9-713-406
REV: DECEMBER 2, 2013

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Intel: Strategic Decisions in Locating a New Assembly and Test Plant (A)

Government incentives can come and go. Decisions need to be long term.
— Brian Krzanich, Intel general manager Assembly Test (2005)

Brian Krzanich, Intel general manager of Assembly Test (AT), looked through his deck of slides one more time. It was March 2005, and in a few days, he would present the AT team's proposal for the siting of its next AT factory to Intel's board. The new facility would be Intel's largest AT plant to date, doubling the size of any existing AT plant and providing the company with more efficient capacity. In 2005, industry average costs to build a new AT factory ran about $80 million with annual operating costs of between $150 and $300 million. He thought back to the fall of 2001, when Intel's global site selection team had first started gathering data on possible sites for a new AT plant. There were a host of considerations implicated in this proposal, with operational and strategic dynamics as well as national and international relationships at stake.

In their preliminary study of possible sites, Krzanich and his team had focused primarily on Asian and South East Asian locations, given that between 2002 and 2005, the total cost of operations in these countries were still the lowest in the world, and these markets represented important and growing opportunities for Intel. While U.S. regulations had prohibited the construction of a semiconductor fab in China, given intellectual property (IP) concerns, Intel had operated an AT plant in Shanghai for almost a decade with a second AT plant opened in Chengdu in 2003; the firm also had several university research and innovation labs in China. Would China be the best place for a third AT plant? India had also surfaced to the top of the short list. Intel's chairman was knowledgeable about the country and its leadership, and some felt the time might be right to build a plant in India. Several other Asian countries also presented viable sites, and locations in Latin America and the Middle East were also being considered.

Several years of data collection, analysis, site visits, and on-the-ground negotiations lay behind the short list. In just a few days, Krzanich was scheduled to travel to Chennai, India, one of the potential sites, with members from Intel's Finance and Enterprise group to pursue additional negotiations with local officials. Krzanich wanted to be sure he had the board's approval before investing time in the next stage of negotiations. What would the board decide?

Professor Juan Alcácer and Associate Director Kerry Herman, Global Research Group, prepared this case. Some data in this case have been disguised. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

The Semiconductor and Microprocessor Industry in 2005

In 2005, the semiconductor industry generated approximately $226 billion in revenue worldwide, about $17.5 billion of which was generated in the U.S.[1] The industry was expected to hit over $300 billion by 2008, driven primarily by demand in consumer products such as personal computers, digital cameras, televisions and cell phones.[2] The semiconductor industry was fragmented, with the top four companies (Intel, Renesas Technology, Samsung and Texas Instruments or TI) controlling about 30% of production.[3] The industry produced silicon-based electronic circuits for use in computers and other electronic devices.[4] One of the major uses of these semiconductors was in microprocessors. In 2005, the top two companies, Intel and Advanced Micro Devices (AMD), accounted for over 90% of global sales of microprocessor production.[5] (**Exhibit 1** provides additional information on the industry in 2005.)

The microprocessor market had been historically dominated by Intel, which held a market share in excess of 80%. The firm's continuously high-paced innovation and regular introduction of new (faster, better, etc.) microchips quickly rendered competitors' offerings obsolete. Intel's manufacturing prowess meant it had the ability to slash prices while maintaining healthy margins (as unit sales increased and production costs declined due to economies of scale). One analyst noted, "Typically, by the time competition can react, Intel has already moved on to the next generation of chips."[6] Penetration of top-tier PC vendors—key accounts in the industry—was also a factor, as large corporate clients favored high-speed processors, a product with higher-margins that made this segment highly attractive. Dell's November 2004 announcement that it would consider using AMD's new chips, for example, was considered a significant break for AMD.

