The Story of Teradyne in Japan

By Richard Dyck

Introduction

Teradyne was founded in 1960, in Boston, for the express purpose of making automatic test equipment for electronic components. Our first product was an automatic diode tester, and in the mid-1960s Teradyne introduced the industry's first computer-operated test system for transistors and integrated circuits. Teradyne systems are used in the production lines of our customers as an integral part of the production process, and the concept from the beginning was to design systems that are rugged, reliable and easy to use.

In the decades that followed our founding, the company diversified into other sectors of the test equipment business—telephone line testers and circuit-board testers, for instance, and into backplane connection systems. But the company's core business, representing about 70% of total sales, is still semiconductor test equipment.

Today, Teradyne has sales of $1.2 billion, employs 5,200 and operates offices throughout the United States, Europe and Asia. We have manufacturing facilities in the U.S., Europe and Japan. In any given year we are either number one or number two in the semiconductor test business, running neck-and-neck with our nearest rival, a Japanese company named Advantest.

The testing of semiconductors

A semiconductor or integrated circuit must be electronically tested at two stages in the manufacturing process, once while it is still a wafer of silicon, and once when it is a finished, packaged device. A device is tested not only to see if it is a usable or "good" device, but also to see if it operates according to performance specifications. As semiconductor chips have increased in complexity, the equipment which tests them has also become more complex. Teradyne's first tester, made in 1960, could easily fit on a desk top, and it sold for about $5,000. The devices tested on this system only had two or three electrical connections, or "leads." Our new J973 logic tester, which we introduced in Japan in November 1996, tests devices of over 1,000 electrical connections at data rates of up to 800 MHz. The selling price of a J973 starts at about $1 million and goes up to about $6 million. The J973 is every bit as complex as the most advanced supercomputer. It took a team of over 200 of the world's best hardware and software design engineers three years to develop the machine, at a cost of approximately $50 million.

The technology of the semiconductor devices which are tested on Teradyne test systems moves very rapidly. As a result, we anticipate that the life cycle of the J937 will be about four years, which means that in 1998 or 1999, we will need to start shipping the successor to this new product. It is not enough for us to keep up with the rapid changes in the semiconductor industry, we must be one to two years ahead of the industry in order to serve our customers and be competitive.

The first test system

Staying ahead of semiconductor technology

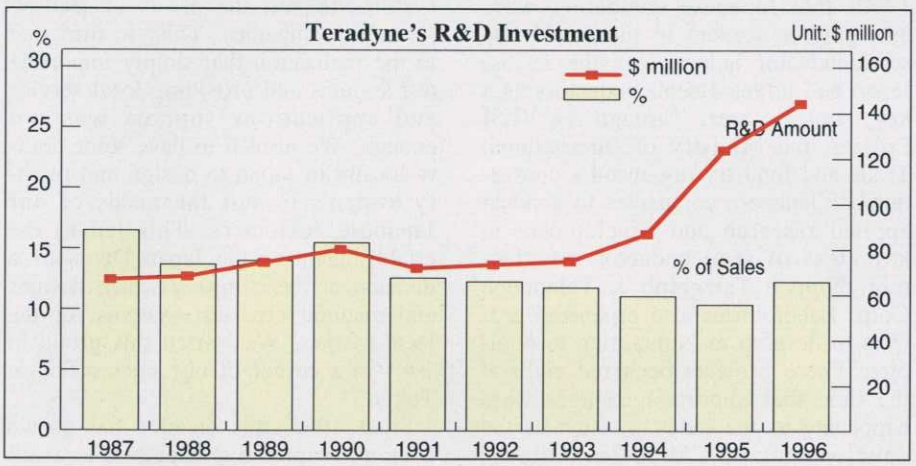
Teradyne's strategy for staying ahead of the technology curve is comprised of three elements:

First, Teradyne invests a large portion of its sales in engineering and new product development. In percentage terms, we devote between 10% and 15% of our total sales to engineering; and, since we are one of the largest companies in our industry, in absolute terms we probably invest more in this area than any of our competitors. The $50 million we spent on the development of the J937 includes the design and manufacture of the custom circuits

used in the tester itself, the building of prototypes and the engineering of both hardware and software. A large portion of the cost is the salary of engineers.

