groups appears to offset much of the fragmentation that otherwise might seem to characterize industrial policymaking in the FRG. As in a number of other Western European countries, notably the Scandinavian nations, Germany's industrial policy is marked by concern with labor issues. In 1974, the BMFT and the Ministry of Labor and Social Affairs set up a joint research program on "humanization of the workplace. " Directed not only at health and safety issues, the program aims as well to identify and encourage organizational changes that would increase job satisfaction (ch. 8). A number of studies sponsored by the program, which is oriented strongly toward field experiments and employee participation, have explored impacts of automation and computer technologies. [71]

The systematized participation of labor in West Germany is especially noteworthy in contrast to Japan or France, In Japan, organized labor is in fact—if not always in appearance—relatively powerless; the consensus so clearly visible in Japan comes, not from full participation, but from a rather passive acceptance by other groups of policies that business and government have agreed on. In France, organized labor is vocal—with a marked radical cast—but labor participation in setting policy has not been internalized as in Germany. French unions traditionally exert pressure on the government through political activism, often confrontational. Even with Mitterrand and the Socialists in power, this is not likely to change much,

## Policies Toward Electronics

Despite its stress on macroeconomic tools, West Germany has, over the years, instituted a considerable number of policies directed at specific industrial sectors, Some have been in portions of the economy where government ownership has been widespread—e.g., energy and banking, In contrast, sectoral involvement in electronics has been mostly restricted to R&D; compared to both France and the United Kingdom, military involvement has not been prominent. Moreover, in further contrast with these two countries, when FRG officials attempted to encourage a "rapprochement" among Siemens and several other computer manufacturers, the large and powerful Siemens concern resisted quite successfully.[72] When AEG-Telefunken—after Siemens the country's largest electrical and electronics producer–fell on hard times, the private sector at first dealt with the crisis on its own. A consortium of 24 commercial banks engineered a massive rescue effort, with financing totaling more than half a billion dollars.[73] Only when the bankers' efforts proved insufficient did the government step in with a package involving further loan guarantees and export credits. 'A As this implies, and as chapter 7 described in more detail, cooperation among industry and financial institutions in the Federal Republic has been common—and an increasing subject of parliamentary scrutiny and public criticism, on grounds that the power of the banks is too great.

Despite efforts such as the aborted Telefunken rescue, government influence has not been exercised as directly in electronics as in

[71] "Research on the Humanization of Work, " Ministry for Research and Technology and Ministry of Labor and Social Affairs, document No. 2181/74e,

[72] Jequier, op. Cit., p. *217,*

[73] K. Done, "The Last Chance Rescue, " *Financial Times, June* 14, *1982,* Under *West German* law, banks can own equity in private firms and act as brokerage houses (ch. 7). German banks held about *40* percent of Telefunken's stock.

[74] See "Germany's Telefunken Insolvent, " New *York Times,* Aug. 10, 1982, p. D1. Nonetheless, the firm entered bankruptcy in mid-1 982.

sectors such as energy (where subsidies have contributed to high domestic coal prices), steel (where firms such as Salzgitter are publicly owned), or shipbuilding (where a range of policy initiatives have been marshaled to shelter the industry from decline) .[75] Still, since the late 1960's the West German Government has sought ways of strengthening the nation's computer industry. While on the whole the German electronics sector has been the strongest of any in Europe, it has shared the common weakness in computers. Part of the reason appears to have been that the bigger electronics firms—Siemens, AEG-Telefunken, SEL–were already heavily committed to other lines of business—consumer products, telecommunications, electrical machinery. Much like such American companies as RCA or General Electric, these large and diversified enterprises never developed much strength as computer manufacturers. From the standpoint of the German Government, there really was no computer industry as such to support. As a result, it proved difficult to devise effective policies for encouraging either the technology of computing or commercial production. As in many other countries, government procurements have been channeled to local firms. Nevertheless, in contrast to Japan and France, the FRG has largely avoided attempts to shield the industry from foreign competition, relying instead on domestic supports and subsidies. * A major thrust of German efforts has been to stimulate utilization of computers through training programs and applications support.

Although benefiting from government funding amounting to more than 100 million deutsche marks (something over $50 million—in fact a relatively small fraction of West Germany's total subsidies during the 1970's for computers and information processing), Telefunken never achieved much success in computer systems. Siemens remains the largest German-owned computer manufacturer, somewhat ahead of Nixdorf in sales (ch. 4, table 42). But Siemens' production is far less than that of IBM's German subsidiary; Siemens has never appeared to view computers as a major piece in its corporate strategy. The company has only about 20 percent of the German computer market, and less than 10 percent for Europe as a whole. Nonetheless, Siemens continues to receive by far the largest share of government funds for R&D in computer technology. 75 The contrast with Nixdorf—a manufacturer of business-oriented minicomputers—is striking. Nixdorf is an aggressive worldwide competitor in its chosen markets, much in the American mold; the company has accomplished this with little government assistance,

Again in common with other European electronics firms, a number of German manufacturers have pursued ties with American and Japanese enterprises, one aim being technology acquisition. In 1978 Siemens purchased 20 percent of Advanced Micro Devices. More recently, the company negotiated an agreement with Japan's leading producer of computers, Fujitsu; Siemens now markets several of Fujitsu's IBM-compatible mainframes in Europe. Such arrangements have brought criticism of government support for Siemens as failing to promote an indigenous computer industry.

## Research and Development Support

Financial subsidies for Siemens' computer efforts have been part of a considerably larger program of technology development in the FRG. Total R&D expenditures grew more than 60 percent in real terms between 1969 and 1980, increasing from 2.1 percent of GNP to 2.3 percent; the West German Government has

[75]See Owen-Smith, op. cit.: p. 174 on coal prices; P. 184 on Salzgitter; p. 173 on shipbuilding.

*Even so, a recent trade dispute shows that—in Germany as elsewhere—foreign firms are often discriminated against. In a case similar to AT&T's choice of Western Electric over Fujitsu in fiber-optics, Bremen University was forced to reverse a decision to purchase a computer system from Burroughs. The contract went to Siemens at a price considerably above the American bid. See "Technology and Trade Policy: Issues and An Agenda for Action, " op. cit., p. 49.

[76]By 1978, the West German Government had supplied Siemens with a cumulative total of 351 million deutsche marks (nearly $200 million) for the development of large- and medium-sized computers. See "Sixth Report of the Federal Government on Research, ' Federal Minister for Research and Technology, Bonn, 1980, p. 82. The computer support programs of the BMFT now seem widely viewed as failures; they have been drastically scaled back.

strongly supported R&D, which has accounted for 3 to 4 percent of the Federal budget during the past decade. [77] Since the initiation of the second data processing program in 1969, the electronics industry, and particularly the components sector, has received a substantial fraction of this spending; 30 percent of German R&D funds have gone to electronics (and electrical equipment)—a greater fraction than in any of the other countries listed in table 77, But while government support for electronics as a whole increased steadily during the latter part of the 1970's, it appears to have peaked at the end of the decade, with the more recent contraction stemming from disappointing results in computer technology. [78]

Disillusionment with support for computer systems has led industrial policy makers in the Federal Republic to reorient their programs toward microelectronics. Here funds have gone toward device physics and processing technologies, as well as IC design and development. Between 1974 and 1978 relatively modest sums were spent by the government on microelectronics R&D—about $30 million annually. A somewhat more ambitious effort began in 1979. Like the computer R&D which it supplanted, VLSI support at first centered on the large electronics manufacturers. In its first program, the government contributed about $300 million over the period 1976-82, with industry participants putting up matching funds and competing on a proposal basis.[79] The German VLSI program has been much less centralized than Japan's; participants work independently, with the responsibilities of government officials limited mostly to coordination and avoiding duplication. Siemens has received 25 to 30 percent of the money, with Telefunken and Valvo each getting 10 percent or more. Industry seems to have regarded the program as useful but not of great impact; the major German electronics firms have traditionally had strong commitments to R&D—including basic research—and government money appears to have gone mostly to efforts that the private sector has judged marginal. Indeed, a principal rationale has been to finance projects with time horizons too long for industry to justify.

