

SHARPENING THE CUTTING EDGE:

Meeting Taiwan's New High-Tech Challenges

SU TZEN-PING, DIRECTOR-GENERAL, GOVERNMENT INFORMATION OFFICE,
TAIWAN

ON SEPTEMBER 21, 1999, THE PEOPLE OF Taiwan were jolted awake by a powerful earthquake measuring 7.3 on the Richter scale, the largest earthquake to strike Taiwan in a century. It destroyed or severely damaged nearly 100,000 houses, claimed the lives of 2,400 people, and injured more than 8,000. The damage done to roads, bridges, and utilities was incalculable.

The earthquake engendered an immediate international response, with aid and assistance flowing to Taiwan from many countries. But the earthquake also caused great anxiety among high-tech industries worldwide which are heavily dependent on Taiwan as an important source of information technology (IT) and electronic parts and products. Without Taiwan's highly efficient production lines and competitively priced products, personal computers and the internet would not be as affordable and popular as they are today.

Fortunately, Taiwanese electronics producers not only excel in high-tech manufacturing and management skills, but also have a remarkable resiliency. Despite the severe effects of the earthquake, the production value of Taiwan's IT and electronics industries still reached US\$44 billion in 1999, an increase of 17.4% over the US\$37.5 billion registered in 1998. Many of Taiwan's IT products topped world production for several consecutive years (see Table 1).

One example of the robustness of Taiwan's high-tech manufacturing is the integrated circuit (IC) industry, the most important area of which is the Hsinchu Science-based Industrial Park, where electricity was restored 72 hours after the earthquake and production levels quickly returned to normal. The total production value of Taiwan's IC industry reached US\$13.6 billion in 1999, a rise of 50% from 1998 (see Table 2). In fact, Taiwan has the fourth largest IC production value in the world, following the US, Japan, and South Korea. Further analysis reveals that the production value of Taiwan's IC foundry and packaging industries is the highest in the world, and

that the production value of the fabless industry (IC design industry) is second only to the US.

Since the IC is the key component of electronic products, a wide range of industries are dependent on the IC industry, and its importance is even more significant than IC industry-specific statistics indicate. In 1999, the market for Taiwan's IC was US\$10.7 billion, accounting for 33% of the market in the Asia-Pacific region and 8.2% of that of the world. Taiwan is the third largest IC supplier in the world, next only to the US and Japan. Given the small size of the island, Taiwan's achievements in high-tech industries are particularly striking.

A HISTORY OF PERSISTENCE

Taiwan is located off the southeast coast of the Chinese mainland in the western Pacific. With an area of approximately 14,000 square miles, Taiwan has a population of 23 million, making it one of the most densely populated areas in the world. From 1895 to 1945, Taiwan was ruled as a Japanese colony. After the Second World War, Taiwan was returned to the Republic of China in late 1945. The ROC central government relocated to Taiwan in 1949, during the civil war with the Chinese Communist Party, which established the "People's Republic of China" in the same year. This was the beginning of long-term confrontation and competition between the two sides of the Taiwan Strait.

Despite serious military threats from the PRC and its efforts to isolate the ROC from the international community, Taiwan's economic success has won global recognition. In mid-1997, when a severe financial crisis swept through the countries of East Asia, Taiwan was able to maintain its economic prosperity on the strength of its strong economic fundamentals. Although its success has been called a miracle, Taiwan could not have reached its current stage of economic development without a wise government policy and a diligent work force. Several important factors helped to transform Taiwan from a

subsistence agricultural society into a high-tech manufacturing center. First, the irrigation, transportation, and power infrastructure left by the Japanese, although severely damaged, was not entirely destroyed by allied bombing during World War II. This gave the people of Taiwan the opportunity to regenerate, rebuild, and develop, with agriculture as the basis for economic progress.

Agriculture provided both the means of livelihood and foundation for developing processing industries and other light industries. Beginning in the 1960s, Taiwan instituted policies of import-substitution and export-oriented manufacturing. During this stage, important policy initiatives included establishing export-processing zones, encouraging foreign investment in Taiwan, and providing incentives for exports. These policies shifted a large percentage of the farming population into industrial production since during the early stage, product assembly dominated industry. Government incentive programs, combined with low-cost and high-quality labor, attracted foreign investment.

FROM PLOWS TO CHIPS

In the 1970s, the ROC government faced serious diplomatic setbacks, including withdrawal from the United Nations and the severing official relations with such important allies as Japan and the United States. When President Chiang Kai-shek, who had long governed the ROC, passed away in 1975, Taiwan entered a period of political uncertainty, but the economy flourished. The government promoted the "Ten Major Development Projects" to stimulate the economy and strengthen the island's infrastructure. The government also established the Industrial Technology Research Institute in 1973, the Institute of Information Industry in 1979, and the Hsinchu Science-Based Industrial Park in 1980, all of which were key factors re-direct-

ing the economy toward high-tech manufacturing. The Industrial Technology Research Institute was established to develop industrial technologies and enhance R&D. The most extraordinary achievement of this semi-official research institute has been abetting the local IC industry, which began in the late 1960s as mere IC packaging facilities set up in Taiwan by such foreign companies as Texas Instruments and Philips. IC packaging, however, is labor-intensive rather than technology-intensive. The core technology of the IC industry is wafer design and fabrication, which were not developed in Taiwan until after 1975, when ITRI sent a team of 38 engineers to the United States under a technology transfer agreement with RCA. In 1980, ITRI provided government investment and technological know-how to the United Microelectronics Corporation. Seven years later, the government helped to establish the Taiwan Semiconductor Manufacturing Company (TSMC). ITRI Chairman Morris Chang, already an international leader in the IC industry, was concurrently appointed TSMC chairman. Both UMC and TSMC are now recognized as world-class corporations that have made Taiwan's wafer foundries the largest in the world.

