In The Spotlight

The chip - Meet its maker

Singapore's Test and Assembly companies are gearing up for hegemony in the global industry. To do so, perpetual innovation, sound business acumen and visionary agendas are paradoxically, the fixed variables to uphold.

If the word Technology is a great and wise man in our modern world, Semiconductors are the living cells in its body, igniting its being and bestowing life into its very existence. Be it serving its utmost in computers, hand phones or electronic gadgets, one cannot underestimate the power of the chip. It is most certainly a far cry from ancient times, when our fore fathers had to make do with simple tools to live their lives. How difficult and inconvenient it must be for them then. Yet, simplicity notwithstanding, people were content and would never dream that a silicon chip would one day help change their descendants' lives, or to make living easier.

The future has evolved to such, and how the chip is manufactured showcases a multitude of ideas and talents put together by great minds. We take a closer look at the manufacturing sector in Singapore and how they play their role in breathing life into a chip.

The manufacturing sector has been crucial in contributing to Singapore's economic success. Not only has it been one to kick start the engines of economic growth, but one that spurred it to further development over the years.

This high tech manufacturing cluster alone speaks for half the manufacturing workforce and has contributed more than 50% of total manufacturing output of $147 billion. In the past, due to events like the war on terrorism, financial crisis and the internet meltdown, companies were compelled to cost cutting measures such as downsizing their staff strength, resulting in retrenchments for thousands of employees.

Singapore stood firm against the storms despite being a small country with limited land. Her main rival back then was Hong Kong, and even she had given up trying to preserve its manufacturing sector as production facilities relocated to inexpensive locations like China. This approach had been shunned by Singapore's leaders, who are determined to prevent a manufacturing mass departure, in resolute belief in Singapore's resilience.

In year 2001, Singapore has 14 chip fabricators, and the government is aiming to see this grow in numbers, in spite of the fall of the semiconductor market in the global region.

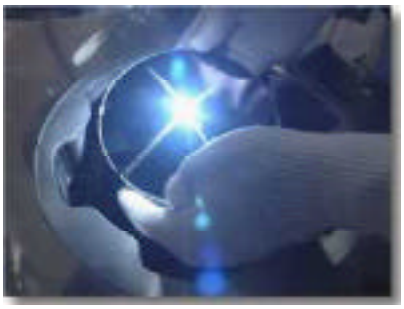
The Economic development board is a government agency which takes charge of promoting the industry by making investments in companies and offering various incentives to multinational companies interested in locating to Singapore. Barry Sim, director of the electronics and precision engineering cluster of the EDB says "We are convinced that we want to be one of the icons of the semiconductor industry, as we still believe in the long term growth of the semiconductor industry."

With that in mind, Singapore plows ahead to build more chip plants. The government has announced new measures to execute this, including a plan to set aside 60 hectares of land in the northern part of the island for more silicon wafer factories. Also in their agenda is to build a new facility for the production of high-grade purified water, essential for chip making. More programs to train people in the skills required by semiconductor industries were also intended.

In The Spotlight

EDB's Sim expresses his confidence that the government is on the right track. He feels that chip making "is suitable for Singapore because it isn't labor-intensive, and it requires highly skilled and educated workers."

Singapore is highly optimistic and hopes to take the semiconductor industry to the next level. Such is the very reason why government -owned Institute of microelectronics is pushing ahead with many plans. Located in Singapore's Science Park, it is in charge of promoting R&D and training its workers to make it a breeze for companies to produce chips in Singapore.



Advanced Micro Devices (AMD)

Another semiconductor company which is prominent in the industry is Advanced micro Devices Singapore, or AMD for short. Established in 1984, AMD Singapore offers manufacturing facilities for the company's microprocessor, telecommunication and network products.

In January 2003, AMD Singapore shifted to their 345,000 square feet, seven-floor test plant and design centre. This new facility expands on AMD's existing 258 square feet production unit and functions as a test centre for microprocessors, integrated circuit design activities and engineering development and research. It even boasts of a 260,000 square foot production capacity.

Today, about 1,365 talented engineers perform manufacturing operations, product engineering, testing and packaging in a carefully controlled production environment at AMD.

The company has experienced vast expansion in its capabilities, particularly in the fields of Integrated circuit design, wafer-sort operation and advanced packaging development. AMD also serves as a centre for analyzing and resolving customer issues and is equipped with engineering laboratories that support device analysis, surface mount board assembly evaluations, packaging characterization and reliability testing.

AMD's joint venture with UMC

In 2002, AMD has entered into an extensive manufacturing agreement with Taiwan's UMC, United Microelectronics Corp. Under the agreement, AMD and UMC will build an advanced fabrication unit for 300-millimeter wafers in Singapore and will open its doors in mid 2005.

UMC will also begin to manufacture PC processors on behalf of AMD in the near future. When it comes to factory space however, AMD had always been drastically at a disadvantage to rival Intel. AMD currently operates 2 fabrication units, while Intel is high up at 13 and building more. This extra manufacturing facility has allowed them to produce larger volumes of chips while, at the same time, cutting costs and accelerating its development.