Chip Production and Manufacturing

Fabrication plants, or "fabs" as they were called, produced semiconductors (i.e., chips) on wafers made of pure silicon.[a] Much of the production was automated, relying on robots working in cleanroom environments. Semiconductor manufacturers followed one of two models in their chip production. Some designed and manufactured their chips; these firms were known as integrated device manufacturers (IDMs). Others outsourced manufacturing to foundries, and were called "fabless." Typical costs to build a 300 millimeter (mm) wafer fab ran about $3.5 billion to $4 billion in the U.S., and about $2.5 billion to $3 billion for an international location. Fabs cost about $1 billion a year to operate, and required highly skilled engineers to run. In 2005, several manufacturers were having difficulty keeping up with the investment required to maintain fab competitiveness, and were shifting to a "fab-lite" model in which they outsourced an increasing share of their production.

Production of a chip typically consisted of 300 to 350 individual steps that took several hours each, and throughput time for an average wafer could be 45 days. Actual machine processing times might be 12 to15 days; the rest of the time was consumed with waiting in buffers in front of tools. For each step, a batch of wafers was brought to a tool which then pulled the wafers out of the carrier one at a time using a robot arm and processed them, returning them to the carrier when completed. Wafers

[a] Computer chips, or microprocessors, were made through lithography, using light to transfer images onto a substrate, typically silicon, the most common substrate used in chip making. Light was directed onto a mask (which created the integrated circuit design on the microprocessors) and then through a series of lenses that shrunk the image down. This image was then projected onto a silicon, or semiconductor wafer (the chip). The size of the light's wavelength determined how powerful a microprocessor would be. The shorter the wavelength, the more transistors could be etched onto silicon wafers, which meant a faster, more powerful microprocessor. The Intel Pentium 4 processor, for example, contained 42 million transistors while the Pentium 3 had 28 million. See Kevin Bonsor, "How EUVL Chipmaking Works," *HowStuffWorks*, http://computer.howstuffworks.com/euv11.htm, accessed March 2012.

were transported to the tools in plastic carriers or pods, either using a robotic transportation system or by fab workers in cleanroom, or "bunny," suits.

Once the wafers were etched with chips in the fab, they were sent to assembly and test (AT) plants. Their technology was less advanced and less capital-intensive than that used in the production of chips. At the AT plant, the chips were cut out of the silicon wafer and incorporated with other components to form the microprocessor. These were then tested, and packaged before being shipped to equipment producers (i.e. customers). AT plants were typically located near producers of the electronic products that would incorporate the microprocessor (many of which were in Asia), rather than near fabs. Products were typically produced at multiple facilities at various sites around the world, or by subcontractors with multiple facilities. Assembly relied on low-cost labor; glass manufacturer Corning, for example, located most of its glass manufacturing for Apple's iPhone screens in Japan and Taiwan. As one executive noted, "Our customers are in Taiwan, Korea, Japan and China. We could make the glass [in the U.S.] and then ship it by boat, but that takes 35 days. Or, we could ship it by air, but that's 10 times as expensive. So we build our glass factories next door to assembly factories, and those are overseas."[7]

Intel's competitors had fabs and plants around the globe. AMD, for example, had wafer fabs in Austin, Texas and Japan, and AT facilities in Bangkok, Thailand; Kuala Lumpur and Penang, Malaysia; and Suzhou, China. In 2005, AMD was considering its first international fab, possibly to be located in Germany. AMD also relied on third-party foundry arrangements, and used U.S. subcontractors for some of their microprocessor assembly and final testing. Fairchild Semiconductor had manufacturing sites in China, Korea, Malaysia, the Philippines and Singapore, along with U.S. sites in Maine, Pennsylvania and Utah. Micron had fabs in Idaho, Virginia, Italy, and Japan; ATs in Idaho, Utah, and Singapore; and memory module assembly plants in Boise, Puerto Rico, and Scotland. Samsung had semiconductor fabs and AT plants in South Korea. STMicroelectronics operated fabs in France, Italy, the U.S., and Singapore. Taiwan Semiconductor Manufacturing Company (TSMC), which had pioneered the stand-alone foundry strategy, had plants in China, Singapore, Taiwan and the U.S.