While most of the money in this first major VLSI program went to big companies, the FRG has also paid a good deal of attention to smaller firms—of which there are more than a thousand in electronics.[80] In contrast to the market orientation of other German industrial policy initiatives, the BMFT—a relatively new agency—has designed an array of sector-specific programs aimed at small enterprises and growth industries like electronics and biotechnology. Small technology-based firms in the Federal Republic often face difficulty in raising capital. As in most countries other than the United States, venture capital markets are miniscule. Viewing this as an obstacle to innovation, and with motives much like those leading to the creation of the National Enterprise Board in Great Britain, the FRG Government set up a venture financing company (Deutsche Wagnisfinanzierungsgesellschaft) in 1975. This organization purchases minority interests in German firms —with the intent of backing innovative developments—while giving the proprietors preferential rights to buy back the equity if their business succeeds.

The turn toward support for smaller companies has also been reflected in the BMFT's latest

[77] "Sixth Report of the Federal Government on Research," op. cit., p. 75; "FRG's Position in World R&D Community Assessed," *West Europe Report, Science and Technology, No. 72,* Joint Publications Research Service JPRS *78876,* Sept. 1, 1981, p. 40.

[78] "Sixth Report of the Federal Government on Research," op. cit., p. 53. While the budget for government expenditures on electronics R&D was scheduled to increase from about 350 million deutsche marks in 1975 and 1976 to more than 600 million in 1980 and 1981, expenditures in these later years were cut back considerably from the amounts originally planned.

[79] M. Gold, "West Germany Reported About To Launch $300 Million VLSI R and D Plan," *Electronic News,* Apr. 30, 1979, p. 1; "European Semiconductor Industry Markets, Government Programs," *West Europe Report, Science and Technology, No. 134,* Joint Publications Research Service JPRS 82686, Jan. 20, 1983, p. 32.

[80] "General Scheme of the Federal Government's Research and Technology Policy for Small and Medium-Sized Undertakings," Ministry for Research and Technology and Ministry of Economics, 1979 updating. Also see *Innovation in Small and Medium Firms* (Paris: Organization for Economic Cooperation and Development, 1982), pp. 133-139; and G. Kayser, "Small Business Policy in the Federal Republic of Germany," *European Small Business Journal,* vol. 1, winter 1983, p. 39.

semiconductor program. The 3-year effort, beginning in 1982 and funded at about $45 million per year is—like a number of Britain's more recent initiatives—directed primarily at applications.[81] This new program comes on top of a 40-percent increase in microelectronics R&D support that had already been scheduled. Most of the applications money will be channeled to small firms, with one of the objectives being job creation; of 1,000 grant applications received during the first 6 months, two-thirds were from companies with fewer than 200 employees, Administration is the responsibility of the VDI Technology Center, established by the BMFT in 1976 specifically to help small- and medium-sized firms develop and apply microprocessor technology.

## The Fraunhofer Gesellschaft[82]

West Germany's attentiveness to smaller enterprises does not stop with microelectronics. The Ministry of Economics supports more than 80 industrial research associations, while the Fraunhofer Gesellschaft (Association of Institutes of Applied Research, FhG)—comprised of some 25 institutes which function as R&D laboratories—has as one of its major responsibilities the diffusion of technology to industry, especially small companies.

Strengthening the FhG, which was founded in 1949 to perform applied research and engineering development on a contract basis, has been one of the more intriguing BMFT initiatives. The FhG remained small until a government decision in 1969 made it the chief vehicle for support of applied research. At this point funding began to increase rapidly. A reexamination of FhG goals in 1973-74 led to a strengthening of its mandate for transferring technologies to the private sector, as well as developing them.

Joint government-industry financing on a project basis is the rule. FhG institutes—which together employ more than 2,500 people—provide technical advice to smaller firms, cooperate with universities, and function as technology conduits. Institutes are organized around technical disciplines; one concentrates on semiconductor devices and processing technology (the Institute for Solid State Technology in Munich), another on computer systems (the Institute for Information and Data Processing, Karlsruhe). Several others work in areas less directly related to electronics.

The Institute for Solid State Technology, one of the more successful of the Fraunhofer laboratories, can serve to illustrate the FhG model. Loosely associated with the Technical University of Munich—the Institute's director holds a chair there, and perhaps 20 students work at the laboratory—the Institute employs nearly 100 people, about half of them engineers or scientists. This makes it the largest organization of its type in West Germany, and perhaps in Europe. Founded in 1974, housed in its own building away from the university, and growing largely through the initiatives of its director, internationally known for his research in semiconductor technology, the laboratory gets 70 percent of its annual funding—about $5 million—via separately budgeted R&D projects. The BMFT typically provides a major share of project budgets, the remainder coming from one or more industrial sponsors. In essence, the government shares risks with industry, Two of the Institute's staff members are paid directly by the BMFT to advise and consult with small- and medium-sized companies. Much of the laboratory's work is concerned with processing technology; prototype circuits can be fabricated, along with small lots of specialized devices such as sensors and ICs for medical applications. The Institute also operates an X-ray lithography facility at West Germany's synchrotrons storage ring in Hamburg.

Perhaps the most noteworthy aspect of the FhG and its mandate from the BMFT is the ori-

[81] See "Increased Government Funding for Microelectronics," *West Europe Report, Science and Technology, No.* 92, Joint Publications Research Service JPRS 80133, Feb. 18, 1982, p. 5; "Special Microelectronics Program, " West *Europe Report, Science and Technology, No. 113,* Joint Publications Research Service JPRS 81392, July 29, 1982, p. 13.

[82] Much of the information in this section is based on interviews. See also H. Keller, "30 Jahre Fraunhofer-Gesellschaft: Rück-und Ausblick, " *FhG Berichte 3-79* (Munich: Fraunhofer-Gesellschaft, 1979), p. 3, and *Vertragsforschung für Wirtschaft und Staat* [Munich: Fraunhofer-Gesellschaft, 1981 ).

entation toward *commercial* technologies. The institutes are not basic research organizations —that function remains with the Max Planck Gesellschaft. Nor do they function as government laboratories, although the relationships between individual FhG institutes and government agencies vary considerably; the ties are closest among the six that carry out R&D financed by the Federal Ministry of Defense. The institutes are a conscious attempt to speed commercialization of new technologies and diffuse R&D results through industry. One way in which the FhG does this is simply to provide a venue for bringing representatives of Federal, Lander, and local governments together with industry and the universities, The Fraunhofer experiment is an attempt to compensate or the weak links that exist in Germany-as in most countries—among these groups, especially where commercial technologies rather than basic research are involved. Likewise, the decision to accept defense-related projects in 1955 was based on the belief that it was better not to isolate defense R&D, but to combine it with civilian work in hopes that each would benefit. (Defense-related projects now account for 20 to 25 percent of the FhG's effort. )

Within Germany, the Fraunhofer Gesellschaft has won high marks for facilitating technology transfer while avoiding direct government involvement in decisions on directions and priorities, but its comparatively small budget—about 230 million deutsche marks in 1981, something over $100 million—limits the assistance that flows to any one industry, *s

## The Future

If a joint strategy for the European Community in electronics comes to pass—a prospect that seems slight, as discussed in the next section, but not so improbable as a few years ago—West Germany's industry would probably be the best placed of any in Europe. But in the more likely event, progress in electronics in the Federal Republic will depend—as it has in the past—on domestic actions, public and private.

