# Japanese Science & Technology (I):

## "Japan Inc." musters its technical strength for competition in the post-industrial age

BY JOHN H. DOUGLAS

Sekai Bunka Photo

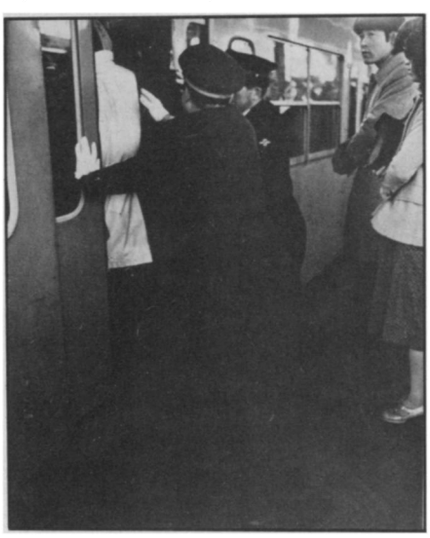
*Why does the rest of the world so consistently underestimate Japan's resiliance?*

Hour after hour, every two minutes or so, a red and white train of Tokyo's Marunouchi subway line rumbles to a stop underground at poetic-sounding Akasakamitsuke station, its doors opening precisely beside white lines painted on the platform. Since the last train, an unending stream of commuters have distributed themselves quietly and evenly behind the painted lines — four lines per car, ten cars per train — and now they wait patiently while a few passengers disembark. At an unspoken signal they rush forward, squirming and shoving with only an occasional grunt or complaint, until a bell rings, signalling the end of the round. Then white-gloved station "pushers" move in to complete the packing and make sure no arms or legs are left dangling through the pincer-like doors. As the train moves off, new queues have already begun to form and the pushers step back for a moment's chat before resuming their work.

If there can be a single explanation of why the rest of the world so consistently underestimates the enormous resilience of Japan, it must have something to do with an inability to comprehend the sort of patient determination evident every day at Akasakamitsuke. These commuters and the Japanese as a whole, display what Santayana called the "irresistible energy and public discipline" that earlier served as the source of American, British and German greatness.

Such attributes are perhaps not noticeable at first glance. The physical setting of Akasakamitsuke, too, lacks distinction — a bank here, a hotel there, down the street a whisky company headquarters. Only when one understands that this is but one of 26 crowded stops on the Marunouchi line, which is one of eight extensive subways in Tokyo, which is only one center of a vast network of rail lines and cities and industrial parks, does the enormity of the Japanese enterprise begin to sink in.

To see the difficulty a Westerner has in approaching Japan, it helps, for example, to recognize that for all its important rail links, Tokyo has no equivalent of Grand Central Terminal. The city has no real center, and institutions most typically Japanese are not particularly grand. It is this lack of some spectacular focal point that so often blinds the foreigner to Japanese accomplishments: Technical achievements have generally followed one another without notable single breakthroughs. Industrial strength has grown rapidly but steadily. Leaders of industry and government are almost uniformly colorless. Indeed, a part of Japan's growing diplomatic troubles with other nations may have arisen because the country arguably lacks any articulate spokesman to present its case to the world.



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*Patient determinism and "pushers."*

The most serious recent underestimation of Japanese ability began three years ago, when Japan was hardest hit among industrial nations by the energy crisis. Dependent on foreign imports for 88 percent of its energy, the country suffered a drop in economic growth rate from an average 10 percent a year to *minus* 1.3 percent in 1974. True, Japan still had the world's third largest gross national product — an economic superpower trailing only the United States and the Soviet Union — but many Western observers commented only half sadly that Japan's long post-war "economic miracle" had finally come to an end.