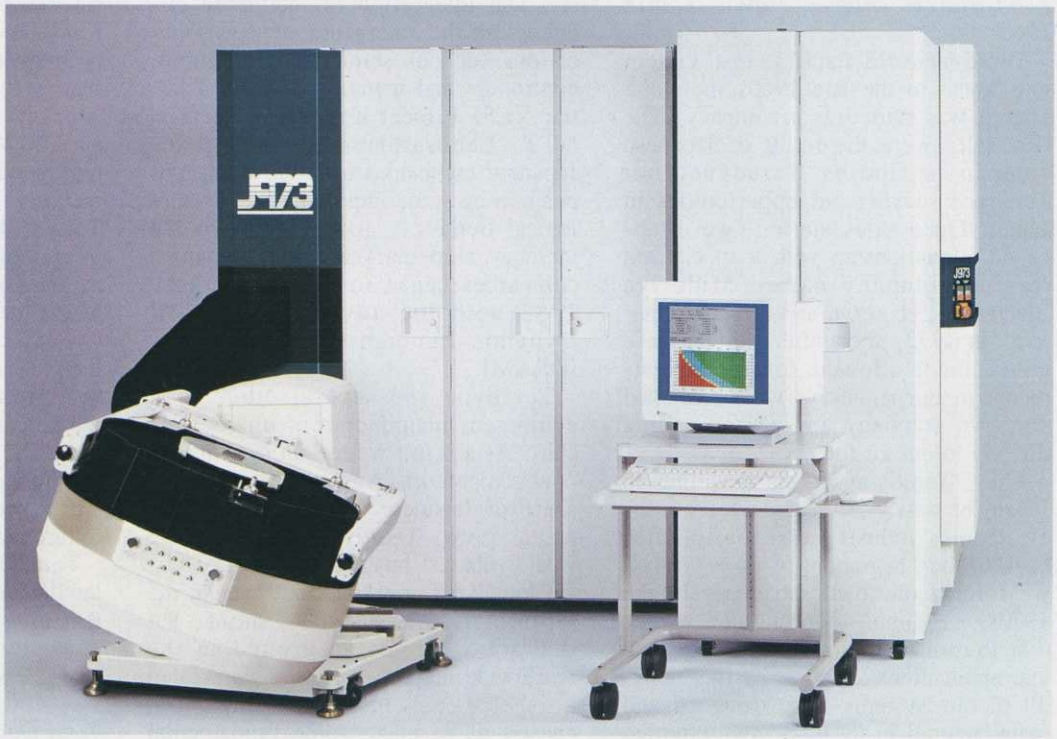
Second, Teradyne employs the best engineers we can find, which in our case usually means hiring new graduate engineers from the top-ranking colleges and universities and training them in the design of the hardware and software of complex test systems. In the U.S., Teradyne hires engineers from universities such as MIT, Stanford, Cornell and The University of California. Our founder and chairman, Alex d'Arbeloff, is not only a graduate of MIT, but he currently serves as the chairman of MIT's Board, and he has always sought to maintain a close tie between our company and the university.

Third, we try to work as partners with the leading companies in the semiconductor industry. This means we must carefully follow the trends in the semiconductor industry, try to spot the companies which will be at the forefront of new technology, and then establish a technical relationship with these companies in order to develop test systems which meet their needs. In the early days of the industry—the 1960s and 1970s—this meant developing close relationships with U.S. companies such as AT&T, RCA and Fairchild. By the 1980s, the names and locations of the market leaders in the industry changed. In the U.S., RCA and Fairchild were replaced by companies such as Texas Instruments, Intel and Motorola. Also, Japanese companies started to emerge as leaders in many segments of the industry—companies such as NEC, Hitachi, Toshiba, Fujitsu and Sony. Today, the expanding list of industry leaders would include South Korean companies such as Samsung, LG and Hyundai.



Economics and support

Because we manufacture production equipment, economics and productivity are key differentiating factors. It is not enough simply to be able to test a semiconductor, a test system must be able to make the tests very rapidly. Semiconductor manufacturers are constantly pressuring their test equipment vendors to lower the cost of tests by lowering the price of the equipment and increasing productivity. Even the most complex logic chip used in the most sophisticated computers is tested in a matter of seconds. Customers are never



J973

satisfied. They drive their vendors and their own test engineers to shorten an eight second test time to seven seconds and then to six seconds. The continuous drive to improve productivity while, at the same time confronting the challenge of ever increasing complexity, is the rule of the day in the semiconductor industry.

Another key factor for success in our industry is the ability to support complex test systems in the production line of our customers on a global basis. The semiconductor industry is a global industry and the major manufacturers maintain global operations. NEC, for example, not only has factories in Japan, but also in California, Scotland, Ireland, Singapore and China. A wafer might be made in Scotland, assembled in Singapore and shipped to the U.S. for sale. As a test equipment supplier, Teradyne must be able to support its customers wherever they choose to set up manufacturing operations.