Past government policies, when directed at electronics, have not been notably successful. Nonetheless, German industry has a sound base to work from. Siemens, if not a leader in computers, probably has the best semiconductor technology of any company in Europe. (Philips is strong in linear circuits because of its emphasis on consumer electronics, but Siemens was virtually the only European manufacturer that recognized the importance of MOS ICs at an early date.) Germany's domestic production of ICs has grown as a percentage of consumption in recent years, a sign of Siemens' continued technical strength and perhaps of positive results from government R&D programs.[84] But the entire consumer electronics sector in West Germany, not just AEG-Telefunken, has faltered under the pressure of Japanese competition. ZVEI, the Central Association for the Electrotechnical Industry, has claimed that increased sales of imported home entertainment products have been a direct cause of shrinkage by such firms as Grundig AG, and consequent losses of jobs; at the end of 1982, Grundig and Philips filed an antidumping complaint against Japanese producers of VCRs.[85] In computers, West German firms have less than 5 percent of world sales. Nixdorf has chalked up respectable profits and exports by concentrating on smaller business-oriented systems; the company has done this on its own, without significant government aid. *As the example of Nixdorf shows--a lesson repeated in other countries-industrial policy is no substitute for well-managed private firms,*

West Germany has thus maintained its position in the second tier of the world electronics industry. Can it compete in the years ahead when faced with *both* American and Japanese

[83] *Vertragsforschung für Wirtschaft und Staat,* op. cit. In 1978, 35.7 million deutsche marks ($18.7 million) went to the four Fraunhofer institutes involved in work related to microelectronics and information processing; see "Cooperative R and D Program, To Stimulate Industrial Innovation in Selected Countries—West Germany," Department of Commerce, National Bureau of Standards, Office of Cooperative Technology, November 1979, p. 69.

[84] G. Dosi, *Technical Change and Survival: The European Semiconductor Industry* (Brighton, U.K.: Sussex European Research Centre, Sussex European Papers, May 1981. )

[85] J. Gosch, "German Consumer Firms Face Bad Times," *Electronics,* Sept. 11, 1980, p. 97; "Japanese VTRs Are Target of EC Antidumping Case," *Wall Street Journal,* Dec. 24, 1982, p. 9.

firms? At present, many of the industry's problems stem from the broader dilemmas of the FRG economy; high interest rates and low profit margins have made it difficult for German companies, which have traditionally borne the bulk of such expenses themselves, to maintain high levels of spending for R&D and new capital investment. In recent years, Siemens has accounted for as much as 12 percent of all West German industrial R&D—for many observers this alone signifies imbalance.[86]

West German firms also face a critical deficit in technical manpower, despite mounting unemployment in the nation as a whole. According to the Association of German Engineers, 16,000 jobs have been vacant for lack of people—particularly in electrical, mechanical, and civil engineering; in 1980 only 3,600 students were enrolled in technical universities able to accommodate 4,700.[87] Such problems are in no sense unique to West Germany—the question is whether government policies will help to resolve them.

## How Effective Are West German Industrial Policies?

Industrial policy has a less distinct identity in the FRG than in many other countries—at least it is harder to summarize. On the one hand, the approach has been more market oriented than in France; certainly planning and coordination on the French model are absent. On the other hand, the West German Government has consistently supported industrial development through macroeconomic measures and by integrating a broad range of perspectives and interests into the policymaking process (critics in some countries might regard this as a weakness). The role of the government, then, is far from laissez-faire. In contrast to the British case, sectoral initiatives have been pursued with a good deal of consistency over time, although such policies have not necessarily entailed extensive involvement by government officials. *The West German case does underscore the critical importance of aggregate policies as necessary (if perhaps not sufficient) to sectoral development.*

Industrial policy in Germany has benefited from a better sense of timing than in the United Kingdom. Government support for R&D in electronics began to pick up in the late 1960's, and has continued to grow—this despite an ongoing debate between the BMFT, which favors expanded sectoral thrusts, and the Economics Ministry, which continues to stress aggregate measures. While R&D programs—including funding for VLSI research and the efforts of the FhG—have not advanced the competitive position of the German electronics industry in any very obvious or dramatic sense, they appear to have nurtured it in a variety of less direct and visible ways. Unlike electronics policies in nations which have tried to leapfrog the competition, the German approach has been one of broad support for more basic kinds of research, in the hope of returns over the longer run.

As the Federal Republic struggles with rising unemployment and continuing economic stagnation, such policies will be severely tested. Formulated in a time of overall growth, there is no guarantee that the FRG view of industrial policy will prove adequate to deal with the adverse conditions promised by the rest of the 1980's. Germany's problem is much the same as that faced by the United States.

## The European Community

In West Germany and elsewhere in Europe, concern over technology gaps vis a vis American and Japanese competitors has led to periodic proposals that the European Community (EC) develop a joint policy toward electronics. Rapid increases in consumer electronics shipments from Japan have stimulated talk of import restraints, but a common effort in R&D has been the most frequent suggestion. A 1980

[86] According to Siemens' annual report for 1980, the company spent over 3 billion deutsche marks (about $1.6 billion), more than 9 percent of worldwide sales, on R&D. Over 90 percent of the money came from Siemens' own funds, the rest from government contracts and grants. For comparison, U.S. firms during the same year spent the following amounts as a percentage of sales: Amdahl, 15.8 percent; IBM, 5.8 percent; Data Genera], *10.0* percent. See '*Spending for Research Still Outposes Inflation, " *Business* Week+ July 6, 1981, p. 60. Siemens is clearly committed to keeping up in technology

[87] J. Tagliabue, "Germany's Economy Stumbles, ' *New York Times*, Apr. 13, 1981, p. D1.

study by Siemens, for instance, held out little hope for indigenous semiconductor industries; the conclusion was that continued growth in European sales would probably benefit Japanese firms the most, with the U.S. market share dropping from three-quarters to less than two-thirds by 1985.[88]

Although much of Europe has suffered similar problems—the twin maladies of recession and inflation, a perceived slowdown in technological advance, rising labor costs, unemployment, low rates of capital investment, slipping competitiveness—joint responses have been slow to appear. In 1980, the EC's industry commission proposed a European strategy in electronics that would have included government-funded programs to develop semiconductor processing equipment, as well as an advanced communications network linking the members of the Community. *g The proposal, which would have required modifications to national procurement policies, stalled when the French dismissed it as insufficient while the British dithered over the implications of exposing ICL to open procurements. So, while the EC countries have recognized the need for a more unified approach, national concerns have thus far remained paramount.