Building a fabrication unit can cost billions of dollars and years to establish. If the market shifts, companies are at risk of a huge loss. AMD's collaboration with UMC can buffer the risks as the capital input is much lesser and they won't have to worry about absorbing all the volume itself. UMC will control half the output capacity of the factory, though part of the company's output could be used to make chips for AMD.

With the collaboration will come a shift to slightly more expensive 300-millimeter manufacturing much later than other competitors. The shift, though, will bring about a production of twice as many chips. AMD states that it has other advantages- The Company's processors are smaller than Intel's, so it doesn't need to migrate to 300-millimeter wafers as yet.

Analysts were firm that the deal could benefit AMD. Dean Mccarron, Principle analyst at Mercury research says, "The Company doesn't need to go nuts on building facilities, but they do need to get their next facility under way so they can increase their volumes."

UTAC

Singapore United Test and assembly centre Limited is a renowned independent provider of test and assembly services for a wide range of semiconductor devices that include memory, logic integrated circuits and mixed signal/RF.

UTAC was established in November 1977 and only began full operations in January 1999. In addition to its manufacturing and engineering operations in Singapore and Shanghai, china, she also has a global network of sales offices in the United States, Europe, China, Japan and Israel.

In 2002, UTAC was ranked the 9th largest independent provider of semiconductor testing by Gartner Dataquest. Offering full turnkey services that include water sort, assembly, test, burn-in, mark-scan-pack and drop shipment as well as package design and simulation, test solutions development and device characterization, failure analysis and full reliability test.

In January 2005, UTAC has started full turnkey volume production of MP3 audio decoder chips for Sigmatel Inc, the market leader for MP3 audio controller chips for MP3 players with more than five million units dispensed in the third quarter of 2004 alone. The company is also a leading manufacturer of analog intensive, mixed-signal integrated circuits audio codec solutions essential for the best sounding audio for computers and digital home entertainment systems.

The MP3 audio decoder chip is literally the essence of the MP3 player. Miss June Chia, Executive Vice President of UTAC says " With Mp3 players projected to boost at an annual rate of 36% from 2003- 2008, we vision Sigmatel growing rapidly to be a customer significance in UTAC's broadband, Mobile/wireless strategy for UTAC's mixed-signal and logic business"

The company is also producing other Sigmatel products such as its audio codec solutions and in the process of qualifying for its Gochip series of USB flash drive controllers. Prior to this, UTAC is also in the process of qualifying environmentally-friendly "green" production solutions for Sigmatel.

Stats ChipPAC, formally ST Assembly and test services (STATS) Singapore

On 10th February 2004, ST Assembly test services Ltd and ChipPAC Inc announced the signing of a merger, creating one of the world's premier independent semiconductor assembly and test Solutions Company. It will be the 2nd largest test house and will own leadership in mixed signal testing, boasting one of the broadest portfolios of assembly products and leadership in advanced packaging technologies such as stacked die, Sip and wafer level packaging.

The company will have a global blue-chip roster of major semiconductor customers and a global manufacturing footprint across Korea, China, Singapore, Malaysia, Taiwan and the United States with close proximity to the major hubs of wafer fabrication, providing customers with total supply chain solutions. It will also be able to combine exposure to communications and digital consumer electronics, with one of the strongest balance sheets in the industry. It is proposed that the new company be named STATS ChipPAC Ltd, and be headquartered in Singapore.

Tan Lay Koon , President and chief Executive Officer of the combined company says "This merger will enable the combined company to be a global player who can provide fully integrated, Multi-site, unparalleled end to assembly and testing solutions, by combining testing excellence of STATS, with the package development and manufacturing assembly excellence of ChipPAC. We believe this is a powerful differentiating factor and a very compelling value proposition for our customers. Importantly, the combined company will have a robust platform for growth as one of the world's

Semiconductor Industry & Challenges In The East

The semiconductor industry's downturn of 2000 through 2003 brought the closure of many unprofitable facilities in the West and accelerated plant migration to the Asia-Pacific. This created a great opportunity to offer new incentives to companies seeking to locate plants in China.

The rise of outsourcing and the 'fabless/ foundry' model created in Taiwan was also another factor that intensified plant migration to China. As of August 2004, more than a dozen foundries were operating in China that would generate almost $1.5 billion in annual revenues by year's end.

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Plant relocation is not only limited to wafer fabs, as other facilities such as semiconductor packaging, design houses, assembly and testing (SPA & T) centers were also established in China, which now produces almost 9 percent of the world's value of SPA&T. "China's foundry industry has transitioned from a low-technology, low-labor-cost captive industry to a globally recognized power in merchant chip manufacturing," according to Infoworld.com.

China's Attractiveness

Analysts have suggested a variety of factors that have combined to trigger this growth phenomenon. The most widely recognized factor is the appeal of the low cost of labor in many parts of China.

However, other equally important factors which have often been understated include the previous migration of electronics production to China and the corresponding need for chip suppliers to be close to their original equipment, design, and electronics manufacturing services customers.

The attractive tax, loan, and land incentives provided by Chinese governments at all levels have also worked their magic in attracting foreign investments into the country.

