High-Tech Investment Revolution

By Toshio Sanuki

Japan's high-technology industry has entered a new development phase. Particularly conspicuous is the growing weight of high technology in private capital spending, a phenomenon which might properly be termed a high-tech investment revolution, and which raises the possibility of a renaissance among Japan's regional industries. How is the high-tech revolution altering the pattern of capital spending? And what effect will it have on the geographical location of industrial plants?

High-tech revolution leads capital spending

Electronics has combined with mechanical engineering to create "mechatronics" technology, a development which in turn has triggered the "5-A revolution"—FA (factory automation), OA (office automation), SA (sales, social and security automation), MA (medical automation) and HA (home automation).

At the same time, electronics is affecting other high technologies such as mechatronics and new materials, producing interactive economic effects. And the new materials revolution in turn is boosting electronics to an even higher level. Such high-tech interaction has also appeared in biotechnology, where electronics is accelerating technological development.

Many people consider high technology a futuristic industry which will not come into being until the distant future; they view it as an industry still on the drawing board. But in the two years since 1983,* rapid evolution has made the industry a reality. One typical example is the rapid rise in the weight of high technology in capital spending. It is this that will cause the coming renaissance of Japanese industry—the structure of which has already been forced to change by the two oil crises of the 1970s—and of regional industries across the Japanese archipelago. The high-tech revolution stands to trigger a new industrial surge in the 1990s.

A review of capital spending by manufacturing firms capitalized at ¥1 billion (nearly $4 million) or more between 1973 and 1984 finds steel, a leading basic-material industry, by far the number one investor in terms of cumulative investment. During this twelve-year period, Japan's steel industry spent ¥11.2 trillion (nearly $46 billion) , a sum equivalent to 20 nuclear-powered aircraft carriers, on new plant and equipment. The automobile industry came next at ¥8.6 trillion, followed by chemicals, ¥8.1 trillion, and electric machinery, ¥6.6 trillion.

But the list looks radically different when limited to 1983–84. Spending most during the past two years was the electric machinery industry, the leader of the electronics revolution. The high-tech revolution that is propelling the 5-A revolution with infusions of computers, communications equipment, word processors, facsimile units and other high-tech equipment is turning high-tech industry into the new pacesetter of capital spending.

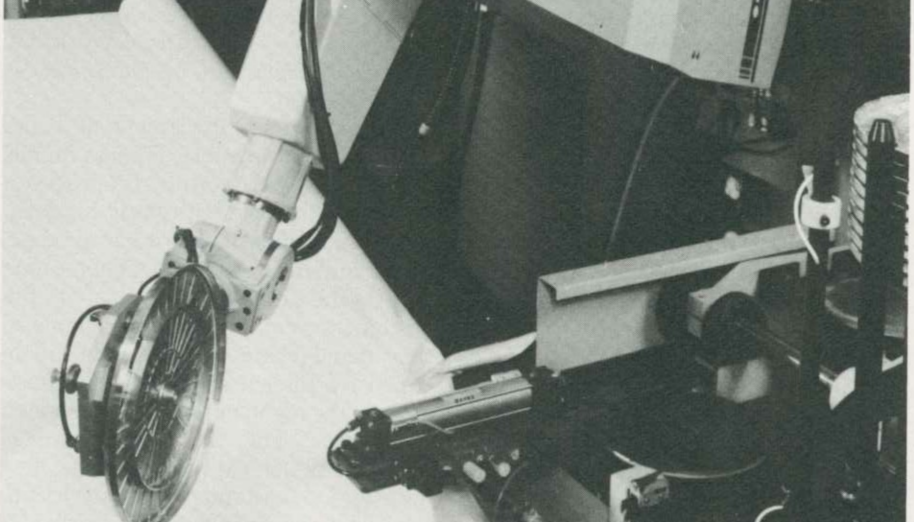
The second largest investor in the two-year period was the automobile industry, followed by chemicals—spearheaded by fine chemicals—and steel, a complete reversal of the ten-year ranking. Chemicals and steel are both basic-material industries. But the former has outpaced the latter in capital spending for the past two years, suggesting that basic-material industries are beginning to separate into two clear categories—industries that cannot survive without a new emphasis on high technology, and those that can keep themselves going a while longer simply by relying on their accumulated conventional low- or mid-tech technologies. How, in fact, is such high-tech orientation developing?

High-tech ratios differ by industry

An industry's high-tech orientation can be quantified by the ratio of capital spending in high technology sectors to total investment (Table 1). Total capital spending planned for 1985 by all industries is projected to rise 17.2% from 1984. But high-tech investment is forecast to climb 45.6%—much faster than the growth in total spending.