Teradyne's history in Japan

First system entered Japan in late 1960s

Teradyne sold its first test system into Japan in the late 1960s, not long after it was started as a company. The first sales were the result of Japanese companies finding Teradyne, not Teradyne seeking out opportunities in Japan. Once sales started, we established a relationship with a specialized trading company named Midoriya Electronics, to serve as our representative. In 1973, soon after the Japanese government allowed foreign investments in our industry, we established our own company and started selling directly to our customers.

Thus, Teradyne has been selling in Japan for nearly 30 years, which in the electronics industry essentially dates back to the "beginning of time." When we formed our own subsidiary in the 1970s, we simply concentrated on the distribution functions: sales, service and applications support. At this point, all of our systems were designed and manufactured in the U.S. and exported into Japan.

The hard times of 1975 through the 1980s

Over the 30 years Teradyne has been operating in Japan, we have had many successes and we have also made some mistakes.

Our biggest mistake, one which nearly lost us our position in the Japanese market, was not recognizing in the 1970s that Japanese companies were emerging as leaders in the worldwide semiconductor industry. In the 1970s, Japan had targeted semiconductors as a key, strategic area. Through the VLSI Project, the Ministry of International Trade and Industry organized a consortium of Japanese companies to conduct applied research and development in key areas of semiconductor manufacture. Nippon Telegraph & Telephone Corp. Laboratories also organized projects to develop manufacturing technology. These projects occurred right at the time that important changes were happening in the industry, such as the development of CMOS technology, which allowed for higher levels of density and integration of integrated circuits, and the emergence of new applications such as semiconductor microcontrollers and memory devices. Thus, the VLSI Project and the projects at NTT Laboratories helped place Japanese companies in an advantageous position on some important new technological trends. A good example is the memory chip market, which Japanese companies began to dominate around 1982 with the advent of the 64K Dynamic Random Access Memory (DRAM).

Teradyne and several other U.S. equipment manufacturers missed this shift. As a result we left an opening for new competitors. And as the worldwide share of Japanese semiconductor companies grew, Teradyne's share of the worldwide test business declined. Thus, we found not only that our share of the Japanese market started to shrink, but that we were losing ground in the worldwide market as well. This created a sense of crisis in our company which caused us to make some fundamental changes in our approach to the business.

The Japan Division—local design and manufacturing

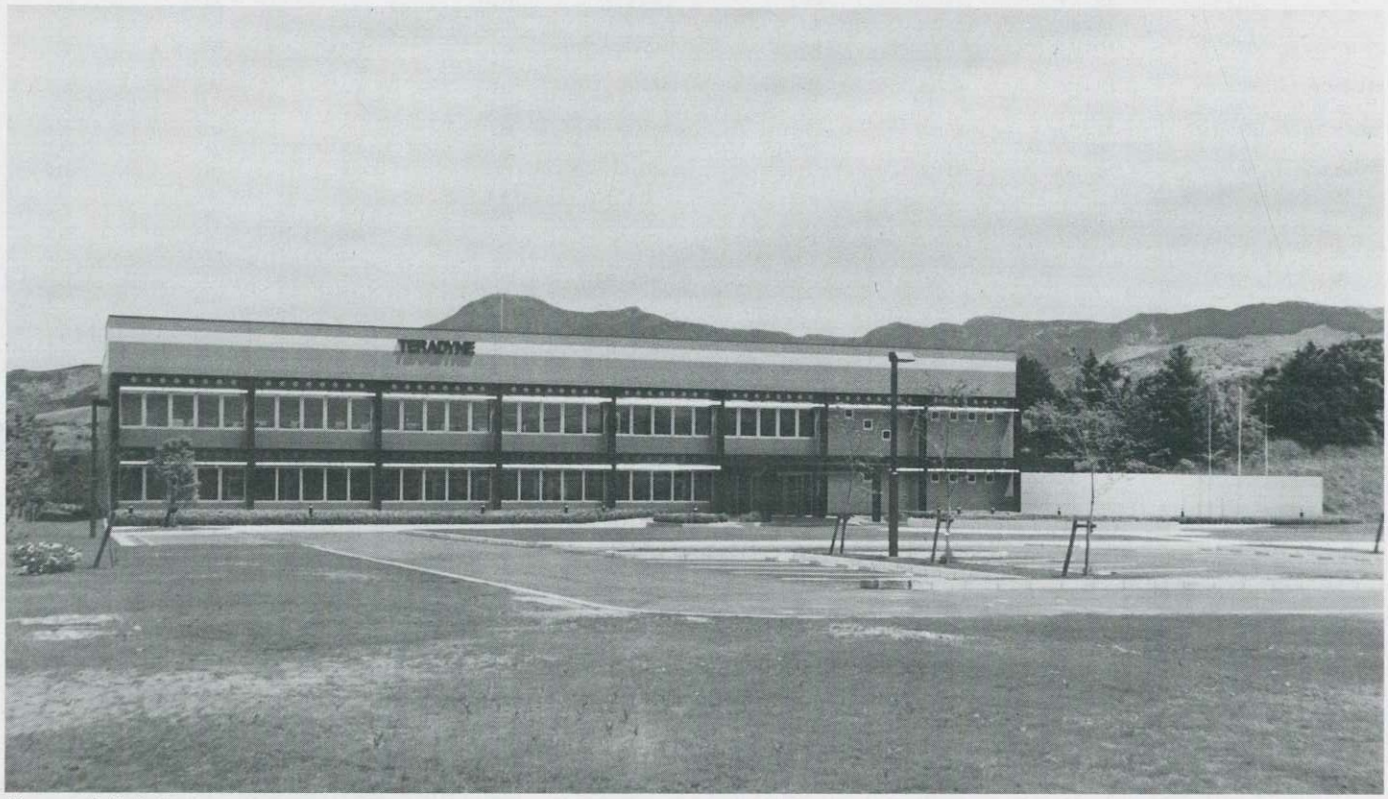
First, we quickly came to realize that to maintain our position as a world leader in semiconductor testing we would need to have a substantial share of the Japanese market. Second, in order to gain a market share in Japan, we would need to start designing test systems to suit the needs of leading Japanese companies. This, in turn, led to the realization that simply importing test systems and providing local service and applications support was not enough. We needed to have some ability locally in Japan to design and modify systems to suit the needs of our Japanese customers. This led to the establishment of the Japan Division—a division of the company which designs and manufactures test systems for the local market. We started this group in 1984 in a corner of our sales office in Tokyo.