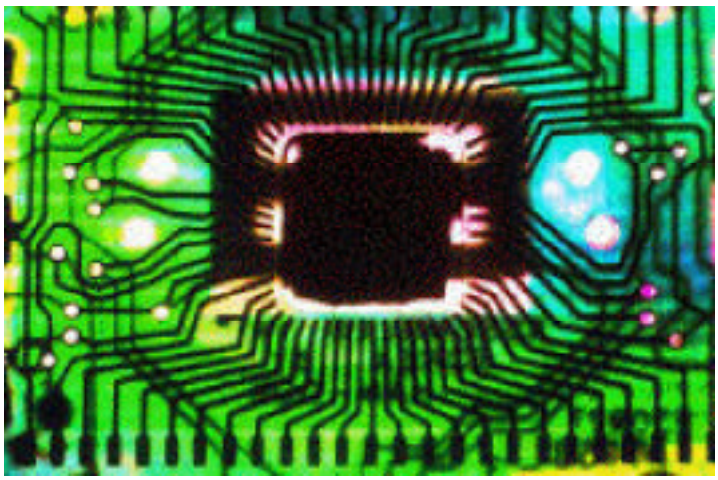
Dependence on Imports

Despite the growth and proliferation of Integrated Circuit (IC) design houses in China, the nation's chip imports are still increasing, according to executives at silicon foundry provider Semiconductor Manufacturing International Corp. (SMIC). In the past, China had to import about 80 percent of its semiconductors from foreign sources, according to SMIC analysts.

In 2004, China is expected to import 83 percent of its ICs from foreign sources, said Richard Chang, president and chief executive from SMIC (Shanghai). The Chinese government is thus trying to encourage local startups to meet this challenge and make the nation less reliant on foreign IC makers.

Implications for Chinese IC Companies

The massive growth has some major implications for the equipment industry. "IC executives and Mainland China officials have finally awakened to the fact that the industry cannot flourish with hand-me-downs and used



equipment." said Robert Castellano, president of The Information Network, in a statement.

Elaborating further, he noted that much of the production equipment used in fab expansion has been tools transferred from older lines by Japanese and Taiwanese IC manufacturers. "But that is changing," he said.

"China's IC manufacturers are buying state-of-the-art 90 nm tools for 300 mm production for their existing facilities. Ready to erode the need for imports are SMIC's 300 mm existing fab and two more planned for 2006, GSMC's 300 mm fab scheduled for 2005, and He Jian's 200 mm fab that will probably be converted to 300 mm next year. The potential for an explosive equipment market is high."

Startups Difficulties

To say competition within the Chinese design industry is intense would be a vast understatement. During the last few years, about $2.5 billion has flowed into Chinese IC design houses, causing them to sprout up faster than mushrooms after a rainstorm.

There were 96 startups in 2000 and 200 by the end of 2001. Since then, that number has at least doubled, as has revenue, from $316 million in 2002 to $656 million in 2003, according to CCID, a government-linked research service. CCID's optimistic projections assume revenue will shoot up to $7.5 billion this year and another fourfold by 2008.

However, Greg Ye, president of the North American Chinese Semiconductor Association, believes that turnover will be very high in China despite the optimistic figure bandied by the CCID, with 90 percent to 95 percent of startups failing. "China may now have as many as 600 IC design companies, but many of these are just a few guys with high hopes and little money."

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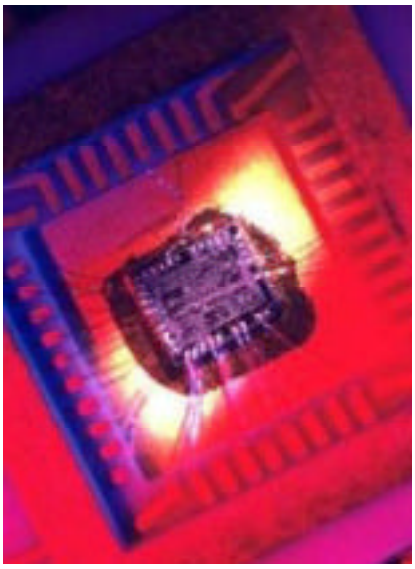
Startup's Money Problems

Money is the biggest hurdle for many startups, especially now, when Chinese banks are being pressured to tighten up credit because of poor lending practices.

"It's an interesting situation. The private companies that have the most chance to become innovators and pursue more unconventional paths to success are the very companies that are facing restrictions on capital," said Kien Leong, a venture capitalist and senior partner in the Shanghai office of Pacific Venture Design.

But very little of China's foreign direct investment is venture capital, and only a small amount goes into the IC design



industry. To date, most investment in semiconductors has flowed to the capital-intensive manufacturers such as SMIC.

And it might stay that way until China strengthens the protection of intellectual property, improves corporate governance and accounting practices, and, most importantly, create a domestic stock market based on transparency and a freely convertible currency.

The last point is important because stock markets have traditionally been a driving force in the U.S. and Taiwanese IC design industries.

In conclusion, China's massive growth will bring about opportunities for businesses; whilst at the same time create unpredictable risks for ill-prepared companies.

China's first 300 mm semiconductor fab

The emergence of 300mm semiconductor manufacturing in China is a mark of Chinese progression in the industry value-chain

Rising high above the flat plain, a largely covered multibillion factory is taking shape. The massive 300 mm (12 inch) semiconductor fab of Semiconductor Manufacturing International Corp (SMIC) now under construction is an important and symbolic achievement for China.