The latest attempt—which bears the name Esprit (European Strategic Programme of Research in Information Technology)—got underway in mid-1982. At first directed chiefly at semiconductor processing, in part because Europe has been heavily dependent on imported processing equipment, Esprit will also support work on chip architectures for VLSI, device modeling, and computer-aided circuit design and testing.[90] The program has been carefully designed to avoid areas where countries and companies compete directly. Funding, planned to be about $45 million over 3 years, will be contingent on substantial contributions from the industrial participants, which number a dozen of Europe's largest electronics firms (ICL, Siemens, Nixdorf, CII-HB, Philips, Olivetti—the planning effort began with company managements rather than government officials). EC planners hope the effort will expand within a few years to encompass more ambitious targets—e.g., projects analogous to Japan's government-sponsored R&D ventures in supercomputers and fifth-generation systems. It remains to be seen, however, whether the Europeans will manage to cooperate effectively—and, if they do, whether cooperation in basic research will make much difference, given that many of the large European electronics companies have always performed high-quality research but have had difficulty translating the results into commercial products.

## Japan

Japan is the exception to many rules in the international electronics industry. Government policies evolved along with the industry; they have consistently supported private firms, directly and indirectly. Subsidies have been substantial, though not inordinately large compared with other countries. Both financial support and indirect measures have been carefully targeted—benefiting some parts of Japan's electronics industry much more than others—a feature that has attracted much attention in the United States. Consumer electronics, for example, has not been a major focus of government policy compared to microelectronics and computers; nevertheless, during the period of consolidation and concentration that extended through the 1960's, the government maintained a series of barriers to imports and foreign investment that effectively limited competition in consumer electronics to local firms. [91] Lib-

88'' Growth of Electronics Market in Europe Seen Benefiting Japan, " *New York Times, Nov. 28, 1980,* p. D3.

[89]"Europe's Electronic Strategy is Modest, But It Still Isn't Easy, '' *The Economist,* July 26, 1980, p. 63. Over the years, the EC Commission has produced a variety of elaborate proposals and studies, to little evident effect. See, for example: "New Information Technologies, " Sept. 1, 1980; "Proposal for Council Regulation Concerning Community Actions in the Field of Microelectronic Technology, " Sept. 1, 1980; "The Competitiveness of European Community Industry, ' Mar. 5, 1982; all Commission of the European Communities, Brussels.

MID. Fishlook, "Why Europe Wants Esprit, " *Financial Times,* Aug. 3, 1982, p. 13; J. Smith, "Can Europe Cooperate on Research?" *Electronics,* Aug. 25, 1982, p. 85.

[91]'' Sources of Japan's International Competitiveness in the Consumer Electronics Industry: An Examination of Selected Issues, " prepared for OTA by Developing World Industry and Technology, Inc. under contract No. 033-1010.0, pp. 31-46; see also *The U.S. Consumer Electronics Industry* (Washington, D.C.: Depart-

eralization began only in the late 1960's, as the government's attention turned elsewhere; by this time Japan's consumer electronics industry had become well established. Foreign investment controls on monochrome TV production facilities were relaxed in 1967, on color production 2 years later (in some contrast with European governments, Japan limited inflows of foreign capital as well as products). Likewise, the tariff on color TV imports—formerly 30 percent—dropped to 7½ percent in 1971. Similar measures were adopted to protect the fledgling computer and microelectronics industries.

TV manufacturers clearly benefited from government support of broadcasting, from the array of direct and indirect trade barriers that Japan erected during the postwar years, and from policies that encouraged exporting. Still, direct and positive support–e.g., for R&D and product development—was modest compared to the attention lavished on information processing. Beginning in the 1960's, computers and semiconductors have been at the center of policies toward electronics and "the information industry." As these sectors grew, Japanese policymakers shifted direction—away from the complex of measures for protecting domestic industries that had been the hallmark of the government's approach during the 1950's and 1960's, toward more positive measures. Rather than simply sheltering local companies, the government sought to actively strengthen Japan's capability in data processing, with the aim of moving into world markets. Financial subsidies, primarily for R&D, were a major vehicle, along with other, less direct supports for research, as well as measures to encourage and facilitate applications of new technologies. An example of the latter is the Japan Electronic Computer Co., which buys data processing equipment from computer manufacturers and leases to users (ch. 4).

Today the information industries are viewed as the flagship of the knowledge-intensive sectors at the core of Japan's emerging industrial structure, the structure that will keep the country's economy growing and competitive into the next century. A unique feature of electronics policy in Japan—since copied by other nations—is official sanction and promotion, not only of the industry as such, but of electronics as the epitome of a broad array of emerging technologies (including CAD/CAM, robotics, composite and ceramic materials, and biotechnology); the policies *of Japan's Government toward electronics are in fact aimed at goals transcending conventional sectoral boundaries.* These policies, for years, have also been consciously directed at leapfrogging other nation's technologies—another aspect of the Japanese strategy that governments elsewhere, particularly in Asia, have tried to emulate. In several respects then, Japan's use of the tools of industrial policy has been innovative; Japanese policy makers have been both more ambitious and more experimental than, for in-

Photo credit Be// Laboratories

Light emerging from glass filaments used in fiber-optic communications

ment of Commerce, September 1975), pp. 12- I 3, and *United States—Japan Trade: Issues and Problems* [Washington, D. C.: General Accounting Office, ID-79-53, Sept. 21, 1979), ch. 5.

stance, their counterparts in France or the United Kingdom.

The efforts of people like Yoneji Masuda have fed the broad consensus which evolved among leaders i n Japanese business and government concerning the critical importance of electronics, and particularly computers. Active since the mid-1960's on advisory councils to the government, Masuda was responsible—as Executive Director of the Japan Computer UJsage Development Institute—for the 1972 report, "The Plan for an Information Society: Japan's National Goal Toward the Year 2000." Respected academic and author of more than 20 books, as a government advisor Masuda advocated a comprehensive national plan for ''computerization" in Japan, including government investment in future-oriented projects such as a ''c o m p u t opolis, or computerized city, and a computer peace corps. Masuda's ideas--which are well within the mainstream of this brand of futurism, based on the assumption that the production of information will gradually overshadow the production of material goods, eventually comprising the next stage in economic development-heavily influenced MITI's (the Ministry of International Trade and Industry) vision of a future information society.[92] Most Japanese policy makers take a more pragmatic view, but the visionary outlook of Masuda and others like him helped crystallize a broadly based consensus on the importance of computer technology.

## The Institutional Setting

In contrast to the United States or the United Kingdom, a well-defined group of government agencies in Japan bears the responsibility for official policies toward the electronics industry. Both policy development and implementation are centralized in MITI, specifically its Information Machine Industries Bureau. Satellites attached to MITI include the Agency for Industrial Technology, with functions in R&D, and the Information Processing Industries Advisory Council, a prestigious group with membership drawn from the private sector.

The only other public agency with significant ongoing jurisdiction related to electronics is the Science and Technology Agency (STA), under the Prime Minister's Office. In size and resources, STA cannot rival MITI. It does, however, coordinate the government budgetary outlays for R&D and related expenditures, preparing, for example, an annual "Science and Technology White Paper. " STA also funds research projects, including contract research by private firms, through its New Technology Development Corp. [93] STA influence over nuclear, ocean, and space technologies has been more extensive than in electronics.

This is not to say that other government agencies do not develop policies that affect the Japanese electronics industry. They do, b u t o n a less regular basis than MITI and STA; moreover, the influence of other agencies tends to be less direct, The Ministry of Finance (MOF) has jurisdiction over macroeconomic matters-e.g., fiscal and monetary policy. In recent years, growing budget deficits have forced the MOF to weigh proposals for sectoral assistance more carefully; competition for funds among electronics and other industries-as well as with government objectives other than industrial—development-has become stiffer. The MOF also exercises a good deal of' influence over the Bank of Japan, while public corporations such as the Japan Development Bank can channel funds to favored companies through loans and grants (ch. 7). Long-term projections by the Economic Planning Agency include forecasts of output by sector of the economy that are widely regarded as reliable guideposts to future business prospects. While neither public nor private banks need subscribe to the government's investment priorities, they often put money into sectors targeted by such plans.

