Japan's national R & D programme

John H. Douglas examines the progress of government-sponsored large-scale projects in Japan

A constructive way of using waste: garbage crushed into blocks for use in the building industry.

IF the continued economic success of "Japan Inc." still puzzles the average Westerner, the role played by research and development in fostering the country's industrial achievements remains even more of a mystery. Yet the conduct of research, like that of business, often reflects a typically Japanese character, and examination of research priorities reveals much about Japan's plans for the future.

The outstanding characteristic of the government-business relationship in Japan's "guided capitalism" is a continual search for consensus. When all parties can agree on a course of action, thorough commitment to massive projects can be secured and planning for a very long time-scale is facilitated. Similarly, the strength of Japanese research and development lies in the ability of government, universities and industry to commit themselves to joint effort toward long-term goals.

Not surprisingly, such research by mutual consent is usually limited to pursuing narrowly defined, immediately applicable ends. Inherently the system lends itself to adapting, rather than originating, new technologies, although this pattern may be changing. There are also structural limitations: nearly three-quarters of Japan's total R&D expenditures occur in the private sector (compared to less than half in Britain), which naturally leads to emphasis on applied, rather than basic, research.

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Instead of directly sponsoring the majority of research, as in the West, Japan's government has more often played the role of midwife for consensus. But in the mid-1960s it became apparent that some major projects would require more direct government support. The Ministry of International Trade and Industry (MITI) was given the responsibility for sponsoring these large-scale projects, and in 1966 a National Research and Development Programme was established under the ministry's Agency of Industrial Science and Technology (AIST).

The partnership of government, industry and university was thus strengthened to be able to handle even more massive and long-range projects. To qualify for support under the programme, a proposed project had to have "urgent importance for upgrading national industrial standards, promoting efficient utilisation of natural resources, preventing industrial pollution, and so on".

Now, after a decade, some 14 projects have been launched under the programme. Two have been successfully completed: the development of an internationally competitive computer system and of a commercially viable desulphurisation process. One project, the development of a remote-controlled undersea oil drilling rig, was suspended in 1975 for reasons that MITI officials will still not discuss.

Current projects

A summary of the 11 remaining projects probably offers as clear a guide as any to the major areas of research and development that the Japanese believe should have the highest priority to serve as a base for future industrial and social development. The three outstanding exceptions to this statement include Japan's nuclear energy programme, the search for alternative energy sources called "Project Sunshine" and the country's emerging space programme, which are funded separately.

● Jet engines: In terms of anticipated total funding over the expected life of a project (see table below), the largest undertaking in the National Research and Development Programme is an effort to promote a technologically independent jet-engine industry. Specifically, the aim of this project is to produce prototypes of a turbofan jet engine particularly suited to Japan's domestic airlines, whose routes are relatively short and require frequent stops. An engine with thrust in the 10 to 15 ton range is envisaged, with parts highly resistant to heat fatigue for frequent take-offs and landings.

Tests of a 6.5 ton thrust prototype are now being conducted in a British wind tunnel (there are none in Japan large enough for the task), and if these and later tests prove successful, a model of this engine may be mounted on an aeroplane within three years.

A related project, which may be funded separately and which has not yet been officially announced, is designed to help Japan's domestic airlines: a short take-off and landing (STOL) craft to be fashioned from the American C-1 military cargo plane. STOL capabilities will reportedly be incorporated by mounting jet engines on top of the plane's wings, so the plane could then carry about 125 passengers. The new project is expected to cost a total of about 17,000 million yen.

● Pattern information processing: Optical recognition of letters, numbers, *kana* (Japanese syllable characters) and *kanji* (Chinese ideographs) has now reportedly been achieved. MITI officials say the first practical application of the system can be expected within two years, probably in the patent office as an aid to processing applications.

This project also includes several parallel efforts including experiments with artificial intelligence and development of new electronic components. Active research is being sponsored in the fields of magnetic bubble devices, semiconductor lasers, holographic memories, very large scale circuit integration (megabit memories on a single chip) and microprocessor architecture for a variety of applications.

● Magnetohydrodynamics: MHD power generation, now the oldest continuing project in the programme, may turn out to be too expensive for even this sort of national effort. One senior MITI official says that MHD offers a "good opportunity for a joint project" with other nations, and he hints that active negotiations toward this end are already in progress.

Present Japanese targets call for testing a 100 kilowatt generator with a copper-iron magnet for 200 hours in 1980. Then, if these tests are successful, a 100 kilowatt generator with a superconducting magnet is planned for 1982.

● Nuclear steelmaking: In anticipation of the successful development of a multi-purpose high-temperature gas reactor (HTGR), funded separately, MITI is coordinating the efforts of more than a dozen major companies to produce the components that will be required by a steelmaking system based on the reactor. Some of the major goals of the first phase of this project include development of a 1.5 megawatt heat exchanger loop, alloys and insulation materials capable of handling the 1000 °C helium gas coming from the HTGR.