Before 2004, although China boasts over 30 working chip fabs, few are capable of producing wafers yielding the high performance and quality required for today's advanced cell phones, computers and consumer electronic devices.

SMIC's Beijing fab is meant to change that as it represents the company's bold attempt to challenge the balance of power in the global semiconductor foundry market, one that has traditionally been dominated by Taiwanese and Singaporean suppliers.

Financing for SMIC's nearly $3 billion Beijing fab invested to date comes from multiple sources, including Goldman Sachs, Motorola, H&Q Asia Pacific and the Shanghai municipal government. SMIC plans to use proceeds from its IPO to fund continuing construction of the Beijing and several other China facilities now under construction.

When completed, SMIC estimates that the Beijing fab will have a total floor space of 179,858 meters square, 17,998 meters square of which will consist of clean-room production areas.

Besides being a source of pride for China, SMIC is hoping that the fab will allow it to accelerate China's entry into the elite club of leading-edge chip makers.

However, the new fab comes with many risks for SMIC. Firstly, signatories to the 39-member Wassenaar Arrangement on high-tech export controls are trying to prevent China from acquiring and developing the most advanced chip production processes and equipment for strategic commercial and military reasons.

Besides being a source of pride for China, SMIC is hoping that the 300 mm fab will allow it to accelerate China's entry into the elite club of leading edge chip makers.

The U.S. Semiconductor Industry Association has also filed complaints against China in a 221 page white paper which highlights the fact that imported chips are subject to a 17 percent value-added tax while domestically produced chips have only a 6 percent VAT, one of several factors fueling China's boom in fab construction.

The 300 mm Beijing fab will also depend heavily on foreign technology. Many process modules and production know how will be provided by German partner Infineon Technologies AG (Munich, Germany).

Besides Infineon, SMIC will also depend on a 200 mm, 0.18 micron process from Singapore's Chartered Semiconductor, a 0.21 micron and a 0.15 micron process from Japan's Toshiba, a 0.20 micron and a 0.16 micron FCRAM process from Fujitsu.

SMIC's customer list also includes few Chinese buyers, but is heavily weighted by companies like Samsung, Fujitsu, Texas Instruments and Silicon Valley's Broadcom.

All fabs, especially for 300 mm chips, depend heavily on the purity of two key ingredients, pure air and pure water. In a city where not even the bravest tourist would brave a drink of raw Beijing tap water, water supply and purity is no small matter.

SMIC has thus prepared back-up reservoirs in case Beijing suffers from potential water shortages in the summer. Such attention to details will help ensure success for the symbolic 300 mm fab.

Lee Chee How

WATER-Lifeline of Semiconductor Manufacturing

Water- Essential for life

Earth is often referred to as the water planet- almost seventy percent of its surface is covered in water, and vital it is indeed to every life form. Living creatures thrive on water to survive and just like us, the semiconductor industry depends very much on water to flourish.

Pure water is essential to the production of semiconductors. Ionic impurities in the water can cause short circuits in the chip and if the water is contaminated, problems will arise as they coat surfaces and cause defects. However, keeping microchips ultra clean during the manufacturing process requires an on-going process of washing them free of chemicals.

Ultra pure water is crucial in today's integrated circuits. It is the primary cleaning agent used to rinse away all contaminants and remnants of silicon etched away during the production process. These contaminants decrease the production of usable circuits, and as the degree of integration becomes more complex, the semiconductor industry requires higher levels of water purity.

On the surface, there is nothing cleaner than a semiconductor manufacturing plant. Dust is kept to the minimal to prevent it from clogging up the microcircuits as they are being assembled. Workers wear lab suits to keep hair and flakes of skin from polluting the environment and water used in manufacturing is filtered to such that it is far cleaner than the water we drink.

The amount of dissolved ionic solids, organics, live bacillus, suspended particulates and silica must approach zero, while other ionic and non-ionic contaminants must approach non-detectable limits. However, a single water treatment process cannot efficiently deliver water of such high purity level.

Arizona's engineering centre studies specialized water needs

Clean water is a major research topic at University of Arizona's engineering centre for Environmentally Benign Semiconductor manufacturing. A collaboration among government and various universities and industry interests, the centre studies the specialized water needs of the semiconductor industry, its supply and use and reuse of clean and pure water.

Certain industrial applications, such as the microchip industry, need pure water. Its quality is no doubt transcending mere standards of drinking water and shifting to a sphere of mega clean water.

Where is the water coming from?

Farhang Shadman, director of the centre says, "We need to purify water to an unprecedented level. Contaminants cannot be tolerated, whether organic, inorganic, or even dissolved gases. In ultra-pure water, contaminants are measured in very low parts per billion and even parts per trillion. This may be two or three orders of magnitude purer than drinking water quality."

The original source of water is in the city and it is purified through various methods such as softening, ionization exchange, reverse osmosis, various radiation treatments, carbon beds and chemical disinfection. The technique of purification in the earlier stages is similar to those used by utilities in treating drinking water.