An independent body, the Fair Trade Commission (FTC)—though peripheral in industrial policy compared to MITI or the MOF--has

[92] Y. Masuda, *The Information Society as Post-Industrial Society* (Tokyo: Institute for Information Society, 1981), p. 29.

[93] *Kagaku Gijutsu-cho/Kankyo-cho* (Science and Technology Agency/Environment Agency) (Tokyo: Kyoikusha, 1979), pp. 48, 77.

often resisted policies formulated by those agencies. Examples include legislation exempting sectors like electronics from provisions of Japanese antitrust law to facilitate "collaboration" among firms for "rationalizing" the industry.[94] The FTC has repeatedly, though seldom successfully, opposed MITI recommendations for antitrust exemptions—but in contrast to the Japanese petroleum industry, where the FTC has frequently investigated particular companies, electronics firms have seldom been scrutinized apart from matters of rebates and resale price maintenance. Even the public outcry over price-fixing among color TV manufacturers fueled by media reports of dumping charges against Japanese firms in the United States—was assuaged informally rather than by FTC decision; MITI persuaded the companies involved to lower domestic prices by 15 percent. Legal challenges to the business activities of Japanese electronics firms have come primarily from abroad: in the United States alone, Japanese electronics companies have been involved in more than 30 lawsuits, the majority over dumping.[95]

In addition to these traditional actors, other agencies and organizations have recently found more prominent roles, The interministerial Council for Science and Technology has been active in developing and coordinating large-scale R&D programs, The Ministry of Education has launched its own 3-year VLSI project, Diet (parliamentary) committees dealing with science and technology have become more visible. Local governments have started to court new technology-based industries; Kawasaki has put together a plan calling for transformation into a "microcomputer city, " while Hiroshima has organized a council to study the impacts of high technology on its established industrial base, Given this proliferation, science and technology policy in Japan may become more politicized in the years ahead (in some energy research areas, such as nuclear power, this has already occurred).

## Policymaking in Japan

Japanese industrial policy is built on close consultation among business leaders and government officials. Corporate executives routinely participate in both formal and informal discussions concerning policies toward electronics. It is an overstatement to claim, as some observers have, that in Japan industry tells government what to do, while in France government tells industry—but this does convey a sense of the difference. The Information Processing Promotion Advisory Council, for instance, brings together representatives of Japan's leading electronics firms to discuss MITI proposals. While such advisory councils meet relatively infrequently, and rarely have a determining voice in policy development, they serve to mobilize business interests and help form a consensus in support of the eventual outcome, Advisory councils are only one such forum. Representatives of the many electronics industry associations in Japan interact with officials from MITI and other agencies through a wide network of public and semipublic institutions. Several organizations bring together government, industry, and university leaders to stimulate work on computer software; the Information Technology Promotion Association (IPA), for one, had a 2.78 billion yen budget (about $13 million) in 1980, raised from both public and private sources. Established in 1970, IPA organizes programs through which private corporations and IPA staff conduct joint research on problems such as computer-aided design or software packages for small businesses.[96]

Similarly, the Japan Information Processing Development Center (JIPDEC)—a semipublic organization with a staff of 150, the bulk of whom are engineers—was established in 1967 with the support of MITI and the Ministry of Posts and Telecommunications. JIPDEC's pri-

[94] *Kijoho no Kaisetsu* (An Explication of the Law for Special Measures for Specified and Information Industries) (Tokyo: Ministry of International Trade and Industry, 1979).

[95] *Denshi Kogyo Nenkan, 1979* (Electronics Industry Annual, 1979, Ministry of International Trade and Industry) [Tokyo: Denpa Shuppansha, 1979), p. 303.

[96] *Konputa Hakjusho- 1979* (Computer White Paper-1979), Nihon Joho Shori Kaihatsu Kyodai (Japan Information Processing Development Association) (Tokyo: Konputa Ejisha, 1979), p. 94,

mary mission is the marketing of software. Loans and grants for some of its programs have been provided by IPA. Operating with a $10 million budget, JIPDEC carries out surveys on information processing, conducts R&D, supports technical training and education, and encourages information exchange through seminars and publications. Examples of JIPDEC projects include a microcomputer promotion center and an Institute of Information Technology for retraining technical specialists, JIPDEC activities also led to the fifth-generation computer project,

## Government-Sponsored Research and Development Projects

The fifth-generation computer effort typifies Japan's approach to R&D–bringing together private sector firms, along with selected public institutions. With funding from MITI and the bicycle racing association, the fifth-generation project—which has attracted worldwide publicity—is overseen by a 22-member panel including representatives from Tokyo University, companies such as Fujitsu, and MITI.[97] About half the roughly $500 milIion budgeted for the lo-year effort is to be provided by the government. A research association (kenkyu kumiai) was setup in 1979 to mobilize nine Japanese companies for R&D on microelectronics devices and peripheral and terminal equipment, as well as software—all aimed at major strides in computing technology. JIPDEC's role has been largely facilitative; the research association now carries the primary responsibility. The association's administrative staff has been drawn from employees of the participating companies, who are dividing the R&D effort.

As discussed in more detail in chapter 5, the fifth-generation computer project is far from an independent *or* all-inclusive effort; its work is proceeding in a context of government-subsidized R&D—as well as company-funded research—aimed at related aspects of information processing. Likewise, the project is only one of a number of follow-ons to earlier MITI-sponsored activities such as the VLSI R&D program (discussed in ch. 5, as well as below) and the Pattern Information Processing System Project (PIPS).[98] Such R&D efforts complement one another; they involve shifting groups of public and private sector participants drawn from a wide range of institutions. In parallel with the fifth-generation computer project, MITI is sponsoring the supercomputer effort mentioned earlier, along with a 10-year program on advanced microelectronic devices and work on optical measurement and control. Despite the funding that MITI provides, the Ministry's officials seldom attempt to guide or direct research, but confine their participation to helping shape objectives and to administrative functions,

Compared with other countries, Japan's approach to aid for electronics is unique in at least three ways: 1) government-supported programs are multiple but carefully coordinated with one another; 2) they are oriented toward facilitating the activities of industry, rather than telling industry what to do; and 3) the time horizons are unusually long. The last point is critical: *the 8- or 10-year planning horizons for many current Japanese R&D projects—with every indication that, while projects will be adapted to evolving circumstances, continuity will be preserved—point to the depth of the government's commitment,* Certainly there are few analogs in the United States, even in defense research–where the 6-year VHSIC program is the exception, not the rule.

## Cooperation in Research and Development

Observers in the West often misconstrue the nature of Japan's "cooperative" R&D efforts. While corporate leaders and government officials do in some cases work closely with one

[97] "Fifth Generation Computers, " *JIPDEC Report,* Japan Information Processing Development Center, summer 1980. The discussion following also draws on interviews with MITI officials in the Information Machine Industries Bureau.

[98] PIPS has been much less visible in the United States than several of Japan's other R&D efforts, but it played *a major role* in laying groundwork for the fifth-generation computer project. See H. Nishino, "PIPS (Pattern Information Processing System] Project—Background and Outline," *Proceedings Of the 4th International Joint Conference on Pattern Recognition,* Kyoto, Nov. 7-10, 1978, International Association for Pattern Recognition, p. 1152,

another during ongoing projects, the more usual pattern has been a carefully planned division of labor. MITI bureaucrats help initiate new projects—after lengthy preliminary discussions with industry advisory committees—by winning budgetary approval, They also monitor ongoing programs, evaluating progress and judging success, Government officials are often detailed to organizations like JIPDEC. Program administration is normally delegated to representatives of participating firms, with the research itself divided among these firms. People from different companies seldom work side by side.