A similar trend is seen among the materials and processing/assembly industries. The former plans an 8.4% increase in total capital spending, but sees a 67.5% surge in high-tech investment. For the latter, the figures are 41.2% and 89.9% respectively; again, the growth of high-tech investment is more than double that of total spending.

An industry-to-industry breakdown underlines the trend. Steel, for example, plans to cut total investment 24% but is budgeting a whopping 189.4% or 2.9-fold



High technology is taking a larger chunk of private capital spending.

*All years are given in terms of fiscal years.

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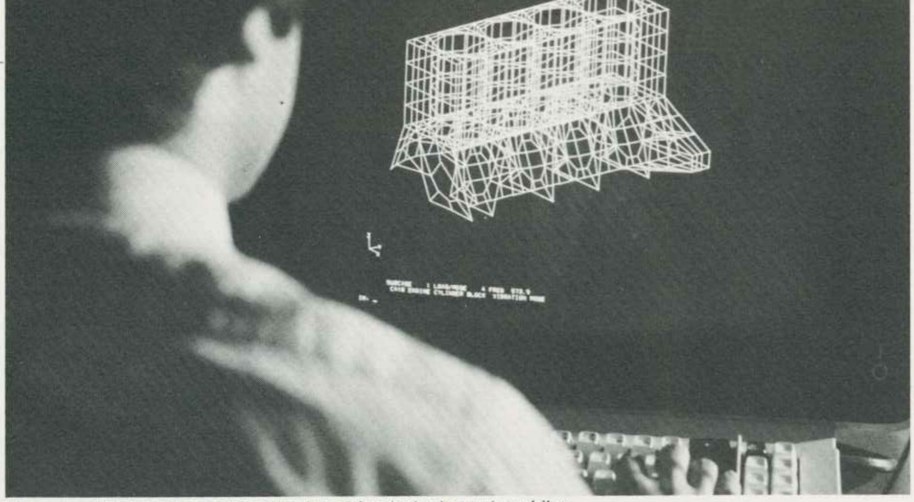
leap for high-tech; the gap between the two growth rates should reach a full 213.4 percentage points. In the ceramics industry, which includes a high-tech *protégé* offshoot fine ceramics, high-tech investment is projected to grow far more sharply—86.3%—than total investment at 40.3%. Automakers plan a relatively moderate 20.9% increase in total outlays, but a 61.5% surge in the high-tech sector, including investment in electronics equipment, new materials and flexible manufacturing systems. General machinery plans a 62.9% increase and electric machinery a 102.8% increase in high-tech investment. The high-tech revolution in capital spending is leaping ahead.

The high-tech ratio, the rate of high-tech investment to total capital spending, is a very low 3.9% in the steel industry but reaches 19.8% in ceramics and 40.3% in chemicals. There is no better indication of the wide difference between the low and the high end of the same basic materials sector. In the face of keen competition from developing countries, basic-material industries have no choice but to turn to high technology for survival. Steel is the prime example, but chemicals are no exception, as they find accelerating the high-tech orientation in their capital spending necessary to their survival.

One might not expect automobiles, the star of Japan's processing/assembly industries, to need much of a high-tech orientation. But they do. The automobile industry's high-tech ratio is a substantial 17.3%; much of its investment goes into R&D on electronic equipment and new materials, computer-aided design and manufacturing (CAD/CAM), computer-controlled production systems and robotics. The high-tech ratio is even higher in electric machinery, itself a high-tech industry, and in general machinery. In the electric machinery industry the ratio is 72.4%, meaning ¥724 billion (nearly $2.9 billion) goes to the high-tech sector out of every ¥1 trillion (nearly $4 billion) in total capital spending.



Computer-aided design system introduced for designing automobiles

The high-tech ratio for the leasing industry is 60.0%, second only to electric machinery. Why is this? The answer lies in the wide gap between the legal and actual life of equipment. Take machinery for producing large-scale integrated circuit (LSI) chips, for example. Mask-processing equipment is technologically viable for only four years, wafer-producing equipment 3.4 years, chip-assembling equipment 3.2 years and testing equipment 3.3 years. The average for these and other semiconductor-related gear is a mere 3.7 years, and given the accelerated technical innovation expected in the future, it can only continue to decline.

In contrast, the legal period of depreciation—the time during which manufacturers are allowed to set aside tax-free reserves equivalent to the cost of their equipment in order to replace it when it becomes obsolete—is set at 50 years for buildings and seven to eight years for machinery. This is far longer than actual technological life, and the wide gap, coupled with rapid technical innovation, is prompting manufacturers to lease rather than purchase high-tech equipment. It is this that has been keeping the leasing industry's high-tech ratio at a remarkable 60%. It is hoped that the tax system will be reformed to bring it into line with the realities of technical innovation.