Ultra purification is a specialized science in itself. To achieve higher levels of water purity, the centre researchers has came up with new methods to attain extremely low concentration ranges of contaminants.

This process requires precise measuring methods, to record very low concentration of contaminants. Thus, the centre is engaged in metrological studies, to realize unique methods for measuring and characterizing water quality. This in turn will enable researchers to keep track of water quality during its many stages of purification process.

Water consumption and conservation

A semiconductor industry not only requires extremely high water quality but also a high volume of water. A modern fabrication plant uses about three million gallons of ultra-pure water.

Running continuously and for 24 hours a day, a fab uses 150,000 liters of water per hour.

A fabrication unit with a clean room of 8,000 square meters will need as much concrete as 25 kilometers of road. Over 4,500 kilometers of reinforced steel bars will be used, as well as 120 kilometers of ultra clean pipe and 250 kilometers of electrical wires.

Gerald Marcyk, a retired director for research at chip manufacturer Intel says "The reality of a fabrication plant is that it's a huge chemical factory." This is especially true as elements with high toxicity are used to modify the electrical properties of semiconductor materials. Volatile organic solvents are sprayed onto silicon wafers to remove waste when they're etched with circuit patterns. Thus, the operation of a single plant generates gallons of water everyday, straining on both energy as well as production costs.

Farhang Shadman, takes this all in his stride.The centre gathers engineers, chemists and physicists from universities around the country who would someday, with their creative ideas, change the face of the business world in making microchips.

The chemical mechanical process (CMP) involves polishing microchips to ensure flatness before the next manufacturing process. This is by far the largest user of water in the operation. With materials layered on a silicon wafer to create micro chips; the centre has focused on CMP to devise new methods of cleaning to optimize water use.

Recycling

Shadman considers recycling the solution to the industry's survival in Arizona. Since abundant water supplies are limited, the plant must recycle for additional water resources for its operations.

The industry could tap into a potential source of water by recycling some of the large volume used in the manufacturing purposes. However, if a very small amount of impurities enters the system, the entire operation would be seriously disrupted or worse, aborted completely. To tackle this problem, the center is considering various strategies for treating discharge for reuse in operations.

As semiconductor manufacturing operates on increasingly thin margins, he feels that the ideas they propose must be in line with improving performance and reducing costs. This often means keeping solutions at its simplest. Shadman's own research group has been working on ways to cut water consumption at the plants.

Radical Changes are considered

To figure out the best way to save water, Shadman's team looked closely at how it's used. Through their findings, it is evident that recycling waste water is not always the best idea because purifying it requires a lot of power. He further added that "Recycling helps the environment in one way but hurts it in another."

Therefore, the group focused on making the use of water more resourcefully by developing sensors that measure microchip cleanliness, and researching on new plant designs. Radical changes to the manufacturing process had also been considered, and would reap extraordinary benefits if the industry takes it into serious account.

According to Christopher Ober, a materials scientist at Cornell University in Ithaca, New York, one such example is the idea of replacing water with 'superficial' carbon dioxide- a hybrid of CO2 that has the properties of both a gas and a liquid.
This material forms at temperatures higher than 30C and at pressures of several millions of Pascal's. It flows like a liquid, although still having surface tension thus giving it some serious advantages over water. Ober explains "For one thing, it can penetrate deep into micro circuitry and dissolve solvents and etching chemicals. Once it has passed through the chip and waste systems, it reverts to being gas, depositing whatever waste materials it dissolved. Unlike water, Superficial CO2 can be easily recycled, and leaves behind a small amount of dry waste, compared to gallons of liquid waste if pure water is used.

Yet, however good and radical it may sound, the downside is that the material has very complicated solubility characteristics to an extent at which not everything will dissolve in it. In addition, the industry is still fairly conservative and may not be receptive to this form of change.

The question still remains-"Can Shadman's initiatives and findings really transform the course of semiconductor manufacturing?"

Skeptics had been less positive about its chances but in an industry where manufacturing techniques are constantly altered, there are no doubts that change and growth is the way to go.

The future lies in the hands of researchers that would surmount the norm, rise above the conventional and change the way we look at the use of water and its role in the semiconductor industry.

-Michelle Zheng

East European Semiconductor Market: Opportunities and Developments

On 1 May 2004, large parts of Eastern and Western Europe were integrated as 10 new countries joined the European Union (EU) - Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia.

A consumer market that comprises 450 million people has thus been created which will rival the United States in gross domestic product as the EU redraws its frontiers all the way to the edge of Ukraine.

Cross-border material flow and pan-European distribution will improve as trade barriers and customs paperwork fade away. All these have resulted in much attention being paid to the opportunities and risks of the East European market.

Backdrop

Ten years ago, Hungary, Poland and the Czech Republic were ideal low-cost manufacturing sites serving Western Europe. Emerging from decades of Soviet mismanagement, their governments offered generous investment incentives and rock-bottom labor costs that drove foreign companies to make direct investments worth billions of dollars.

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The manufacture of commodity equipments has migrated east. Generally, the production of larger equipments has moved to Eastern Europe and small portable equipments to the Far East.

Europe now consumes approximately 20 percent of all semiconductors, and the forecast projects that this market share will continue as European electronics equipment manufacturers shift production to Eastern Europe rather than Asia.

