Moving Ahead–at the Speed Of Light: The Japanese Optoelectronic Industry

By Yoshitatsu Tsutsumi

The Japanese optoelectronics industry may be young, but it is growing fast. It was first taken up in official statistics in fiscal year 1978. According to a March 1981 report by an advisory committee to the director general of the Machinery and Information Industries Bureau, Ministry of International Trade and Industry (MITI), the industry's production that first year was worth ¥23.9 billion ($99.6 million) (Fig. 1). By fiscal 1983, the Optoelectronic Industry and Technology Development Association (OITDA) was estimating turnover for the year at ¥430.7 billion ($1.8 billion), up 54.6% from just a year before (Table 1).

The optoelectronics industry owes much of its remarkable growth potential to its parents. Its father is the electronics industry, which had turnover of ¥10.4 trillion ($43 billion) in fiscal 1981, for 14% growth year-on-year. On its mother's side, the optical industry, turnover was ¥1.2 trillion ($5 billion) that same year.

While the child is still smaller than either of its parents, it is already giving many other industries, both old and new, a run for their money. The nuclear power industry, now 30 years old, had sales of ¥2.5 trillion ($10.4 billion) in fiscal 1982, for an annual growth rate of 14%. The space industry, with only ¥100 billion ($417 million) in annual sales, has been stagnant for the past five years. Thus optoelectronics has already surged past the space industry, and is growing even more rapidly than nuclear power.

A bright future

How about the future? OITDA's long-range forecast, published in March 1982 and based on a survey of its 175 members, predicts the market will continue to grow, reaching some ¥1 trillion ($4.2 billion) in 1985, ¥2 trillion yen in 1990, and nearly ¥12 trillion ($50 billion) in the year 2000 (Table 2). The average annual growth rate from 1980 to 2000, the report says, should hit 28%.

These are bold and ambitious figures. If true, the child will soon surpass its mother, and within 16 years could even overtake its father. The largest single industry in Japan is now automobile manufacturing, with annual turnover of ¥23.8 trillion ($99 billion) in 1981. The optoelectronics industry could be half as large as early as the year 2000.

Large as these figures may be, they seem quite credible. OITDA's questionnaire asked member companies about their production levels—past, present and future—on 75 items already in production. New optoelectronic products not yet on the market, such as laser fusion reactors and optical computers, were excluded. On this basis, actual production in 1980 came to ¥82.8 billion ($345 million). A small start, perhaps, but the goal is tremendous. OITDA has carried out follow-up surveys every year, and so far actual performance has risen as predicted.

The 75 items covered by the survey fall into three categories: components, equipment, and systems. In 1980 the share of components was 65%, equipment 22% and systems 13%. In 2000, OITDA estimates the share of components will fall to 22% while equipment and systems will rise to 42% and 36% respectively. This shift will not only increase total sales, but will also lead to greater product diversity by the turn of the century. The items were carefully chosen not to overlap with products of other industries, especially the electronic and optical industries. For example, VTRs, video cameras and electron microscopes are excluded, while laser discs and DAD (digital audio discs) are retained.

Of these items, some were already enjoying over ¥10 billion in sales in fiscal 1982. On the component side, light emit-

Table 1 Annual Turnover of Optoelectronic Industry Unit: ¥ billion

	FY1981 (actual)	FY1982 (actual)	FY1983 (estimate)
Components	89.3	165.3	236.1
Equipments	42.7	83.5	142.0
Systems	27.8	29.7	52.6
Total	**159.8**	**278.5 (+74.3%)**	**430.7 (+54.6%)**

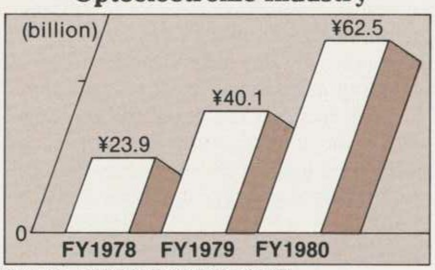
Source: Optoelectronic Industry & Technology Development Association

Table 2 Future Growth of Optoelectronic Industry Unit: ¥ billion

	1985	1990	2000
Components	194 (22%)	411 (19%)	2,639.2 (22%)
Equipments	563.4 (62%)	1,362.9 (64%)	5,037.8 (42%)
Systems	146 (16%)	350 (17%)	4,294 (36%)
Total	**903.4 (100%)**	**2,123.9 (100%)**	**11,971 (100%)**

Source: OITDA Report

Fig. 1 Annual Production of Optoelectronic Industry



Source: Advisory Committee of MITI

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ting diode (LED) sales reached ¥40 billion ($167 million). Lasers—including semiconductor, gas, solid and liquid lasers—reached ¥9 billion ($38 million), as did solar cells and light receiving devices—including photodiodes and phototransistors. Combined sales for the many varieties of optical fibers—SI, GI, single mode, polarization maintained, image, glass and plastic—exceeded ¥15 billion ($63 million).