In fact, the juggernaut had merely lurched. Japan has perhaps adjusted to the new order better than any other industrialized nation, its economic growth only temporarily halted by the initial oil shock and now only partially subdued by sustained high prices for energy. Inflation and unemployment have been relatively well controlled. The yen has just passed the parity level it had with the dollar immediately before the oil crisis. Japan's economy is still the fastest growing of the industrialized nations — 6.5 percent a year versus 4.5 percent for the United States. Its balance of trade has risen from a deficit of $6.6 billion in 1974 to a likely surplus of $14 billion by the end of this year. Japan is now the world's largest producer of ships (with enough capacity to more than meet the whole expected world demand in 1980), and the largest exporter of steel, automobiles and television sets.

*First in a series of articles on current developments in Japanese science and technology. Contributing editor John H. Douglas is spending a year in Japan as a Fulbright Research Journalist.*

# The Coming Challenge


Embassy of Japan

*Tape recorders, like television receivers and automobiles, roll off Japanese assembly lines by the millions.*

Providing the momentum for this industrial development has been a solid record of technological achievement, whose importance has also sometimes been seriously underestimated. The myth still persists that the Japanese are mainly technological "copiers," whose business successes have somehow resulted from collusion and direct government subsidy. Even as an oversimplification, this myth is unnecessarily misleading. Japanese engineers and scientists have generally played the role of technology adapters, not merely copiers.

Government involvement with industry has more often taken the form of forecasting, planning, coordinating and persuading than granting money or giving orders. As one American government expert explains it: "'Japan Inc.' is not a monolithic system in which government leads and business follows blindly. It is rather more of a participatory partnership. The partners work best when there is consensus...."

Underestimating Japanese technical accomplishment can have some devastating practical consequences. Too often the wrong issues are being raised. Current demands for import restrictions to protect American industries from Japanese goods, for example, ignore technological reality. And although some excuse is made that Japanese wages remain somewhat below those in the United States, a much more important factor in the current competition is that American workers are often trying to labor with worn-out tools.

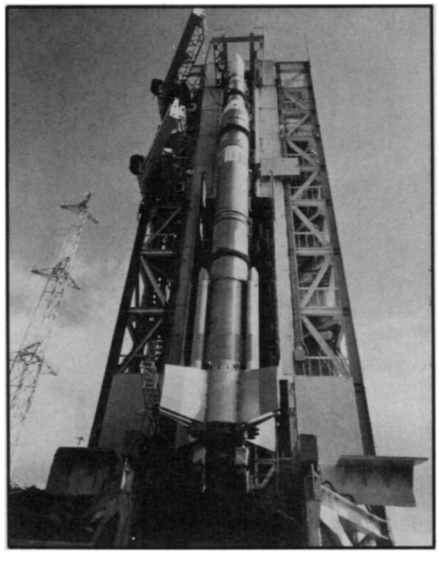
The present fight over the flood of cheap Japanese steel that has swamped the U.S. market and forced closure of some American plants provides an excellent case in point. Most of the public debate has centered on the legal question of whether or not Japanese firms are "dumping" their goods (selling at a loss) in order to get rid of surplus stock. The question is greatly complicated by the American government's definition of dumping, a formula that demands that a sale price be more than 18 percent above actual construction cost. (Japanese firms, which usually operate with low profit margins, say this regulation is unfair and claim they are not really selling at a loss.)

Important as it is, this legal debate has tended to obscure a more important underlying reality — the technological superiority of Japanese steel mills. Since steel production lends itself well to economies of scale, the Japanese have devoted years of effort to mastering the technology of huge production facilities. Of 15 blast furnaces in the world with capacities of more than 4,000 cubic meters, 11 are in Japan, none in the United States. The mills are also highly automated, including the use of several hundred computers to control everything from production to bill collection. Although total labor costs are said to be comparable to those in the United States, the individual Japanese steelworker is 1.8 times more productive.

Technology has also been used to optimize the use of raw materials. Two common measures of resource efficiency in the steel industry are pig iron output per furnace and the amount of coke required to produce a ton of pig iron. By both measures Japanese furnaces are the world's most efficient. By recycling waste heat and introducing other energy-saving technologies, Japanese mills are able to produce a ton of crude steel with only about two-thirds the energy required in American mills. Japanese engineers have also done some pioneering work in the field of pollution control, and about 20 percent of all plant and equipment investment by the Japanese steel industry now goes for pollution prevention.