The steep rise in the high-tech ratio, and especially in the electric machinery industry, will greatly change the future pattern of capital spending. And this, in turn, will accelerate the high-tech orientation of Japan's industrial structure, albeit after a certain time lag. Capital spending by the electric and general machinery and chemical industries, for instance, accounts for 40.2% of that by all industries. But their share of high-tech investment is much higher at 51.2% (36.2% for electric machinery, 5.0% for general machinery and 10.0% for chemicals: Table 1). Clearly the weight of high technology in the industrial structure is bound to rise, and the pace of this transformation is likely to be much faster than expected.

Emerging high-tech orientation in declining industries

The textile industry has long been regarded as the archetype of a declining in-

Table 1
High-Tech Ratio of Capital Spending

	Sum of high-tech investment (1985)	Growth of capital spending (%) (1983–85)		High-tech ratio (%)			Investment share (%) (1985)		1983–85	
	(¥ billion)	Total spending	High-tech spending	1983	1984	1985	Total spending	High-tech spending	Increase in high-tech spending (¥ billion)	Contribution to increase (%)
Industry	3,755.3	17.2	45.6	18.9	22.4	24.2	100.0	100.0	1,176.1	100.0
Manufacturing	2,535.4	26.4	84.3	23.6	32.4	34.3	53.3	67.5	1,159.6	98.6
Nonmanufacturing	1,219.9	10.0	1.4	15.4	13.3	15.0	46.7	32.5	16.5	1.4
Basic materials	576.0	8.4	67.5	14.5	21.2	22.5	13.3	15.3	232.2	19.7
Chemicals	375.0	16.6	50.0	31.2	37.2	40.3	9.7	10.0	125.0	10.6
Ceramics	57.0	40.3	86.3	14.7	18.5	19.8	1.2	1.5	26.4	2.2
Steel	24.6	−24.0	189.4	0.9	3.4	3.9	0.3	0.7	16.1	1.4
Nonferrous metals	80.6	25.9	201.9	14.2	33.0	34.7	1.0	2.1	53.9	4.6
Processing/assembly	1,959.4	41.2	89.9	33.1	42.2	44.0	40.0	52.2	927.4	78.8
General machinery	189.0	40.1	62.9	36.6	42.2	42.8	4.5	5.0	73.0	6.2
Electric machinery	1,359.0	76.8	102.8	66.9	72.5	72.4	26.0	36.2	689.0	58.6
Autos	187.7	20.9	61.5	12.9	15.6	17.3	4.5	5.0	71.5	6.1
Leasing	1,155.9	−3.3	−3.3	65.1	60.0	60.0	46.3	30.8	−39.2	−3.3

Notes: Based on Japan Development Bank capital spending survey; years are in fiscal.

Table 2 High-Tech Plant Locations and Computer Installations

Region	Plants built (FY 1976–84) No.	Share (%)	Gap (national average=100) Ratio of electric machinery	Ratio of computer installations	Employment ratio of college graduates	Per capita income (FY 1985; $)
Hokkaido	29	1.7	12.3	51.7	77.1	7,879
Tohoku	544	31.8	136.8	35.7	58.1	7,002
Kanto	607	35.4	145.6	170.2	132.9	9,728
Tokai	112	6.5	64.9	73.6	81.8	8,433
Kinki	90	5.3	103.5	113.7	115.5	9,012
Hokuriku	95	5.5	62.3	48.1	70.3	7,802
Chugoku	73	4.3	36.0	56.7	84.0	7,777
Shikoku	37	2.2	58.8	36.2	74.4	7,027
Kyushu	149	8.7	52.6	42.5	79.4	7,274
Nation	1,713	100.0	100.0	100.0	100.0	8,518

Notes: 1. Ratio of electric machinery = Electric machinery shipments/Total factory shipments
2. Ratio of computer installations = Value of computers in operation/No. of employees
3. Employment ratio of college graduates = Employees with college education/Total employees
4. Per capita income based on author's estimate of prefectural income distribution; exchange rate is ¥245/$1.

Sources: Table of Industrial Statistics, Survey of Computer Deliveries and Repurchases, Survey of Plant Locations (MITI); Annual Report on Prefectural Economies (Economic Planning Agency); National Census Report (Management & Coordination Agency); Annual Report on Economic Statistics, Annual Report on Foreign Economic Statistics (Bank of Japan)

dustry. But is it? Today manufacturers are trying to computerize design and dyeing. A computer already designs traditional *"Nishijin-ori"* brocade fabrics in Kyoto, electronically controlling the 5.06 million interstices made by 2,250 silk threads the length and breadth of the loom.