Parallel efforts include construction of a steam reforming test plant to make a reducing gas from light hydrocarbons, development of an apparatus for charging a shaft-type furnace under the new conditions, and completion of a conceptual design for the proposed system. If phase one is completed on schedule, by 1979, a nuclear steelmaking pilot plant is proposed, to begin operation as early as 1986.

● Complex manufacturing: Begun during the current fiscal year, this latest project aims at production of a single machine complex that can handle many successive manufacturing steps—such as grinding, milling, welding, forging and casting—at one location. Computer control and the latest laser technology will be incorporated.

● New process for producing olefins: Unsaturated hydrocarbons of the olefin series (general formula C_nH_{2n}) form the raw materials for many key petrochemical industries, and the Japanese fear that these industries will be threatened by anticipated shortages of imported naphtha, from which the country's olefin supply is presently produced. Since countries with domestic sources of natural gas or light oils are not so concerned with the naphtha problem, Japan has emerged as perhaps the world leader in developing a technology for producing olefins directly from crude oil, which is more likely to remain available.

During the first stage of the project, which ended in 1973, a test plant capable of treating five tons of crude oil per day was built. During the second stage, a 120 ton per day pilot plant is being constructed and experimental work is proceeding to see if olefins can also be produced from the residual oils left after vacuum refining of crude oil.

● Resource and energy recovery. Japan's extremely concentrated population (only about 20% of the country's land is flat) suffers acutely from problems that for many other countries are still only nuisances. The National Research and Development Programme has so far attacked four of these problems: air pollution, urban waste, traffic congestion and water shortages.

Japan's National Research and Development Programme

Project	Anticipated Life	Lifetime Cost (10^9 yen)*
Jet Engine	1971–1980	25.4
Pattern Recognition	1971–1980	25.0
MHD	1966–1982	18.4
Nuclear Steelmaking	1973–1979	12.3
Complex Manufacturing	1977–1983	12.0
Olefin	1975–1981	10.0
Resource Recovery	1973–1981	9.8
Traffic Control	1973–1978	7.3
Desalination	1969–1977	6.7
Electric Vehicles	1971–1977	5.7

(£1 ≈ 450 yen)

To recover useful materials and energy from urban wastes, two 100 ton per day experimental treatment plants are now being developed. The feasibility of several of the technologies involved has already been demonstrated and the project is expected to be completed successfully within three or four years. Technologies now being considered for practical application include cryogenic shredding of wastes, magnetic and air-stream separation techniques, and internally heated fluidised-bed pyrolysis.

● Traffic control: To help drivers cope with some of the world's worst traffic congestion, what is probably the world's largest advanced traffic control experiment is now being conducted in a ward of southwestern Tokyo. In an area of about 30 square kilometers, traffic is being monitored by a highly automated control centre, which advises drivers of road conditions and routing options, through a variety of media.

Some 300 test vehicles have been equipped with a display panel that automatically tells a driver the fastest route to a predetermined destination. Another 1,000 vehicles have been provided with a simpler driving information unit that flashes such messages as "Road Construction Ahead". And three roadside display boards at key locations provide all drivers with notice of road conditions and recommended detours.

● Water desalination: For a country so notoriously damp and rainy (with more than twice the annual rainfall of Britain), Japan would seem to have little reason to give such high priority to a project for taking fresh water from the sea. But again because of the extreme concentration of people, water shortages are expected to begin in Tokyo and other major cities perhaps as early as 1980.

The MITI-sponsored desalination project, which ends this year, involved construction of a 100,000 m^3/day test plant using multi-stage flash evaporation (MSF) to produce fresh water. As a result of successful experiments at the plant, the Japanese now claim to lead the world in MSF technology, and private companies are exporting commercial desalination plants with capacities of 30,000 m^3/day.

● Electric vehicles: In the other major project to be completed this year, five second-generation electric vehicles (two cars, two trucks and a bus) have been successfully designed, built and tested. MITI officials say the next step toward full commercialisation must be removal of legislative and economic disincentives and further improvement of accumulators for the vehicles.

During the fiscal year 1977, MITI's total expenditure for the National Research and Development Programme, including management cost, was 14,484 million yen (about £32 million). Thus, although the programme was designed to infuse government funds into areas of research that private companies might hesitate to enter alone, public expenditure remain relatively small. Commercial success in any one of the projects could conceivably bring to Japan enough foreign exchange to support the whole programme.

Rather than producing the "spin-offs" that result from open-ended research common in projects sponsored by Western governments, the MITI projects pull along a family of "spin-in" technologies. When, for example, a holographic memory or a new high-temperature alloy is finally developed, an eager market will be waiting. Theoretically, the disadvantage of even such long-range, loosely defined "applied" research is that it will not produce the sort of original breakthroughs that come haphazardly from basic research. So far, however, Japan has had little trouble importing these fundamental advances from abroad. As long as this flow of ideas remains adequate Japan's National Research and Development Programme will remain one of the country's biggest bargains. □