

The Coming Commercial Utilization of Space

By Yuta Sagara

Space is a fascinating new frontier with unlimited potential. Ever since the world's first artificial satellite, *Sputnik*, was boosted into orbit in October 1957, man has launched numerous satellites for communications, meteorology, earth observation and planetary exploration.

With the debut of the U.S. space shuttle, a new era of commercial utilization of space has dawned. In this new age metal alloys, compounds, electronic materials and pharmaceuticals difficult or impossible to manufacture on earth can be produced in space using the extreme states of weightlessness, near-perfect vacuum, extreme high and low temperatures and limitless solar energy.

Japan, which started its own space program in 1955 with the successful launching of a "pencil" rocket only 23 centimeters long, has grown into the world's third-ranking country in satellite launches, next only to the United States and the Soviet Union. Japan is now developing entirely on its own a full-sized rocket, the "H2," capable of placing a satellite weighing up to two tons in geostationary orbit. Two private companies have started a satellite communications business, and three Japanese have been selected to fly a space shuttle mission and conduct scientific experiments in space. Moreover, Japan has decided to participate in the manned space station to be constructed by the United States in cooperation with major Western countries.

In anticipation of the age of full-scale commercial utilization of space, Japan has started development work on an un-

manned space laboratory system called *Free Flyer* for testing materials in the micro gravity of space.

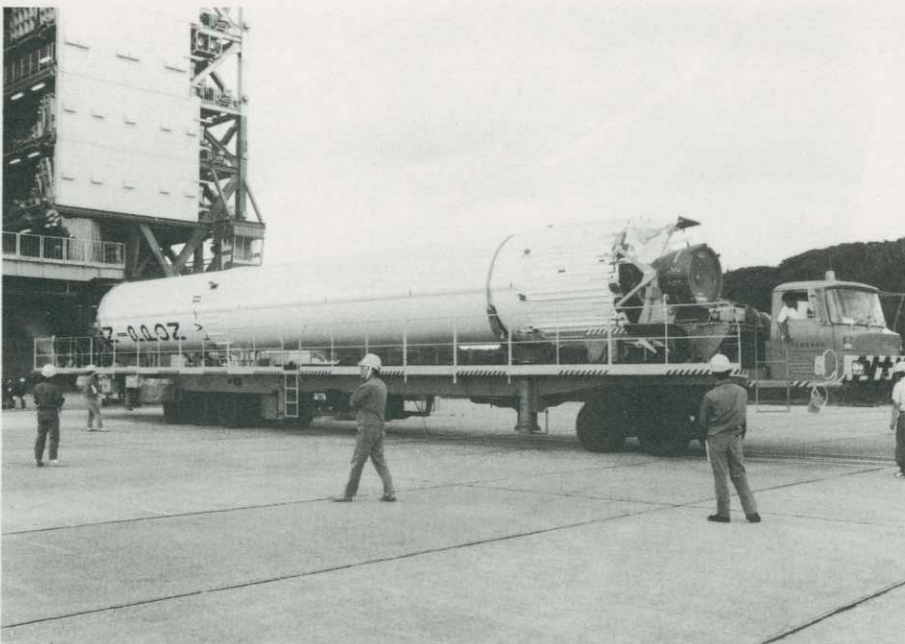
Forecasted explorations

It is said that in the 21st century, space will be the work site for high-tech industries. What is the likely future of the Japanese space industry as it explores man's next frontier?

The supreme organ for Japanese aerospace development is the Space Activities Commission, an advisory organ to the prime minister chaired by the director general of the Science and Technology Agency. Under this committee's super-

vision, actual space development is undertaken by the Institute of Space and Aeronautical Science (ISAS) of the Ministry of Education (formerly the Institute of Space and Aeronautical Science of the University of Tokyo), which is primarily in charge of scientific observation, and by the National Space Development Agency (NASDA), which is in charge of the practical utilization of space. Space development is also supported by such user organizations as the Ministry of Posts and Telecommunications, the Ministry of International Trade and Industry (MITI) and the Ministry of Transport.