Among optoelectronic equipment, laser discs (both video and audio), laser and LED printers, laser machining equipment, light sensors and light transmission equipment were all ¥10 billion sellers. As for systems, light communication system sales alone reached nearly ¥30 billion in fiscal 1982.

The future is brighter still for this young industry, and this is equally true for each of the four major fields of optoelectronics: light communication; light instrumentation; light information processing; and light energy.

Telecommunications

Telecommunications represent a vast market. Total sales of communications services came to roughly ¥7 trillion ($29 billion) in fiscal 1982. Nippon Telegraph and Telephone Public Corp. (NTT) is now developing an "Information Network System" (INS) that will be in service nationwide by 1995. NTT will eventually put ¥30 trillion ($125 billion) into INS, and has earmarked ¥1.72 trillion (¥7.2 billion) for the system in fiscal 1984. INS will of course make full use of light communication, as well as satellite communication. A single optical fiber, finer than a hair, can carry more than 1,000 telephone conversations simultaneously, and once combined with high performance lasers, one single-mode optical line will be able to handle 23,000 telephone calls at once. This huge capacity makes optical fiber eminently suitable for a wide range of transmissions—voice, data, character and picture. The age of light communications should see the full blooming of a host of new media.

In order to support INS and otherwise upgrade Japan's telecommunications network, NTT is building new communications highways. In Tokyo, Osaka and 10 other districts, it is laying 110 kilometers of optical fiber cables, representing 3,000 kilometers of single strands. Eventually the entire country, from Sapporo in the north to Okinawa in the south, will be connected by these optical "freeways," forming an integrated system for communication and information processing.

Moreover, with the end of NTT's monopoly on telecommunications and its reorganization into a private company next April, a flood of new enterprises are ex-

Optoelectronics technologies are widely used in building, expressway and sea transportation controls.

pected to try their hand in this market. High technology company Kyocera Corp. and a consortium of 24 other firms are planning to establish a new telecommunications company to rival NTT. Meanwhile, new entries are also planned by the Japanese National Railways (JNR), the Japan Highway Public Corporation, major electric power companies, and office automation equipment manufacturers.

Light instrumentation

Light instrumentation is also expected to evolve into a vast new market. A blast furnace in a modern steelworks has 800 sensors to measure temperature, pressure, flow rate, constituent materials and other factors during steelmaking. Moreover, the furnace is extremely hot, with the interior reaching 1,800 degrees Celsius. Optoelectronic devices are ideal for this instrumentation because they do not require direct contact with the furnace, yet still offer a wide range of applications and high accuracy and reliability. At present, a single modern steelworks uses as much as 12,000 kilometers of copper wiring weighing between 8,000 and 10,000 tons for instrumentation. Optical fibers can be much shorter and lighter. They can also be used in wet locations, and are heat resistant. As an insulator, the glass that optical fibers are of is free from electromagnetic noise. And if cut or short-circuited, light fibers do not spark.

All these characteristics are desirable for helping ensure the safety of chemical plants, skyscrapers and supertankers. Recently the major shipping company Japan Line tested a marine optical telemetry system in the 80,000-DWT tanker "Japan Stork" for a year. Kawasaki Steel Corp.'s Mizushima steelworks has light instrumentation highways, more than 41 kilometers long, completed in November 1983. Connected with 670 terminals, they form an integrated network for process control, work scheduling, job assignments, safety monitoring, logging in data, and research and development work.

Kajima Construction Co., meanwhile, incorporated a light instrumentation system in an urban development project completed in March 1982. The system monitors and controls the air-conditioning, lighting, water and electricity in the seven-story building, and also serves as a fire alarm. It further allows for visual monitoring and remote control repositioning of the roof-top solar heating system, and has the capacity to accommodate the future introduction of office automation equipment. MITI's Agency of Industrial Science and Technology has been sponsoring since 1979 a seven-year project for developing a light instrumentation and control system which will entail a total cost of ¥18 billion. Upon completion of the project in 1986, the prototype system will be introduced to an oil refinery for process control, pollution monitoring and safety control.

Information processing

A huge market also awaits optoelectronics companies in information processing. In fiscal 1981 alone, Japan spent ¥36.1 trillion ($150.4 billion) on information services. Office work expenses total more than ¥30 trillion every year. Today, 40 years after ENIAC became the world's first electronic computer, there are more than 86,640 computers worth well over ¥4 trillion ($16.7 billion) in service in Japan.

While the optical computer is still far from reality, it will have a revolutionary impact on information processing when it does arrive. Optical computers, using light rather than electric pulses to carry information, have at least three significant advantages; they are free from electromagnetic interference; they permit two-dimensional parallel processing; and they eliminate the need to convert input and output from the optical signals in light fiber communication lines to electronic signals in the computer. Basic research and development activities are well under way. An Optoelectronics Joint Research Laboratory was established in Kawasaki near Tokyo in October 1981 with a staff of 50 and an annual budget of ¥1 billion. The lab's goal is to perfect optoelectronic integrated circuits (OEIC), the building blocks of an optical computer.