Opportunities & Market Developments

Total semiconductor production increased due to the resurgence of local OEM production following the currency devaluation during the 1997 Asian crisis and the 1998 collapse of the Russian ruble.

With a strong, telecom-driven market pull developing throughout Europe, conditions will soon be ripe for more direct foreign investment in state-of-the-art wafer fabs in Eastern Europe and Russia.

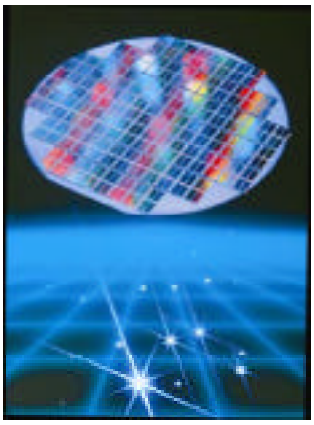
This will likely happen within the next two to four years, most probably as a joint venture with a local company.

In Hungary, top-tier companies such as Elcoteq Network, Flextronics International and Jabil Circuit run

robust manufacturing operations and export products throughout Europe.

The Czech Republic has also succeeded in pulling in high-volume manufacturing plants from such companies as Celestica, First International Computer and Quanta Computer.

Catalyst Semiconductor has also



opened its first international product development centre by incorporating Catalyst Semiconductor Romania (CSR) as a wholly owned subsidiary of Catalyst Semiconductor.

Initially, CSR will focus on design, characterization and test development for some of Catalyst's memory and mixed-mode products and will soon take on additional responsibilities such as developing product applications and providing technical customer support for the European market.

"By setting up this subsidiary we are executing on our growth strategy and leveraging lower cost engineering talent available in other parts of the world," said Mr Voicu, Catalyst President.

Low Costs & Quality Labor

Companies enter Eastern Europe with the prospect of filling their need for highly skilled employees in lower cost locations, thus maximizing the return on R and D investment.

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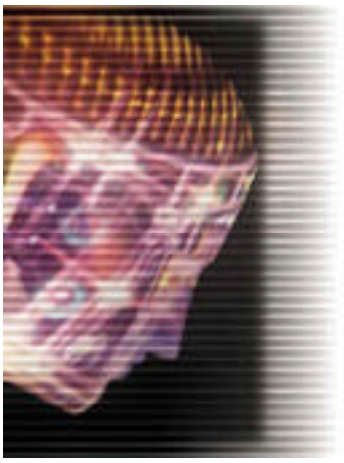
Many companies are now nurturing a growing pool of designers in Eastern Europe. The rising number of engineers emerging from universities in Eastern Europe, and their increasing sophistication, also helps companies meet their labor needs and diversify their labor resources.

There has thus been a move from OEMs to contract manufacturing plants in Eastern Europe as these countries possess a good supply of engineering talent and their cost structures also make it attractive to build products in these countries.

"The negatives in Eastern Europe", said Carlo Bozotti, corporate vice-president of STMicroelectronics, "are improving dramatically, but their speed of improvement is a key factor in the long-term development and viability within these countries."

"Second, for some time eastern Europe has been a source of less expensive labor. Now it is also going to become important for design," continued Bozotti, praising the IP Design Center that ST has brought up in Prague.



Slow Growth

Despite the rosy outlook for East Europe, there are still some risks which need to be noted. More dramatic increases in IC production are currently hampered by a lack of investment and an obsolete production base, with suppliers trapped in the very low ASP end of the market.
In addition, the Eastern European microelectronics industry continued to show slow improvement in its semiconductor capability.

Its technology base has remained essentially unaltered since the collapse of communism in 1989, and there is still no continuous massive investment in the region's microelectronics industry, either from local sources or from Western investors. In other words, East Europe is still perceived more as a 'possible' than a 'must be in' destination such as the dynamic Asian Pacific region.

Asian Competition

While successful market niches have been developed in the linear, discrete, optoelectronic, low-en microcontroller and high-power product areas, together with ASSPs for the calculator, watch and low-end consumer product markets in East Europe, these are not the products required for the emerging future communications markets, according to EETimes.com.

The situation is further hampered by the fact that the total semiconductor market is only $1.2 billion, significantly below its 1989 $2 billion peak, but double its $663 million 1996 low point.

Despite this gloomy statistic, MHM's Michael Hannon still recognizes that, "although migration in electronic manufacturing is impacting high-volume products, Europe will still be an important production base for lower volume products produced by small- and medium-sized companies."

"Additionally, design remains a key European function, including component specification." So, although component suppliers will eventually follow manufacturing to China and Eastern Europe, they will need to maintain a strong presence in Europe for the immediate future.

"Any manufacturer there [East Europe] for pure cost savings will end up eventually moving to China."

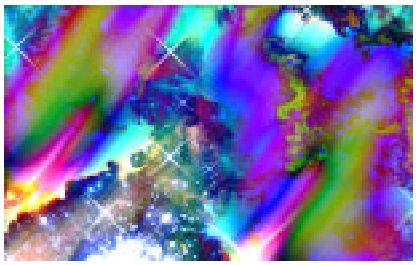
Future Problems

During the past decade, Eastern Europe, particularly Hungary and the Czech Republic, had been centers of system-level electronics manufacturing and assembly work, but many of those companies are now on the move as they see European Union integration driving up wages.