ISAS, carrying on the tradition of



Japan is now the world's third leading satellite launcher after the U.S. and U.S.S.R.

the pencil rockets, successfully orbited Japan's first artificial satellite *Ohsumi* in February 1970. In August 1985, it launched the deep space probe, *Suisei* (comet), which played an active part in tracking Halley's comet. So far the institute has launched a total of 15 scientific space vehicles.

NASDA, for its part, successfully launched the *Kiku-1*, a technical experimental satellite, in September 1975. Most recently, in February 1986, the agency launched the direct broadcasting satellite *Yuri-2b*. So far it has orbited a total of 17 satellites, including communications, broadcasting and meteorological satellites. Of the 17, all but three that were launched by the U.S. used Japanese launch vehicles.

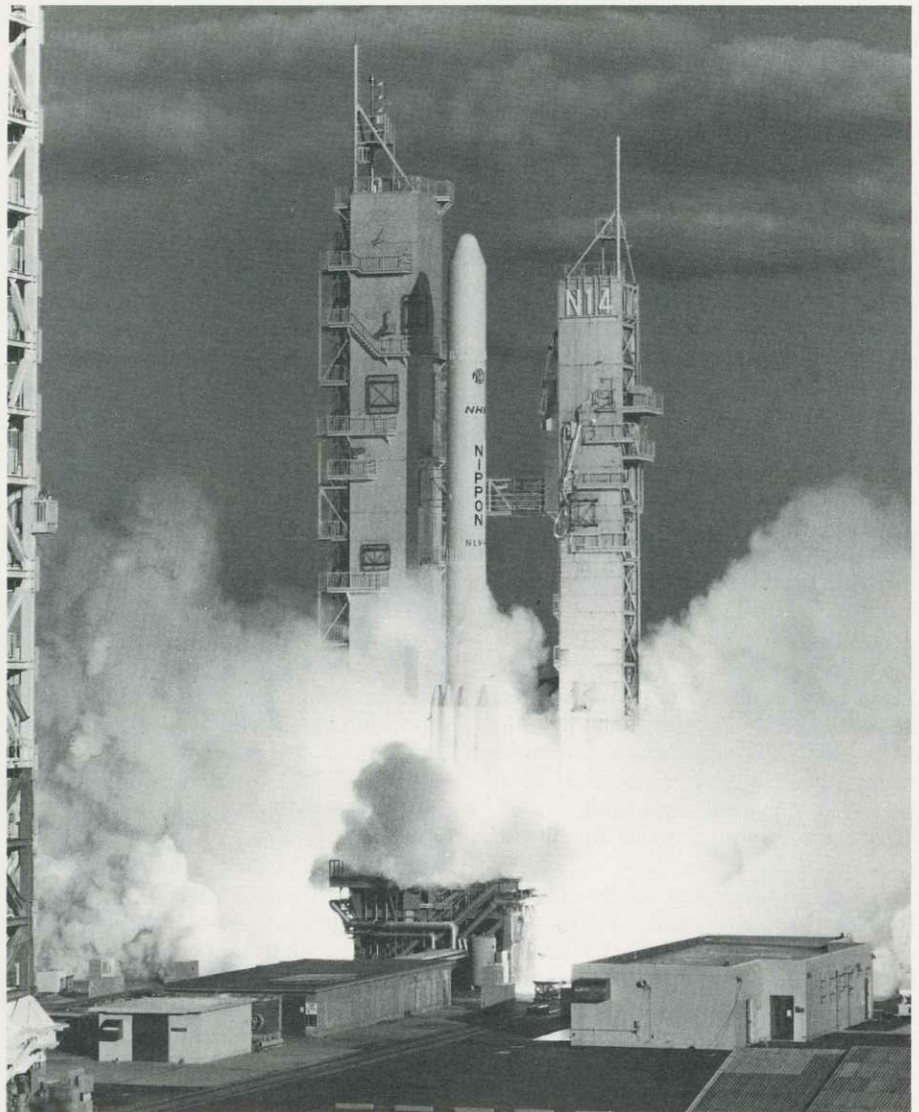
In pace with the progress in space development and utilization, Japanese space-related industries are steadily increasing their sales. According to a survey by the Society of Japanese Aerospace Companies, aerospace industry sales in fiscal 1983 totaled ¥170.3 billion. By item, sales of rockets reached some ¥32 billion, satellites ¥45 billion, and all other vehicle-related items, including parts and components, ¥98.6 billion. Sales of earth stations and other ground facilities totaled ¥59.4 billion, while software sales hit ¥12.3 billion.