The reasons why Japanese steelmakers were investing more in plant modernization than American steelmakers were are complex and require further investigation, but the upshot is that Japanese mills can produce steel at between 10 and 30 percent less cost than U.S. mills (depending on whose figures you believe). Because of this differential, other American industries are now happily importing about 20 million tons of steel a year from Japan and elsewhere, which may displace

*Japanese space program is taking off.*



Embassy of Japan

as many as 100,000 American workers from steelmaking jobs.

The most important thing to realize, however, is that the present steel crisis is no more than a warning of possibly greater technological challenges to come.

A fundamental change is taking place in the Japanese government's direction of the nation's industry. The shock of rising raw material prices and growing competition in some industries from developing countries have shaken the Japanese into recognizing the inherent limits a small, resource-poor country has as a manufacturer of heavy industrial goods. As the world's largest importer of oil, iron ore, coal, lumber, lead, wood, cotton, zinc and several other basic materials, Japan is literally at the mercy of international commodity markets. To escape this dependence, Japan Inc. has apparently committed itself to shifting its priorities from material-intensive to knowledge-intensive industries.

The logic behind this decision is readily apparent. The country's only real resource is its technically competent, highly disciplined population, willing to fight for places in an archaic education system and to endure a daily struggle with subway pushers for the privilege of toiling in rigidly structured companies for the longest work week in the industrialized world. Thus, any enterprise that can substitute grim determination for expensive raw materials is tailor-made for Japan.

The first fruit of this determination is knowledge itself, and already the Japanese are beginning to sell the expertise they gained while building their heavy industries. By 1973, they controlled about eight percent of the world's market in building industrial plants for other nations. Having created the world-famous "bullet trains," Japanese National Railways is now acting as a consultant to Amtrak, as the United States considers how best to improve its long-neglected rail system. Honda Motor Co., having pioneered the energy-efficient, low pollution CVCC automobile engine, recently turned down a request from American Motors Corp. for rights to build the car in the United States. Instead, Honda has decided to build its own American plant.

The Japanese are also shifting the emphasis of their domestic investment toward "high-technology" industries. Probably the most important of these initiatives is the commitment to build a domestic computer industry, for the computer is the equivalent of the steam engine in powering the post-industrial revolution (SN: 10/4/75, p. 220). But this venture is also the riskiest. First, the Japanese must drive their seemingly irresistible force against one of the world's great immovable objects — IBM. Second, they must develop a new level of technical sophistication, if they are to adapt and

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*Bigger, better and faster trains to come.*

improve the relevant foreign technology when it is available. The rapidly developing computer market permits no lag.

Already the fledgling industry has scored some impressive successes. Fujitsu Ltd. reportedly beat out IBM recently in the sale to Australia of a giant $36 million computer system. And in the push to develop technology for the next generation of computers, an R&D project sponsored by two government agencies and six private companies is attempting to produce within three years a Very Large Scale Integrated circuit (VLSI), containing many times the number of elements on today's best solid state circuit chips.

Other R&D projects designed to produce profitable new technologies or secure a broader energy base include:

- Nuclear power. Japanese nuclear reactors now generate more power than those of any other country, except the United States. The nation's first experimental breeder reactor, *Joyo*, went critical in April and the first nuclear fuel reprocessing plant began operation in September.
- Space. Japan launched its first stationary weather satellite, *Himawari*, in July, using American facilities, and the first Japanese communications satellite is scheduled for launch next year. A recent government report envisions having Japanese scientists cooperate with the American shuttle program in the 1980s, while developing space stations and a shuttle of their own for the 1990s.
- Medical equipment. Fifty Japanese medical institutions now use computerized multiphasic health check-up systems, informally called "human dry-docks." Two hundred sophisticated Computerized Tomographic (CT) scanners are being used, and electronic equipment to detect the presence of cancer cells and to perform chromosome analysis is being developed.
- Transportation. A prototype High Speed Surface Transport (HSST) train has been developed by Japan Air Lines Co. The vehicle, successfully tested last April, runs without wheels by using the magnetic field of a superconducting magnet to float it one centimeter above a guide rail. It is reputed to be the world's largest "maglev" train. Japan National Railways is developing a slightly different version.
- Ocean minerals. A Tokyo-based firm that has been supplying the expertise to drill for oil in the territorial waters off the Soviet Union recently reported discovering what may be the "largest oil deposit in Asia," off the northern tip of Sakhalin island. A Japanese research vessel has been exploring the possibility of mining manganese nodules off Hawaii since 1975. And two different methods for obtaining uranium from sea water are being investigated in hopes of building a pilot plant in the early 1980s.
- Alternative energy sources. The government-sponsored "Project Sunshine" is currently funding such programs as a one megawatt solar electric plant scheduled for operation in 1980, a one megawatt geothermal plant scheduled for completion this year, and pilot plants for coal gasification and liquefaction to be completed by 1980.

If even a fraction of these and other ambitious technical schemes are successful, Japan's competitive position in the world is likely to become even stronger in the future than it is today. A provocative estimate of just what this technological challenge may mean to the rest of the world has been offered time and again by futurist Herman Kahn, who says that Japan will probably succeed in its century-old ambition of not only catching up with the West, but surpassing it. As early as 1962, Kahn was saying, "It would not be surprising if the 21st century were the Japanese Century." Then, in 1970, he predicted that Japan's gross national product would probably pass that of the United States at about the turn of the century. New, lower growth rates would set this prediction back about four decades, but Kahn's analysis remains a fascinating one.

Two of his points, particularly, need re-emphasis. First, recent captivation with mainland China must not blind the world to the fact that economically Japan is two or three times larger. "Japan, not China, is the big power of Asia." Second, despite a consistently pacifist foreign policy, Japan is a potentially formidable military power. Although less than one percent of the country's gross national product goes to its "Self Defense Force," the absolute size of this military budget is the seventh largest in the world, and roughly 90 percent of the required military hardware is produced in Japan itself.

For each of its strengths, however, Japan has allowed to persist some corresponding weaknesses, as if to fulfill the ancient oriental principle of yin and yang. Despite talk of encouraging new realms

of R&D, the Japanese government budget for science and technology remains the lowest of any major developed country. Although most dependent on raw materials of all the industrialized states, its rate of contributing to the technological development of the Third World is the smallest. The Japanese system of education and employment has created a stable, dynamic society of highly trained technocrats, but many observers wonder whether uniformity has been stressed so much as to crush the freedom necessary for real creativity in science and technology.

Finally, in the face of an increasing need for effective dialogue with the world at large, the Japanese often remain embarrassingly isolated and inarticulate. In the words of Harvard's Edwin Reischauer, "They have developed enough skills to handle specific economic and other relations with the outside world, but not to make a contribution to the solving of world problems that is commensurate with their size and skills."

In the faces of commuters at Akasakamitsuke one sees reflected these paradoxes of modern Japan. To them, the oil crisis meant the hiring of 2,000 more pushers to help accomodate the extra people who rode subways rather than driving their cars. Along the train platform, Japan's "economic miracle" is readily apparent in the multitude of fashionable clothes and other accoutrements of prosperity. (Japanese businessmen have now supposedly surpassed the British as the world's best dressed.) But the price of industrial prominence is also visible, for public works and private amenities have often been sadly neglected. Aboard the trains many women hold little handkerchiefs to their noses to ward off the smell of pollution and the crowd, and half of these people reportedly go home to houses without flush toilets.

There are other costs as well. In the name of political expediency some marginally productive activities, particularly farming, have had to be artifically supported by the rest of the booming economy. Thus the whisky company headquartered in Akasakamitsuke has recently prompted protest rallies in Glasgow for its success in imitating scotch at a lower price, but the cost of some fatty hamburger meat to go with a drink runs about $3 a pound in Tokyo. Meanwhile, Australia and New Zealand beg to export more beef to Japan.