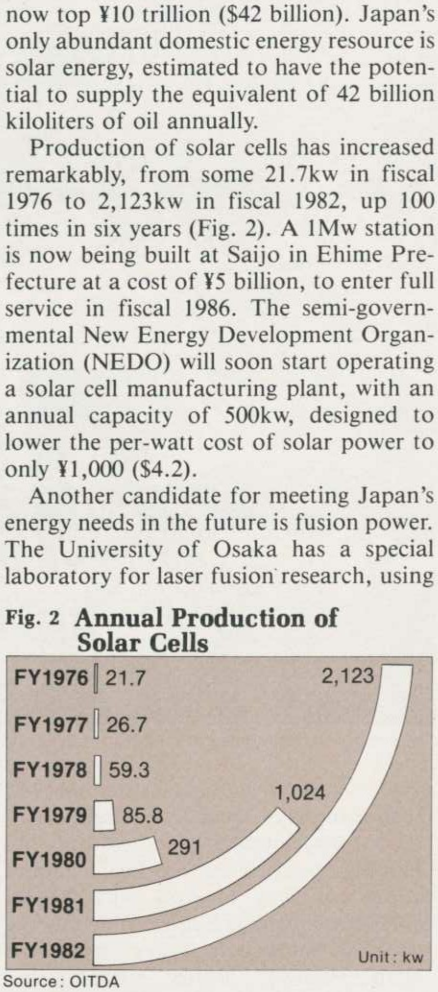
Energy

Energy is Japan's Achilles' heel. Lacking significant oil fields of its own, the country had to spend $58.9 billion on imported energy—oil, coal, LNG and others—in 1983. Sales of petroleum products exceed ¥30 trillion ($125 billion) a year, while annual sales of power utilities now top ¥10 trillion ($42 billion). Japan's only abundant domestic energy resource is solar energy, estimated to have the potential to supply the equivalent of 42 billion kiloliters of oil annually.

Production of solar cells has increased remarkably, from some 21.7kw in fiscal 1976 to 2,123kw in fiscal 1982, up 100 times in six years (Fig. 2). A 1Mw station is now being built at Saijo in Ehime Prefecture at a cost of ¥5 billion, to enter full service in fiscal 1986. The semi-governmental New Energy Development Organization (NEDO) will soon start operating a solar cell manufacturing plant, with an annual capacity of 500kw, designed to lower the per-watt cost of solar power to only ¥1,000 ($4.2).

Another candidate for meeting Japan's energy needs in the future is fusion power. The University of Osaka has a special laboratory for laser fusion research, using powerful lasers to trigger the fusion reaction. Cumulative investment in this research since fiscal 1972 exceeds ¥10 billion. A breakeven experiment designed to get more energy out of the reaction than it takes to generate it is planned after 1987, and scientists at the Osaka lab have already confirmed neutrons from fusion reactions in earlier tests. Designs are already complete for a laser fusion power station with a capacity of 426Mw, to be called Senri No.1.

Fig. 2 Annual Production of Solar Cells



Source: OITDA

Ushering in a new age

Optoelectronics is a typical high technology industry based on two key innovations—lasers and optical fiber. Many other industries, old and new, will benefit from the spinoffs from its growth. Industrial robots fitted with optical fiber cables will be safer because they will be free from electromagnetic noise. Automobiles will also use optical fiber cables. Laser printers are already the fastest printers available for computers. Laser scanners are finding wider and wider use in store point-of-sales (POS) systems, and laser and audio disc players are attracting new customers. Fiberscopes and laser scalpels are proving useful in medical diagnosis and therapy. Even the newest generation of aircraft are using optoelectronics in the form of laser and optical fiber gyroscopes.

From March to September next year, Japan will hold the 1985 Tsukuba International Exposition at Tsukuba Science City north of Tokyo. Some 30 million people are expected to visit the ¥600 billion extravaganza. But it is not all play. For six months every kind of optoelectronic technology will be put to work at the exposition.

In another government-sponsored demonstration, MITI's ¥4 billion "Hi-Ovis" project is now being remodeled after six years of testing. "Hi-Ovis," located in Higashiikoma near Nara, is a prototype of the wired city of tomorrow where two-way interactive voice and video communications will be commonplace. MITI's Agency of Industrial Science and Technology is also sponsoring another project, this one a prototype laser machining plant at Tsukuba. Costing some ¥13 billion to develop between fiscal 1977 and 1984, the automated plant is designed for completely unmanned, 24-hour continuous operation. Even the JNR is considering using light communications and instrumentation for its linear motorcar, Japan's next-generation high speed rail service to replace the Shinkansen "bullet" trains.

With all this interest in every sector of society, one thing seems certain. The optoelectronic industry is out to vitalize the Japanese economy. In the years to come, it will profoundly change the face of Japanese society. ●