Intel Corporation

Intel was founded in Mountain View, California in 1968 by Robert Noyce and Gordon Moore, two physicists who worked at San Jose-based Fairchild Semiconductor. Intel was originally called NM Electronics, but the founders soon changed the name to Intel (for "Integrated Electronics"). The company began producing semiconductors, and created the first commercially available dynamic random access memory (DRAM) chip in 1970. The next year, Intel produced the first commercially available microprocessor, moved its headquarters to Santa Clara, California, and went public, raising $6.8 million.

In 1972, Intel opened an assembly plant in Malaysia, their first operations outside of the U.S. In 1979, Andy Grove, who had been with the company since its founding, was named president and by 1983, the company recorded $1 billion in annual revenue. In 1987 Grove was named CEO; he held the post until 1997. Intel's famous "Intel Inside" marketing campaign debuted in 1991, firmly embedding the Intel brand name in the popular conscience. Under Grove's leadership, the company's revenue grew by more than sevenfold and its stock appreciated more than 1,600%. Craig Barrett was named CEO in May 1998. In 2005 Barrett became chairman of the board and Paul Ottelini was named CEO.

By 2005, Intel was the largest semiconductor manufacturer in the world.[8] Intel supplied about 80% of the central processing units (CPUs) used in PCs, workstations and servers; these accounted for about 90% of Intel's gross profits.[9] PC chipsets and NOR flash memory were also important products; flash memory products, used primarily in cell phones, constituted about 7% of sales.[10] Intel's largest customers were Dell and Hewlett-Packard (HP), which accounted for 19% and 16%, respectively, of total sales in 2004 (no other customer accounted for more than 10% of total revenues).[11]

Intel had research labs and innovation centers located strategically around the globe. Along with its research labs in Berkeley and Santa Clara, California; Pittsburgh, Pennsylvania; Hillsboro, Oregon and Seattle, Washington, Intel Labs were located in Beijing, China; Europe (16 sites); Bangalore, India; Guadalajara, Mexico; and St. Petersburg, Russia. Intel had four innovation centers, one each in Dubai; Ireland; Russia and Turkey. (**Exhibit 2** shows Intel's geographic footprint in 2005, **Exhibit 3** provides financial information.)

Intel's Plants

Semiconductor and microprocessor companies had wafer fabs; AT plants; systems contract manufacturing (SCM) which built motherboards, server boards, and some networking products; and development fabs, which developed products and manufacturing processes. In 2003, Intel had transitioned from manufacturing 200mm (~8") wafers to making 300mm (~12") ones, which the company claimed allowed "for more efficient use of capital investment in equipment by providing more than twice as many equivalent chips per wafer as 200mm wafers."[12] This had meant building out new equipment and processes, with larger fabs to handle the requirements of 300mm wafer production (i.e. higher ceilings). The IP associated with a wafer fab was such that U.S. regulations prohibited companies from building certain fabs outside the U.S. As a result, by December 2004, about 70% of Intel's wafer fabrication, including microprocessors and chipsets, was conducted in the U.S.; about 13% took place in Israel and 17% in Ireland.

While the company produced most of its semiconductors in the U.S., the majority of its AT plants were located internationally. Manufacturing wafers was semi-labor intensive and that labor had to be highly skilled. In contrast, an AT could be managed by two college-educated personnel and required less educated labor to operate the facility. Krzanich noted, "We tend to try to locate in a region that's low cost, but there's an advantage to being close to our customers. Asia works nicely for that. The AT is the last step before shipping to the warehouse. But we airship everything. We can get to a dock within a day—24 hours. Still, Asia is convenient."

A new plant could take three to five years to build; converting an existing plant took about the same time. Intel had guidelines regarding the number of products and revenues linked to a plant, and no one plant should account for more than 40% of Intel's revenues. Krzanich explained, "We want plants to be able to do more than one product. We engineer for that up front."