Indeed, hardly had a number of contract manufacturers began operations in Eastern Europe in the early part of this decade when they were off again to Southeast Asia. So in one sense the Eastern Europeans are being pushed to move up the food chain to design work.

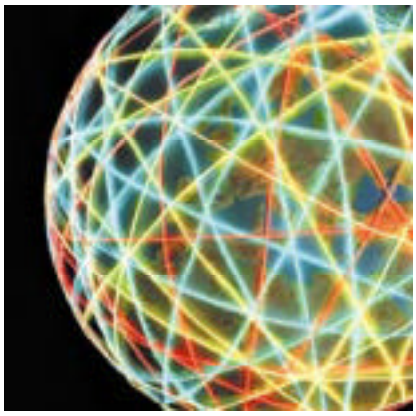
"Those regions are no longer potentially low-cost," said Malcolm Penn, chief executive officer of market research firm Future Horizons. "Any manufacturer there for pure cost savings will end up eventually moving to China." Jean-Pierre Belouguet, vice president of sales for Solectron Europe, which runs two factories in Hungary, said EU accession will have an impact on costs, though it won't be instantaneous.

"You may say three years from now



the cost of labor [in the new EU member countries] will be pretty much the same as in countries like Portugal, which is the lower-cost end of West Europe," he said. "Definitely [costs] will be higher than today."

In Eastern Europe, living costs have also been rising steadily, making it more expensive for locals and creating pressure for wage increases. Bulgaria, for example, has a 6.6 percent inflation rate forecast for



2005, more than three times the EU average, according the ECB.

EU accession has also stirred debate about a potential outflow of skilled labor from East Europe. Engineering graduates may migrate as they are attracted to not only higher wages but also the prospect of doing high-end work in Western Europe, where most companies still keep their core design teams.

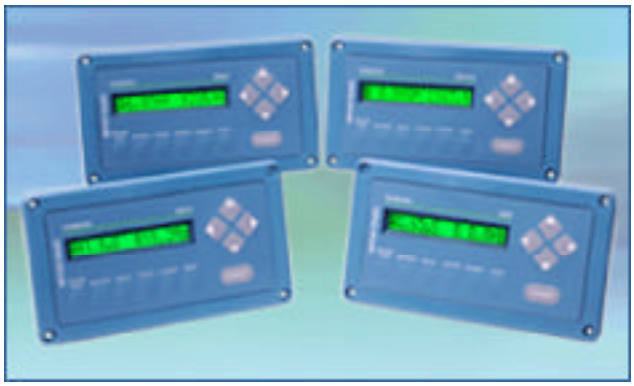
Lee Chee How

China, an Emergent Market for Integrated Circuits

Spurred by the lucrative Semiconductor Industry, China is fast gaining speed and proving herself an industry player to reckon with.

Market researcher, Research and Markets reported that mainland China represents a huge opportunity for semiconductor manufacturers and equipment as well as materials suppliers. The emerging semiconductor market will exhibit growth far in excess of any other country in the 2001 - 2006 time frame.

The semiconductor industry is positioned for explosive growth in fab construction, leading to tremendous opportunities for semiconductor equipment and materials suppliers. In China's 10th five-year development plan, 25 new advanced fabs are earmarked.



However it is said that by 2005, Chinese-produced semiconductors will not keep up with demand despite the projection that only 23% of chips are needed to meet demand for an ever increasing amount of telecommunications, computing, and consumer electronics production in China will be domestically manufactured. China is lagging far behind the leading industrialized countries in chip production.

China's production of integrated circuits reportedly reached 4.1 billion chips in 1999, half of which was exported, and sales exceeded RMB $10 billion. However, the remaining amount only satisfies less than a tenth of China's demand for intergrated circuits.

In 2000, the Ministry of Information Industry Electronic Information Product Management Department pointed out that China's integrated circuit sales volume only accounted for 1% of the global market. There was still a gap between China and the rest of the world in terms of advancements in computer technology.

The development and production of integrated circuits is the most sophisticated high- tech product in the world today. Its development and production capability is a sign of the progressive scientific level of a country. In 2000, China had seven microchip manufacturers, more than 20 IC design companies which had a sales volume of more than RMB $10 billion and more than ten packaging plants. China could already develop and produce 0.25 micron microchips, which were not far from the world's most advanced microchip technology. However, most of the microchips made in China were 0.5 microns then.

Semiconductor manufacturers in Shanghai reportedly grabbed a 38.6 percent share of mainland China's overall IC market in 2003. Shanghai Integrated Circuit Industry Association (SICA) reported that the wafer foundry services registered a 98.6% growth to $695 million in 2003, from $350 million in 2002.

Its IC design sector experienced a 132.5% boost in production amounting to $103 million, from $44.3 million in 2002. SICA revealed that some Shanghai manufacturers shelled out investments of about $14.46 billion in 2003 and employed over 63,000 people, 37 percent of whom had technical background.