The two government-supported VLSI projects—paralleling one another in time—illustrate these patterns. The first, oriented toward communications, was carried out by the public corporation Nippon Telegraph & Telephone (NTT) under the aegis of the Ministry of Posts and Telecommunications. The second, directed at applications of ICs to computers and much better known outside Japan, was sponsored by MITI; with 40 percent government and 60 percent private funding, the $300 million, 4-year effort took the form of a research association linking five participating firms, Three laboratories divided the work: a shared facility managed by the VLSI Technology Research Association; the Computer Development Laboratory jointly run by Hitachi, Fujitsu, and Mitsubishi; and the NEC-Toshiba Information Systems Laboratory. Staffs of the latter two laboratories came, not from the larger group of participants, but from the companies operating them; the joint facility drew engineers and scientists from all five, as well as MITI employees from the AIST. MITI was deeply involved in planning and organization during the preliminary stages. Later, the teams from the participating companies independently carried out their assigned research tasks. Only in the association's joint laboratory was a real effort at cooperation—with technical people from different companies working together—undertaken; this was a minor portion of the overall program, restricted to more fundamental research.[99] Individual firms did not cooperate on either product designs or processing technology. Thus, while the MITI-sponsored VLSI project has become known abroad as a "cooperative" effort, the actual extent of interaction among participating firms was limited; spokesmen for the Japanese electronics industry say that dividing the research enhanced the overall success of the project. It appears that the organizational form involved a compromise between attempts to encourage individual interactions—with objectives such as stimulating personnel development—and the more concrete technical goals. Certainly as the work undertaken by joint R&D projects in Japan moves toward development, interfirm cooperation declines; a MITI-orchestrated follow-on to this VLSI project, which began in 1980 and emphasizes chip designs and applications, takes the form of totally independent efforts by each participant.

The work of the "Research Association for R&D on New Function Elements, " also beginning in 1980, can be viewed as another follow-on to the VLSI project; it illustrates the way in which MITI-sponsored research efforts complement one another. This association's laboratory draws on a larger group of companies. Matsushita, Sanyo, Sharp, Oki, and Sumitomo Electric—none as strong in their technology as the five companies that had participated in the VLSI project—will all be involved in one or more of three major microelectronics development efforts.[100] These are:

- Three-dimensional circuit elements—which can be visualized as more or less conventional ICs stacked atop one another, increasing the density,
- High electron mobility transistors (HEMTs), one variety of which consists of extremely thin layers of semiconducting

[99]Interview with Mr. Nebashi, I B M-Japan and formerly at the VLSI Cooperative Laboratory, *Nihon Keizai Shimbun*, Jan, 19, 1981, p. 1.

[100]"FY82 Government Projects in Electronics Listed, " *Japan Report,* Joint Publications Research Service JPRS 1,/10676, July 22, 1982, p. 55,

materials such as gallium arsenide or gallium aluminum arsenide; these structures carry the potential for higher switching speeds, hence faster computers,

- Radiation-hardened devices suitable for use in extreme environments such as nuclear powerplants or outer space (resistance to heat and vibration is a related objective).

The first two especially will support both the supercomputer and fifth-generation projects.

## The Role of Universities

University-industry interactions in R&D are no closer in Japan than in other countries—again perhaps in some contrast to the common perception. Close collaboration is rare, even though the rules prohibiting professors in the national universities from working for private companies can be circumvented. Contract research and consulting by university faculty are more limited than in the United States,

Japanese policy makers universally express the wish that university-industry relations be improved, and that sufficient numbers of well-trained professionals be available to meet the economy's needs. To date, however, little progress seems to have been made—nor, in fact, have new policy initiatives directed at such concerns emerged. As discussed in chapter 8, Japan's colleges and universities have for some years been turning out more engineering graduates than in the United States. Nonetheless, as in other industrialized countries, there has been concern over future shortfalls in the supply of engineers and scientists; a recent survey covering the hiring plans of more than 1,600 Japanese firms points to stiff competition during the 1980's for university graduates trained in technical fields.[101]

## How Significant Are Supports and Subsidies in Japan?

As for any country, it is impossible to place a monetary value on the policy measures that benefit Japanese electronics companies. Nor would an attempt at such an accounting be very meaningful. Indirect benefits—e.g., temporary exemptions from antitrust provisions—escape quantification. Even when government funds flow directly to industry—as in the cost-sharing typical of joint R&D projects in Japan, or the subsidies for the West German computer industry during the 1970's—the real questions concern the effectiveness with which the money is spent,

Nevertheless, subsidies deserve special attention in the case of Japan because the (J. S. electronics industry has argued that they have been a key to the competitive success of Japanese firms. Research funding is only part of the total picture of industry-specific support, but as table 77 indicates—and in common with other industrialized countries—more than a quarter of all Japanese R&D expenditures, both government-funded and industry-sponsored, have gone to the electronics/electrical machinery sector. At the same time, *government* expenditures on research are not high compared to other countries; considering *only* R&D, and counting only expenditures *directly* related to electronics, public funding is quite small—about 1 percent of the total for 1978, according to the Japanese Government.[102] This is hardly the whole story; it does make the point that R&D in Japan is primarily the responsibility of private industry, Japanese R&D is heavily concentrated on commercial applications; neither military technologies nor basic research get the attention they do in other countries. Looking at all R&D spending, the private sector in Japan provides over 70 percent of total funding—more than in the United States, where industry spending accounts for 50 to 60 percent (table 77).

MITI's annual compilation of government supports and subsidies for the "information industry" is the most comprehensive listing of

[101] "Daisotsu Danshi Nohi Niketa" [Number of Male Graduates Declines), *Nihon Keizai Shimbun*, Aug. 27, 1981, p. 1.

[102] In 1978, government bodies in Japan, including state and local, reportedly contributed 6.8 billion yen (about $34 million) to the total of 580 billion yen (about $3 billion) spent for R&D on "electrical machinery." This includes household electric equipment, as well as communications and electronics. Most of the R&D work is for development, See *Kagaku Gijutsu Kenkyu Chosa* (Report on the Survey of Research and Development, Prime Minister's Office, Statistical Bureau) (Tokyo: Nihon Tokei Kyokai, 1979), pp. 39-40, 94.

programs related to electronics. (For the United States, no comparable data exist—in part because no one agency has responsibility for such programs). For 1980, the Japanese Government budgeted about $1.3 billion toward the development of the information industry—expenditures encompassing much more than just the R&D programs highlighted above; a large fraction of the total consists of loans and loan guarantees rather than direct grants.[103] Included in the total, for instance, is the more than $200 million that the Japan Development Bank loaned to the Japan Electronic Computer Corp. for lease financing; this aids Japanese computer manufacturers by reducing the funds they would otherwise have to commit to rental and lease arrangements with their customers, as well as absorbing risks associated with repurchasing.

The computer industry has received a substantial share of direct subsidies. Budgeted MITI expenditures for major projects closely related to data processing—including several of those outlined above—are listed in table 80. The table is not inclusive, and is intended only to give an idea of the magnitudes of typical government expenditures, These sums are not large compared to R&D spending by industry itself in either Japan or the United States, or in comparison with government funding in other countries. Portions of such subsidies have funded large-scale, long-term programs aimed at social applications of electronics technologies—e.g., health care, regional energy saving, computerized traffic control systems. The figures in the table also include money for conducting surveys on computer usage, administering qualifying examinations taken by computer technicians, and the costs to the government of special tax deductions extended to companies that train information processing specialists.