In ceramics, another "declining" basic-material industry, the high-tech orientation is growing not only in fine ceramics but in glass operations, where the weight of investment is shifting from the conventional float glass used in the construction industry to facilities for producing picture tubes used for personal computers and videocassette recorder display units. Future capital spending will be targetted on plant for picture tubes used in the terminals of new electronic media services, and equipment for manufacturing liquid crystal display units.

The nonferrous metal industry is switching from coaxial to optical-fiber cables following the emergence of the enhanced electronic systems known technically as Information Network System (INS), an integrated services digital network developed by Nippon Telegraph and Telephone Corporation. In the spotlight in the electronic machinery industry will be shape memory alloys, alumina and zirconia fibers, amorphous silicon and amorphous alloys, and other new materials.

Needless to say, the chemical industry is increasingly focusing on fine chemicals as it switches away from petrochemicals. Capital spending in such electronics-related engineering plastics as silicon, ABS, fluoric and epoxy resins is rising rapidly, as is investment in electronics-related materials like silicon and gallium arsenide.

The new high-tech orientation is evident as well in processing and assembly. The general machinery industry has rapidly boosted investment in smaller, more precise numerically-controlled machines and machining centers. Investment is also expected to surge with the introduction of CAD/CAM, automated conveyors and automatic testing systems. Capital spending related to the OA revolution, centering on the "Three C's" (computers, communications and cards), is rising steeply. A prime example of stepped-up high-tech investment in miniature products is bearings, which are becoming smaller and more precise than ever; the precision of Japanese-made commercial miniature bearings is already greater by one digit than U.S. bearings used in military missiles. The high-tech revolution in these less glamorous areas also deserves attention.

It is hardly necessary to dwell on the high-tech revolution in the electric machinery industry, itself the heartland of electronics and mechatronics. Suffice it to cite just one example of how even small- and medium-size companies can take advantage of the new technologies. Using CAD techniques, Japanese engineers have been able to develop an "ultra-thin motor" by producing a precision sheet coil only 300 microns thick and combining four of them into a 1.2-mm sheet coil. The plant to commercialize this technology can be built for a relatively modest ¥7 billion (about $29 million), and already there are a number of smaller firms taking the plunge.

The sharp rise in the ratio of high-tech investment will be followed by corollary developments on the factory shipment front. The ratio of high-tech product shipments to total factory shipments was only 3.1% on a value basis in 1980. But it will reach 20–30% by around 1990—a pace far faster than originally expected—and could hit 60% by the year 2000.

Clearly, the high-tech orientation of Japan's industrial structure is gathering steam. And the side effects are already apparent. Even geographically, the change is being reflected in the increasing location of high-tech plants in the country's provincial areas.

New transportation networks spur regional plant location

Table 2 shows the opening of new high-tech plants in Japan's outlying regions between 1976 and 1984. In all, 1,713 such plants were established in provincial parts of the country during the nine years. The Tohoku region, covering the northern part of Honshu, Japan's largest island, accounted for 544, or 31.8%, of the total. The relatively large concentration of high-tech plants in this area mirrors the completion of an expressway and a *Shinkansen* bullet train line linking it to Tokyo. Before that, Tohoku was a remote, isolated area, bound to the capital by a single narrow road, described as *"oku-no-hosomichi"* (a path deep in the country) by the famous seventeenth-century Japanese poet Basho.

Similarly, two of the world's four largest production centers for silicon, a symbol of the high-tech revolution, are found in rural Japan—"Silicon Island" or Kyushu, the westernmost of the main islands, and "Silicon Road," stretching from Utsunomiya northeast of Tokyo to Morioka, the capital of one of the six prefectures in Tohoku. And then there is the "Kanto Corridor" circling Tokyo. In the Kanto area, which encompasses both the corridor and Tokyo, 607 high-tech plants, a full 35.4% of the national total, were put up during the period surveyed. Tohoku and Kanto together account for 67.2%.

The Kanto area not only produces hardware, it also plays a crucial role in high-tech R&D, the commercialization of new technologies, and software development. The actual production of the high-tech goods developed and commercialized there is often transferred to other regions.

Any effort to accelerate regional development in the future clearly must include inviting in high-tech industries. At the same time, efforts must be made to increase the high-tech ratio of existing industries. By forming a complex of information industries for technological development involving development of new technologies and software, it will be possible to continuously boost the high-tech orientation of regional industries.

Only success in such far-reaching efforts can yield the national and regional industrial renaissance so essential to Japan's 21st century. ●