Requirements for a New Plant

Intel's fabs Intel's fabs produced a variety of semiconductors including microprocessors, chipsets (microchips that controlled information flow), and flash memories (found in digital devices including cell phones). By 2005, Intel operated fabs in Arizona, New Mexico, Oregon, and Massachusetts in the U.S, a fab in Israel, and several fabs in Ireland.

Assembly and test plants In 2005, Intel had AT sites in Arizona, China (Chengdu), Costa Rica, and Malaysia. Intel's standard 250,000 square-foot plant took about five years to get up and running, and required about 2,000 personnel initially, eventually increasing to about 3,500 employees. The newly planned 500,000 square-foot plant would take about 14 years to be fully operational, given the additional complexity and numbers of people on the construction site; it would eventually run with 4,000 to 5,000 personnel.

Locating a New Plant

When considering a new location for a fab or AT plant, Intel had many things to think about. The first was whether to construct an entirely new plant or to update an older facility. Once the decision to go ahead with a new facility was made, the company had to decide whether to build it domestically or internationally. Aside from local infrastructure costs (power, water, labor, etc.,) Intel also considered how much of their footprint they wanted in any given location, and how much transportation would cost if they opened a new location. Additional factors such as security and environmental conditions weighed against costs and proximity to Intel customers and their markets.

Country, state and even local governments used incentives to lure companies to set up local facilities, in the hopes of gaining such benefits as job creation, local investment in community resources such as education and healthcare, and steady tax revenues over time. Often an anchor industry tenant could then influence other industry suppliers and service providers to locate in the vicinity. Government officials in Slovakia predicted that a new Peugeot factory would yield an additional 6,000 to 7,000 jobs—beyond the 3,500 jobs specifically linked to the factory—from secondary suppliers.[13] When Mercedes-Benz chose to build a new plant in Alabama in 1993, many were skeptical of the deal offered: close to $253 million in incentives.[14] However, by 2002 the investment seemed to have paid off, as Honda and Toyota both located new facilities in-state, and other industries, such as aircraft manufacturing giant Boeing, looked to locate in Alabama. The local economy got a boost as well, with employees and companies that did business with Mercedes generating about $14 million a year in state income and sales tax. One study found that Mercedes and its suppliers helped create nearly 10,000 jobs in the state, paying nearly $354 million a year in wages.[15] In addition, Mercedes spent about $1 billion a year on parts, supplies and services from Alabama companies. Other less directly related benefits included a new Target superstore and modern shopping mall that were built nearby; sushi became available in the local grocery store.[16]

By 2004, competition between countries to attract foreign investment was heated. In the EU, for example, Central and Eastern Europe, as new entrants to the EU, had to obey rules that limited tax incentives to 15% of the value of an investment, in contrast to the significant tax breaks they had been able to offer in the past.[17] Outsiders, such as Bulgaria and the Ukraine, however, were not affected by these rules, and soon became preferred locations. Other incentives could include land grants, such as the 200 hectares of prime industrial land the Czech Republic offered to Hyundai Motor Company for €7 million in the hopes of luring the car manufacturer to build its €700 million plant on a site northwest of Prague.[18] Competition between U.S. states was also fierce; in 2003, when Boeing called for proposals from states vying to be the location of Boeing's new assembly site, Washington state—where most of Boeing's existing assembly sites were located—offered tax incentives packages worth $3 billion over 20 years if Boeing stayed.[19] Alabama offered Mercedes-Benz a 20-year exemption from state income taxes, bought the proposed plant site at market value and offered it to Mercedes for $100, and provided tax concessions that enabled Mercedes to pay for plant construction out of the money it would have spent on state income taxes. Alabama's governor matched North Carolina's offer to build a $35 million training center at the plant, and agreed to pay employee salaries while they were in training (about $45 million); when Mercedes wanted to double the size of its existing Vance, Alabama plant, the state offered an additional $115 million in incentives.[20]