Unlike the traditional original equipment manufacturer (OEM) assembly industry, this sector controls high technology wafer fabrication.

The ROC government thus established Taiwan's IC industry by introducing new technology, developing talent, guiding investment, and transferring technology to private companies through ITRI. Because of the success of this model, Taiwan was able to avoid the predicaments of other developing countries that merely relied on low-wage labor to process goods for developed countries. Taiwan's investment in IC design and production technologies made these industries profitable. Furthermore, Taiwan's IC industry is a business to business industry, and its final clients are not mass consumers. Unlike information technology and electronic products, prices do not reflect high profit margins or excessive percentages of marketing costs. Although Taiwan's IC factories are far from the main markets in the United States and Japan, Taiwan's manufacturers still maintain a competitive advantage. The management and production efficiency of Taiwan's IT and electronics products have benefited PC consumers around the world, playing an important role in the rise of such information gi-

Product	Output			Share of World Output (%)	
	1998	1999	Growth (%)	1998	1999
Notebook PC	4,331	9,355	53.7	40	49
Monitor	48,344	58,729	17.7	58	58
Mother Board	50,859	64,378	21.0	61	64
SPS	50,860	80,221	36.6	66	70
CD/DVD	20,060	48,690	58.8	34	34
Case	58,872	75,768	22.3	75	75
Scanner	12,330	21,901	43.7	84	91
Graphics Card	17,282	18,583	7.0	31	31
Keyboard	54,579	79,445	31.3	65	68
Mouse	49,552	68,160	27.3	60	58

ants as Compaq, Dell, HP, IBM, Intel, and Microsoft. Furthermore, while Taiwan began by supplying information products as an OEM, now many Taiwan name brands are gradually emerging as international market leaders. For example, Acer is now one of the world's most famous PC manufacturers and is a leading producer for newly emerging markets in developing nations.

Formerly, the image of "Made in Taiwan" products was often negative, denoting inexpensive products of poor quality; but today, a leading producer of monitors like Mag Technology Co., Ltd. Or scanner manufacturers Umax Data Systems Inc. and Microtek International Inc. are recognized around the world for excellence in manufacturing. The label "Made in Taiwan" on technology products now represents high quality. Moreover, as the domestic market for cellular phones has grown, Taiwan's information industry has expanded its production from IT and electronics to telecommunications, thus continuing the prosperity of Taiwan's high-tech industries. In an effort to maintain the health of Taiwan's high-tech sector, the Institute for Information Industry has promoted the standardization of Chinese language software and R&D for Chinese language input and output technology. It has also held "Information Month" activities which encouraged the public to learn about and use computers, thus increasing the overall productivity of society. In addition, with the growing use of the internet, the government-supported Seednet program has rapidly become Taiwan's second largest domestic Internet Service Provider.

THE CHALLENGES AHEAD

Taiwanese companies entered the software market relatively late, focusing instead on hardware components. Because of this late start, in 1994 the ROC's software export volume was only US\$98.4 million; in 1999 however, software exports jumped to US\$242.7

Sector	1998	1999	1999 world ranking	Leading Countries
Fabless	1,453	2,295	2	USA, Taiwan
Foundry	2,895	4,343	1	Taiwan
Integrated Device Manufacturer	2,340	3,851	4	USA, Japan, Korea, Taiwan
Packaging	1,670	2,038	1	Taiwan
Testing	405	572		
Total	8,733	13,100	4	USA, Japan, Korea, Taiwan

million and volume is expected to reach US\$386 million in 2001. One notable software company is the anti-virus software publisher Trend Micro, which has been listed on the Japanese exchange. The ROC government has successfully promoted the expansion and globalization of software companies and encouraged them to list on the Taiwan Stock Exchange or trade over-the-counter; thus, solving long-term capital problems and positioning these businesses for access to the rapidly expanding market on the Chinese mainland.

Despite its roster of successful ventures, Taiwan's high-tech industry must fight complacency and continue to develop knowledge-based industries, in order to meet new challenges of the knowledge-based economy. The industry must accelerate the transformation of traditional industries into e-businesses to promote global competitiveness; further develop the current strengths of the information industry by combining key elements of society, the economy, and information technology to create a synergy and raise national competitiveness; promote the integration of the computer software and hardware industries to raise the added value of information hardware production; attract high-tech talent from around the world to Taiwan to establish an "Asian Silicon Valley"; and promote the development of home information electronics and telecommunications to rapidly expand the production value of high-

tech industries.

The 21st century will be the era of the knowledge-based economy. The importance of knowledge or technology will far exceed the traditional factors of capital, land, and labor in economic development. Without correct and effective strategies for development, the gap between developing and developed countries will continue to widen. By establishing the science parks and ITRI, the ROC government has provided appropriate and effective strategies for the IC industry. Although the production value of Taiwan's IC industry is still behind that of Japan and South Korea, its capability for product development and added value surpasses South Korea, and it is more profitable than much of Japan's IC industry. In the area of IC development and production, the future challenge for Taiwan's high-tech industry will be maintaining its high added value and market share, while the information and electronic products industries must increase the added value of key components.

In recent years, the island has not only managed to resist the regional financial crisis, which affected even Japan and South Korea, but has also successfully and peacefully transformed itself into a modern democratic state. Taiwan serves as a rational and effective development model for many Asia-Pacific countries, which find Western experiences unsuitable to their cultural and economic needs. ■