Of total demand for aerospace products, domestic demand, mostly from NASDA, accounted for 80.7% and export demand, mainly for ground facilities, made up the remaining 19.3%.

The Japanese aerospace industry has grown steadily in recent years, but it is still barely one-thirteenth the size of its American counterpart. In order to expand the industry, it is vital to promote the utilization of space by the private sector.

Among the large-scale projects currently planned, the H2 rocket, participation in the manned space station, an earth resources exploration satellite and the *Free Flyer* are expected not only to expand the scale of Japan's space industry but also to enhance the country's high-tech development capabilities.

The H2 rocket, which unlike previous NASDA boosters is to use entirely Japanese technology, will be a two-stage rocket some 46 meters tall, 4 meters in diameter and weighing about 24 tons. A high performance liquid oxygen-liquid hydrogen LE-7 engine similar to that installed in the U.S. space shuttle and generating 93 tons of thrust will be developed. Two solid fuel auxiliary rockets with combined thrust of 130 tons will be attached to the first stage. The second-



stage rocket will be an improved version of the LE-5 liquid oxygen-liquid hydrogen engine (10.5-ton thrust) used in the H1 rocket scheduled for launching for the first time this summer. The H2 rocket can put up a geostationary satellite weighing up to 2 tons, or boost a 9-ton satellite into low-earth orbits up to 300 kilometers in altitude. The H2 will be as powerful as the Ariane-4 rocket currently under development by the European Space Agency (ESA).

The cost of developing the H2 rocket is estimated at ¥200 billion (about \$1.1 billion at the rate of \$1/¥180). Development starts this fiscal year, aiming for a test flight in fiscal 1991. The H2 can also be used with a small manned spaceship instead of a satellite. NASDA and the National Aerospace Laboratory of the Science and Technology Agency have already begun research on a small, reusable transport vehicle to make repeated trips into space.

Space station cooperation

The Space Station Project, which the U.S. is undertaking in cooperation with other Western countries, is aimed at constructing a permanent, expandable multipurpose manned space station orbiting the earth at an altitude of 500 kilometers. Japan, together with the ESA and Canada, will participate in this project, contributing an experimental module of its own design to be linked to the space station. The module will have a pressure chamber, an exposure chamber and a supply chamber. The main station will provide electricity and water as well as information transmission and receiving services. The pressure chamber will serve as a laboratory for materials and life science experiments. The exposure chamber, equipped with a worktable and an outside manipulator, will be used to conduct scientific observations and communications experiments using a remote

control device. The supply chamber will be used for storing supplies and test materials for experiments.

Originally, the space station was scheduled to start operations in 1992. However, due to deteriorating American finances and the explosion of the space shuttle *Challenger*, the start of the project has been delayed until the mid-1990s.

The space station is to be built in four stages and completed by the year 2000. Japan's financial share in the first phase alone is estimated at ¥200 billion to ¥300 billion.

Japan cannot compete in the commercial utilization of space if it relies only on such giant national projects as the H2 rocket and the space station. The U.S. and European countries are already vigorously promoting the utilization of space by the private sector.

Japan has so far devoted itself to independently developing technology to catch up with the U.S. and the advanced European countries, but it still lags seriously behind in space utilization. In the U.S., for instance, satellite communications were commercialized 10 years ago, while Japan still does not have a private-sector communications satellite of its own.

Japan, however, has finally gotten a start in the commercial use of space. As a result of the April 1985 revision and enforcement of the Telecommunications Business Law and other related legislation, three private satellite communications companies have now been established. Of the three, Japan Communications Satellite Co., Inc. was licensed by the Ministry of Posts and Telecommunications and has placed an order with Hughes Aircraft Co. of the U.S. for the manufacture and launch of two satellites. Space Communications, meanwhile, has ordered a satellite from Ford Co. of the U.S. Both companies are scheduled to launch their first satellites with the Ariane rocket in 1988.

MITI's pivotal role

As Japan takes these first steps into the age of space commercialization, MITI's role will prove vital in the full-scale utilization of the space environment.