Taken together, it is the comprehensive nature of such programs—not their spending levels—that distinguishes Japan's policies toward electronics and other targeted industries.[104] The very fact that the government publishes an information industries budget indicates the care with which the bureaucracy monitors developments in electronics and disseminates information among government, business, and financial circles. It is this attentiveness on the part of government, and the fact that most programs are coordinated by MITI, that sets Japanese industrial policies apart. Over the years, funding by the Japanese Government has grown, but the significance of MITI's initiatives goes well beyond financial support; indeed, to look only at the money spent is to un-

[103] *Denshi Kogyo Nenkan 1979,* op. Cit., p. 340.

[104] The " Research and Development Project of Basic Technologies for New Industries, " established in late 1981, is another example. The original plan called for total spending of about $460 million over 10 years; however, the first year's expenditures have been scaled down by the finance-conscious MOF. Private corporations are being funded to participate in one of 12 R&D "themes," such as biotechnology and advanced materials. The "New Function Elements" microelectronics projects mentioned earlier are also part of this umbrella program, See "AIST *1982,* " Agency of Industrial Science and Technology, Ministry of International Trade and Industry, Tokyo, pp. 6 and 7.

Table 80.—Japanese Government Expenditures on Selected Projects Related to Computer Technology

| Project | Budgeted expenditure (millions of dollars)[a] | |
|---|---|---|
| | 1981 | 1982 |
| Basic technology for next-generation computers | $28 | $22 |
| Basic software technology | 24 | 20 |
| Microelectronics ("new function elements") | 3.1 | 4.5 |
| Supercomputer R&D | 0.14 | 3.3 |
| Peripherals | 4.8 | 2.6 |
| Fifth-generation computer R&D | 0.07 | 1.7 |
| | $60.1 | $54.1 |

[a] Fiscal year basis, converted from yen at 22o to the dollar for 1981,249 for 19132

SOURCE "FY82 Government Projects in Electronics Listed," *Japan Report,* Joint Publications Research Service JPRS U10676, July 22, 1982, p 59 derestimate the impacts of such programs, They have considerable symbolic and psychological value in galvanizing the efforts of many participants behind a set of goals shared by government and industry. Programs in electronics have typically been aimed at breaking bottlenecks viewed as critical to continued progress. Both the VLSI project—which, as outlined in chapter 5, was intended to help Japan catch up to the United States in digital MOS ICs—and the fifth-generation computer project, with its software push, have been designed to serve such purposes. The supercomputer project is quite different; not particularly important in any commercial sense, it is first and foremost intended as a highly visible symbol of Japan's ability to compete technologically with the United States—from the Japanese perspective, supercomputers are one of the critical propaganda battlefields of the "computer war. "

Comparing Japan's industrial policy with efforts in Britain or France points to a major difference: government policies in Japan are directed at further strengthening a private sector that is vital and still expanding rapidly, not at revivifying a stagnant industry. Government programs in Japan complement the dynamism and international orientation of the country's electronics firms; they have contributed to, but not created, their competitive ability.

## Recent Trends

Major thrusts of Japan's industrial policy have been aid and encouragement for exports of electronics and, to a lesser extent, overseas investment, The international activities of Japanese electronics firms are especially visible in Asian markets, where interdependence is growing (ch. 4). A study by the Electronic Industries Association of Japan forecasts strong expansion elsewhere in the Far East, and urges Japanese firms to develop strategies of "accommodation''—promoting Japanese investment and technology transfer, while importing low-technology, labor-intensive electronics products from other Asian nations.[105] These international moves by Japanese electronics manufacturers have for many years had the active support of Japan's Government.

In the United States, many signs indicate that Japanese manufacturers are now often recognized as peers. Technical exchange agreements between American and Japanese electronics companies—rather than outright purchases by Japan–are on the upswing. Mitsubishi and Westinghouse have arranged a joint venture to design and manufacture ICs. Hewlett-Packard is getting RAM technology from Hitachi. The U.S. Department of Defense has persuaded Japan to transfer defense-related electronics technologies to this country (although what these technologies will consist of is far from clear). American semiconductor firms are setting up design centers in Japan, as well as production facilities—while Japanese firms do likewise in the United States, each seeking to draw on the other's technical talent.

Movement toward cooperation amidst ongoing commercial rivalries has not been confined to the initiatives of private companies, In response to criticism from the United States and elsewhere that MITI-sponsored electronics R&D constitutes an unfair subsidy, Japan has suggested steps in the direction of international cooperation. For example, foreign firms have been invited to participate in discussions aimed at an enlarged fifth-generation computer project having the form of an international joint venture.[106] Such proposals—even if carried through—would not by themselves stem the rising tide of criticism aimed at Japan's industrial policies, as well as the country's indirect and nontariff barriers to trade. Still, if nothing else, they are a sign of the confidence the Japanese now have in their own abilities—while also being a well-calculated public relations ploy.

There are two fundamental perspectives in the United States on questions of Japan's subsidies and indirect trade barriers. On the one hand, those who believe free flows of technology to be a prerequisite for economic growth

[105] *Denshi Sangyo no Kokusaika no Hoko to sono Eikyo ni Kansuru Chosa Hokoku* (Survey Report on Trends in the Internationalization of the Electronics Industry and Their Influence, Part 1 I on East and Southeast Asia), op. cit., pp 271-291,

[106] "Dai GoSekai no Conputa: NichiBeiOo no Kyodo Kaihatsu Shido" (Fifth-Generation Computer: Beginning of Joint U.S.-Japan-West European Joint Development), *Nihon Keizai Shimbun*, Aug. 30, 1981.

and technical innovation call for equal access by U.S. firms to programs sponsored by the Japanese Government. The other view is held by those who would prefer restrictions on outward flows of U.S. technology in an effort to preserve "technological security. " As debates in this country continue, the procurement, R&D, and customs and standards activities of Japan's Government will be scrutinized by partisans of both viewpoints.

## How Effective is Japanese Industrial Policy?

Any judgment of the contribution of Japan's industrial policies—or government policies anywhere-to international competitiveness in electronics rests in part on intangibles. Precise evaluations are impossible. What is the "worth" of the networks for information transmittal and consensus-building woven by MITI? What are the costs and benefits of the ambiguities and uncertainties surrounding antitrust enforcement in the United States?

In judging the effectiveness of Japanese industrial policy, the starting point is its basic thrust—to cultivate rather than confine the nation's electronics companies. The institutional apparatus that has evolved over the years has contributed far more than absolute levels of financial assistance might indicate. The end result has been effective mobilization of institutional and human resources, comprehensiveness in government efforts, a substantial degree of policy integration without rigidity. The focus of Western observers on cooperation between government and business only hints at how the system works.