Publication "The Consumer Electronics Outlook": China report also cites the growing strength of China's IC design industry. China now has more than 463 design houses and the trend is towards 0.25 micron and finer processing technologies. It is expected that output of locally designed ICs will grow by 37% annually from 2003 to 2007.

The report focusing on China's electronics industry is the first of a three-part series, based on field research and in-person interviews conducted by editors and staff writers from Global Sources publications including EE-Times China, ESM-China and Market Intelligence Reports.

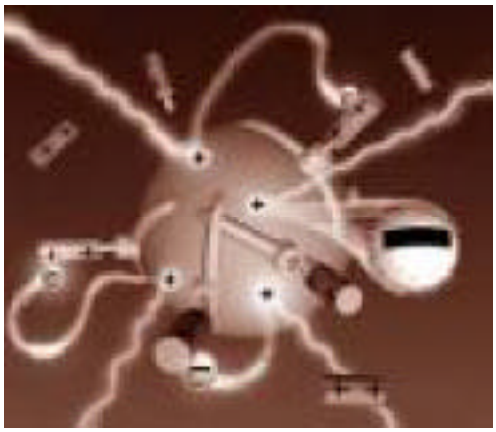
It draws on China Customs Statistics, and data from the Ministry of Information and Industry, and other government and industry organizations. The second and third reports examining the communications and computer products manufacturing segments respectively, will be released in the first half of 2005.

An annual conference which was held in Beijing in December 2004, featuring the Republic's technological capability, touched upon the microelectronics industry, with the IC being amongst the focused sectors. The integrated circuit segment, has always been regarded as strategically important, and was awarded priority when the Republic formally announced the four modernizations program in the late 1970s.

However, in an interview in 2003 at the Ministry of Information Industry, an official argued that China should rely on foreign direct investment to establish the costly and complex production facilities that are required for IC production. This would be the quickest way to improve the IC industry, while enabling China to concentrate its domestic resources on chip design.

China Center of Information Industry Development (CCID) argued that it is now the right time for multinational companies to enter its IC market as it will be one of the important bases of global electronic and information products with an expanding domestic market18. CCID argues that the development of a robust domestic IC is one of the government's main industrial priorities, which is supported by favorable policies and granted an advantage in low cost production and rich human resources.

There have hardly been any wholly foreign-owned enterprises in any Chinese industry until recently. The Chinese government now welcomes investments and several 100% owned Semiconductor producing enterprises are now in existence or are being established. These enterprises include Motorola Tianjin Integrated Semiconductor Manufacturing Complex - which commenced operations in 2001, with a total investment in a range of US$1.5 billion -, Suzhou Matsushita Semiconductor, and Ultimate Semiconductor - a Malaysian enterprise which signed an agreement with the Shanghai government in 2003.



The Republic has also attracted a number of multinational foundries. The report commissioned by the Semiconductor Industry Association (SIA) in the U.S. says that these foundries being established in China are unique in the country's context. Besides separating design function from production, these enterprises resemble western MNCs much more than any prior Chinese Semiconductor enterprises.

These enterprises, at least partially government-owned **and** controlled, include Semiconductor Manufacturing

International Corporation (SMIC) from Shanghai, and Beijing Semiconductor Manufacturing Corporation (BJSMC). The first is an enterprise with investments from Shanghai Industrial Holdings, Avant and others while the second is in collaboration with the Beijing Municipal Government, Beijing Economic and Technical Development Area (BDA), and Shougang Iron and Steel. The latter will accommodate facilities for the partnership between SMIC and Infineon Technologies.

Others enterprises include Grace Semiconductor Manufacturing International (GSMC) which was founded in 2000, and also Wuxi CSMC – Huajing which has been operating since 1997.

The SIA report also states that a long-standing source of weakness in Chinese Semiconductor industry has been the shortage of makers of semiconductor equipment and materials, assembly, testing, packaging and logistics firms.

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An earlier review stated that the Republic is still incapable of producing most of the equipment used in an 8-inch IC production line, though it can produce some supplementary machinery. As for 6-inch lines, Chinese firms are technically capable of producing almost all required equipment but no one firm has been manufacturing enough to be considered a world-class producer."

However, the SIA report argues that this problem is rapidly being addressed in both Shanghai and Suzhou as leading semiconductor enterprises, as well as materials, design and support firms are establishing operations in Zhangjiang HiTech Park, with its Shanghai Zhangjiang Semiconductor Industry Base (ZSIB), and the Suzhou Industrial Park.

ZSIB is well on its way to become a major centre for semiconductor production in China, while Beijing Economic-Technical Development Area plans to establish a complete industry chain surrounding the new semiconductor foundries being located there. The Republic has in the past not been a major market for major equipment suppliers because of the low production volumes in the country as well as export-control restrictions.

However, by 2010 the Republic could have become one of the biggest markets for semiconductor-related equipment, partly served by domestic companies. In the meantime, China will have to import most of the needed equipment. China, being the world's largest consumer market, presents an attractive opportunity to foreign investors, especially to those who are interested in high-tech manufacturing investments. With the Republic's central government's support in increasing high-tech manufacturing capacity, through the offer of low-interest loans, tax exemptions and direct investment for the expansion of existing facilities, a substantial boost in labor employment is anticipated to meet the higher manpower demand of the industry.

Alexis Lee