Since 1984, this division has grown from a group of five engineers to a full fledged division of 80 people. In 1992 we moved the division from Tokyo to Kumamoto, to an industrial park developed by the Japanese government. The reason for moving to Kumamoto was not only to escape the costs of Tokyo, but also to find a place where we could hire good engineers, something which we have always found difficult in Tokyo. Kumamoto is located on the island of Kyushu. There are seven national universities in this area, all of which have first-rate engineering faculties. Since establishing our division in Kumamoto we have been able, each year, to hire new graduate engineers from Kumamoto University, Kyushu University and Kyushu Institute of Technology. For a foreign company our size, it would have been a dream at best to hire new graduates of this caliber.

Teradyne views the establishment of the Japan Division, and the moving of that division to Kumamoto as a major strategic move to serve our Japanese customers and grow our share in Japan.

Total Quality Management

Another major change which Teradyne has made over the past



Kumamoto facility in Kyushu

decade is the adoption of Total Quality Management (TQM). There are arguments about whether Total Quality Management (or Total Quality Control) originated in the U.S. or Japan. The fact is that in the period up to the 1980s, Japanese companies did a much better job at deploying quality management processes and integrating them into the daily work of their employees. Thus, when the management of Teradyne came to the conclusion that we needed to adopt TQM techniques, we went to the source—Japan. We arranged for the services of Prof. Shiba Shoji, who was then on the faculty of Tsukuba University. Prof. Shiba spent several years in the U.S. working with Teradyne employees and helping us deploy TQM throughout the company.

We believe that Teradayne is now well placed to succeed in the Japanese market. The move to Kumamoto has allowed us to develop a group of engineers who can respond locally to the needs of our customers. The investments which the company makes in engineering and product development help assure that we will be on the forefront of semiconductor technology. Total Quality Management helps enable us to provide reliable products at competitive prices. In addition our global support teams helps ensure that we can support our customers wherever they choose to build their factories.

A new, emerging trend in the semiconductor industry is the complex web of alliances among our customers. There are many examples. Hitachi has formed a joint venture with Texas Instruments for the manufacture of memory chips in Texas. Toshiba has established a joint venture with IBM for manufacturing in Virginia. The 64MB DRAM device made by Toshiba is the result of a three way alliance among Toshiba, IBM and Siemens. Intel is manufacturing flash memory devices in cooperation with Sharp in Fukuyama City, Hiroshima Prefecture. These alliances give our industry an added dimension of complexity and present a new set of challenges and opportunities. Teradyne has spent 30 years building up a strong, local organization in Japan to support our Japanese customers; now that our customers are becoming more global, we need to work on striking the right balance between local and global support.

Richard Dyck is Vice President of Teradyne, Incorporated, and Representative Director of Teradyne K.K. He joined Teradyne in 1982. Mr. Dyck graduated from California State University and received his Ph.D. from Harvard University in 1975. He also studied at Waseda University, Kyushu University and Tokyo University.