In response to the increasing interest on the part of the industry, MITI established the "Space Environment Utilization Investigation and Study Committee" within the Machinery and Information Industries Bureau in October 1984 to investigate ways to use space to develop industrial technology.

The committee's work demonstrated

that the utilization of the micro gravity of space could have a major impact on the development of industrial technology in semiconductors, organic materials and biotechnology. Accordingly, MITI established the "Round Table Discussion on Utilization of Space for Industry" in June 1985 and is now conducting concrete studies on the technical and legislative problems involved in industrial utilization of the space environment preparatory to working out concrete measures.

MITI increased its space-related budget in fiscal 1985 to ¥3.4 billion, 2.5 times more than the preceding year. The fiscal 1986 budget is about ¥6 billion.

The principal space development and utilization projects now on MITI's agenda are an earth resources exploration satellite and the unmanned space laboratory system.

The principal objective of Japan's first earth resources satellite, the *ERS-I*, will be to explore for oil and other mineral resources. To help secure a stable supply of resources and energy for Japan and to implement effective resources policy measures, MITI started developing the *ERS-I* in fiscal 1984 jointly with the Science and Technology Agency. *ERS-I* will be the world's first satellite designed specifically for practical resources exploration. Aggregate development cost, including the booster, could reach ¥70 billion. It is scheduled to be launched by an H1 rocket in fiscal 1990.

The development of the vehicle itself is being undertaken by NASDA, while MITI is in charge of R&D work on the various observation systems which will be at its heart, including synthetic aperture radar (SAR) and optical sensors. This research is being carried out under the large-scale industrial technology research and development system of the Agency of Industrial Science and Technology.

SAR is an observation system capable of detecting even minor unevenness and small inclines on the earth's surface using microwaves transmitted by the satellite. Unlike optical sensors, which passively receive reflected sunlight, SAR can obtain data on the earth's surface regardless of the presence of clouds, night or day. It is expected to display its superb capabilities not only in resources exploration but also in national land surveys and the observation of agriculture, forestry and fisheries resources.

The visible near-infrared radiation meter (VNR) in the *ERS-I* optical sensor uses a charge-coupled device (CCD) to classify light reflected from the earth's surface into four wavelength bands

ranging from visible radiation to near-infrared. VNR has a shortwave infrared range effective for exploring oil reserves. Its resolution is 18 meters, superior to the 30-meter resolution of the U.S. earth observation satellite *Landsat 5*.

Designated by MITI as its star project for industrial space utilization is its program for space-based materials experiments utilizing weightlessness and other extreme states. MITI started two projects to this end in fiscal 1986, one for comprehensive research on the utilization of the space environment and the other the *Free Flyer* unmanned space laboratory system.

Comprehensive research on space utilization is aimed at establishing innovative materials-processing technology in electronics, biotechnology and new materials, and developing the apparatus and equipment needed for conducting experiments in micro gravity.

Japan has already reached agreement with West Germany's Ministry of Research and Technology on participation in West Germany's space lab program (D2) scheduled to start in 1988. At home, meanwhile, a semigovernmental company dubbed the Space Technology Corporation was established in April 1986. The capital of this new company will eventually be increased to nearly ¥10 billion. Of the initial capital, about 70% was provided by the government-authorized Japan Key Technology Center and the remainder by six private companies.

In an age of industrial space utilization, it will not be to Japan's advantage to remain dependent forever on other countries for space experiments. That is the reasoning behind the great importance MITI places on the development of the *Free Flyer*. The *Free Flyer* will be a free-flying artificial satellite for developing high technology in electronics, biotechnology and new materials utilizing micro gravity. The U.S. and France are also concentrating on the development of free flyers as scale models of space factories to be constructed in the more distant future.

The *Free Flyer*, which MITI hopes to launch in fiscal 1992 now that ¥180 million has been approved for the project in fiscal 1986, will be released into space from a U.S. space shuttle. Unmanned, it will automatically conduct experiments in the manufacture of materials in space for several months. A space shuttle will then recover either the test materials or the whole system for analysis. With the start of operations of the *Free Flyer*, Japan will step onto center stage in the industrial utilization of space. ●