With few exceptions, Japan's Government has used the same policy tools to promote electronics as other nations: in the early years, tariff barriers combined with controls on foreign technology and capital flows; today, supports and subsidies for R&D and commercialization. While the highly publicized VLSI R&D project has been held out as a unique instance of cooperation—one that would violate antitrust laws in the United States—under closer examination much of the appearance of interfirm cooperation vanishes. The program was effective because it was carefully crafted to help Japanese firms overcome specific weaknesses that MITI and industry leaders had identified: emphasis on linear devices, a legacy of production for consumer products; lagging capability in the processing of large-scale ICs, because Japanese firms were dependent on semiconductor manufacturing equipment from the United States; lack of experience in digital circuitry among engineers and technicians, In contrast to government-supported R&D projects in West Germany or the United Kingdom, the Japanese were able to define their needs and agree on a program that would help them catch up to the United States. It is the *consistent and coordinated attentiveness to the problems and potentials of electronics (and other industries) that distinguishes the policies of MITI and the rest of Japan Government more than the character of individual programs or policy instruments*.

At a more general level, the *long-term orientation* of policies toward electronics—typified by the fifth-generation computer project—also distinguishes Japan from other countries. Further, development of the electronics industry —while a goal in itself—has been pursued for larger reasons: electronics is viewed as the key to Japan's overall industrial development, the first ingredient in the knowledge-intensive, energy-efficient economy that the country's technocrats are striving toward,

Japanese industrial policies have certainly not been universal triumphs—efforts to prop up declining sectors (steel) or to counter international market trends (petroleum) have not been particularly successful. But policies toward electronics have complemented the dynamism of private companies already well positioned both domestically and internationally. It is the congruence of public policy and evolving shifts in industrial structure that, in the end, is the hallmark of present-day Japanese policies toward the information industry.

# Summary and Conclusions

Among nations that have set out to promote their electronics industries, the policy tools come from a common list: R&D funding, investment grants and subsidies, procurement, merger and trade policies. No avenue emerges that can guarantee success in strengthening the competitive ability of a country's electronics firms. Under closer scrutiny, many of the policies adopted by nations like Japan—sometimes thought to be unfair or unique—are not so dissimilar from those used in other advanced industrial economies, even the United States. Matters of timing, comprehensiveness, consistency—rather than the types of policies adopted-differentiate the industrial policies of various countries,

As competition in the international electronics industry has intensified, governments have stepped in to help their own entrants. In the early 1960's, European and Japanese fears over the "American challenge" sparked systematic attempts to protect and strengthen domestic computer manufacturers. At that time, the preferred policy approach began with trade protection-tariffs, controls on flows of foreign investment and technology, discriminatory procurements. Several countries encouraged mergers among computer firms. In the 1970's, as trade liberalization under the General Agreement on Tariffs and Trade continued, industrial policies shifted away from overtly protectionist and defensive approaches. Today, *supports for R&D, indirect subsidies such as tax incentives, and other less direct measures comprise the foundations of public policies toward electronics in virtually all countries*. Except in threatened sectors like consumer products, trade liberalization has been accompanied by a parallel movement toward policies with secondary rather than primary effects on international flows of electronics goods. If there is an exception, it is the United States—where, leaving aside defense-related policies, the most prominent measures have continued to be regulatory.

Can, then, industrial policies create comparative advantage? The answer is clearly no. Competitive success in electronics, here and abroad, depends on many factors, of which government actions are only one. Taken alone, public policies are seldom as important as the capabilities of a nation's private companies: human resources and their utilization, including the quality of management; costs and availability of capital; technological ability in electronics and the complementary infrastructure; overall market conditions—these are more central to international competition. Public policies can add or subtract from them, but the ability of governments to compensate for weaknesses—or to reverse declines in competitiveness—is circumscribed. Although they can either help or hinder industrial development, *public policies alone do not determine—directly or indirectly–the competitive standing of electronics industries in any nation.*

Today, policy makers in the U.S. Government must decide whether to continue the ad hoc approach of years past or move toward measures aimed more consciously at preserving and strengthening the advantages that the American electronics industry draws from its setting and structure. If the choice is to develop a more comprehensive industrial policy, much can be learned from studying foreign experience—West Germany's Fraunhofer Gesellschaft, Japan's VLSI project, Britain's schemes to promote commercial applications. But no recipe for success emerges from the countries that have experimented with industrial policy, It is one thing to say that policies toward electronics should be in tune with overall changes in industrial structure and international markets; it is quite another to actually design and implement an effective industrial policy amidst the ongoing uncertainties and ambiguities that characterize the political and economic context,

Government policies, then–as illustrated by the countries examined in this chapter—are generally tailored to the level of technological and commercial development of firms in the local industry. It is no coincidence that the nation which led initially in semiconductors, in color TV, in computers—the United States—made no attempt to devise a systematic policy orientation toward electronics. Where was the need? Nor is it surprising that the countries with more comprehensive policies have generally been those that have perceived themselves at a disadvantage. But why have some countries been more successful in mobilizing institutional resources to create sustained and coordinated industrial policies than others?

A variety of forces work to enhance the ability of government officials to design and implement coordinated, timely, and comprehensive policies toward industries like electronics. A relatively centralized policymaking apparatus, where a single agency or a select few have well-defined responsibilities, is one. The grab-bag nature of British policies mirrors the agencies charged, at one time or another, with policy development. In countries where government officials belong to a respected civil service they are more likely to have the resources to analyze and initiate actions with positive effects on industry. The dominance of political appointees in the United States, and their rapid turnover, works against the kind of consistency seen in nations like Japan. So too does the lack of understanding of technology characteristic of both bureaucrats and politicians in this country. An elite civil service does not ensure success, as the mixed record of French industrial policy shows. But especially in Japan—where consultation and cooperation between industry and government have been closer than in many other countries, if not so close as sometimes pictured in the West—consensus is easier to achieve than in nations where adversarial relations are the norm. Easier too is carrying through the actions that have been agreed on. Such factors have enhanced the effectiveness of industrial policy in Japan, the one nation that has so far managed to catch up—in at least some respects—with the United States. Of course, Japanese electronics firms have been favored by other circumstances as well–skilled labor supplied by a long-established educational system is only one example. Structural features of the political and economic system in Japan-–natural resource endowments, existing capital markets, political stability, established mechanisms for policymaking, characteristic systems of labor-management relations—have tended to shape and limit industrial policy decisions, rather than the other way around.

As Japan and other countries seem likely to discover, it may be easier to develop policies aimed at catching up than to devise strategies for keeping up or jumping ahead. For one thing, as internationalization of industrial and market structures proceeds, the influence of national governments will diminish. But the fundamental point is that in any industry or technology, creating a new model is harder than following a recognized leader. Government aid has helped electronics firms in other countries improve relative to American competitors; the situation for the United States has been—and remains—different. The *leaders, be they American or Japanese, have to break new ground—a commitment that industrial policymakers in Japan have long since made.* Japan's publicly voiced determination to improve the technological base for the country's electronics industry stems from a recognition that past successes have been built on the adaptation and commercialization of technologies originating elsewhere, mostly within American firms. Now, Japan is a leader along with the United States. The public as well as the private sectors in each country face the need to develop appropriate strategies for the years ahead.

*Industrial policies for the* 1980's *and beyond will be most successful where policymakers grasp the dynamics of ongoing shifts in domestic and international markets and industries.* To the degree that public policies ignore or attempt to counteract such forces, they will be less likely to reach their objectives. Policies designed to complement and reinforce ongoing trends will be more likely to have positive effects. This is not to say that public policies cannot help shape these trends. If it is true that the industries which fueled postwar economic growth—steel, petrochemicals, automobiles—have attained a stage of relative maturity, then emerging technologies are indeed an appropriate focus of government policy. Technologies based on genetic engineering, advanced materials, computer-integrated manufacturing—as well as electronics and information processing—will contribute to growth in existing as well as new industries. It follows that the appropriate emphasis of public policy may not be electronics alone, but economic adjustment and technological development more broadly.