The future of Japan and of its increasing technological challenge to the rest of the world are thus clouded with uncertainties. The West can no longer afford to underestimate Japanese abilities, but to understand the likely impact of recent initiatives will require close examination of several specific projects and also of the society supporting them. Such an analysis will be attempted in the following articles of this series. □

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**THE FLYING CIRCUS OF PHYSICS: With Answers** — Jearl Walker — Wiley, 1977, 295 p., drawings, paper, $6.95. Physics problems from the everyday world, some easy, others enormously difficult that scientists spend their lives trying to solve. A book intended to make you think about the physics around you. Answers are included as well as a bibliography keyed to the questions.

**HOW BIRDS FLY**—Russell Freedman—Holiday, 1977, 64 p., drawings by Lorence F. Bjorklund, $6.95. The rigid wing of an airplane is simple compared with the flapping wing of a bird. A simply written book with beautiful drawings intended as an introduction for those who have wondered how a bird stays up, how it uses its wings and how it maneuvers.

**THE INSECTS: Readings from *Scientific American***—Thomas Eisner and Edward O. Wilson, Eds.—W H Freeman, 1977, 334 p., illus., $15, paper, $7.95. Ecologically dominant animals on land, the population of insects has been estimated as 200 million for each human on earth. Insects as ideal model systems for basic research is an implicit but well-developed theme in a large number of the articles.

**NUCLEAR PROLIFERATION: Motivations, Capabilities, and Strategies for Control**—Ted Greenwood et al — McGraw, 1977, 211 p., $8.95, paper, $4.95. According to two of the authors, the nuclear power industry now growing worldwide will, unless altered, significantly increase the risk that nuclear weapons will proliferate. Dr. Greenwood analyzes the political climate and suggests ways to make it less conducive to proliferation.

**THE PICTURE OF HEALTH: Environmental Sources of Disease**—Erik P. Eckholm—Norton, 1977, 256 p., paper, $3.95. "Significant improvements in health require massive attacks on the major sources of disease: unjust social systems, reckless personal habits and carelessly used technologies," says the author of this study, jointly sponsored by the United Nations Environment Program and Worldwatch Institute.

**PIGEONS AND DOVES OF THE WORLD**—Derek Goodwin—British Museum-Natural History (Cornell U Pr), 2nd ed., 1977, 446 p., color photographs & drawings by Robert Gillmor, $27.50. Pigeons and doves (which ornithologically are the same) are discussed as to general characteristics, then each living or recently extinct species is described in detail. Beautifully illustrated.

**PLAYING GOD: Genetic Engineering and the Manipulation of Life** — June Goodfield — Random, 1977, 218 p., $8.95. Discusses the scientific, legal and moral aspects of recombinant DNA research and its implications for society, extending this problem to the relationship of the scientific profession to contemporary society.

**THE RAND McNALLY ATLAS OF THE OCEANS**—Martyn Bramwell, Ed.—Rand, 1977, 208 p., color photographs and drawings, $29.95. With text, many color photographs and drawings, the component parts of the ocean are presented—its life, its surface and depth, its islands and archipelagos and its interface with the continents; also included are man's interaction with, and intervention in, the oceans.

**STRESS AND ANXIETY: Volume 4**—Charles D. Spielberger and Irwin G. Sarason, Eds.—Hemisphere (Halsted Pr), 1977, 336 p., graphs & charts, $18.95. Based on papers, presented at a conference in Norway in 1975, that are concerned with the fundamental nature of stress and anxiety, the development of objective procedures for measuring these concepts and research on the effects of stress and anxiety on behavior.

**TAKING CARE OF YOUR CHILD: A Parents' Guide to Medical Care**—Robert H. Panell et al—A-W, 1977, 407 p., $10.95. Practical information together with decision charts for 91 common childhood problems to help parents decide when to take a child to the doctor, and when and how to provide home treatment.