While China had dominated as the provider of low-cost labor manufacturing with a huge untapped domestic market, other countries were beginning to catch up. India was emerging as a breeding ground for electronics manufacturing services companies, and several large players, such as Nokia, were making increased investments in the country. However, some observers noted that India required companies to move new equipment into the country, rather than bring in older equipment and producing older technology, or "trailing-edge chips."[21] Additionally, given its under-developed infrastructure, India was still a hard sell for semiconductor production. One insider noted, "[T]he infrastructure is not up to global standards, especially the power grid. They also don't have adequate water facilitization."[22]

The Short List

There were a number of locations that made the team's initial list, including countries in Southeast Asia and the Middle East along with China, Latin America, and India. Building an Intel fab or AT plant carried many positive benefits to a nation's economy, including infusions of capital to local infrastructure, educational and other human capital benefits, and competitive technology benefits.

In advance of the first round of local site visits, Blain Trendler, manager, Global Site Selection and Development, and his team pulled together data relevant to an AT factory's needs on each of the sites. These included: issues related to utility availability, reliability, and rates; environmental health and safety issues, including waste water and disposal of other plant waste; human resources, work-force development and other employee training issues; incentives, including grants or exemptions; logistics (including airport, shipping and transport, and customs) and supply chain needs; risk management issues, including natural disaster insurance, IP protection and security; and possible political risks. (**Exhibit 4** provides Intel's parameters for general site criteria.) Trendler's team also gathered information on foreign exchange, currency and loan conditions associated with each site. These initial inputs were supplemented with data from federal and international organizations and non-governmental organizations (NGOs) such as the World Bank, along with data and feedback from other multinationals (MNCs) already on site. Each potential site could benefit from Intel's decision, including the investments the company made into local infrastructure, education and training, and health services. Once an anchor tenant such as Intel located in a technology park, other technology and service companies were quick to follow suit.

This initial round of data was then supplemented with on-the-ground findings, gathered by the team through on-site visits. Krzanich said, "We know what we need: a million gallons of water a day, 40 MVA kilowatts of power, and so on. Then we talk to other business leaders about local issues such as labor, the government, etc. If we see someone else is already there, we are more confident that things will work. The infrastructure is already in place and is clearly working."

Potential Sites

By early 2005, the short list was coming together, offering several completely new locations for Intel to consider, as well as a few locations where Intel already had plants. Asia still seemed the most attractive location for an AT, given its low overall costs. The team had also considered several Middle Eastern locations, although political instability in some countries made Krzanich and his team wary of locating there. Workforce issues also informed Intel's consideration of these sites; as Krzanich said, "In the Middle East, all of the labor is from countries like Vietnam, Pakistan, and India, who go there to get better pay." At the same time, however, Intel worried about being shut out of some markets if they had no local presence. Others were concerned that locations with existing Intel plants, or a significant competitor presence, did not offer as many opportunities for a new plant. While not being the first to build a plant in a new location had some benefits, there were drawbacks as well. "If there are lots of other players, maybe I won't get the best deal," Krzanich said, "on top of which I have to worry about my IP. A guy next door is trying to build the same thing." He added:

> If someone already has assembly and test in a location, we know there will be a skilled workforce there. At the same time, there'll be competition for that workforce. In those instances, we also worry about our talent. In some countries, if you're a manager at this grade at Intel, you can get probably a 50% pay raise and two job levels higher at any other company. They look at us and they know we develop people, good managers and leaders. We have a hard time keeping our mid-level managers, because in some countries they can move to very lucrative positions.

The team soon narrowed the list to six potential sites. (**Exhibit 5** provides country-level economic and development indicators for potential sites; **Exhibit 6** provides select site information.)

China: Dalian

China had attracted multinationals for several decades, with low cost one of its strongest draws. Intel already had two AT plants there—in Chengdu and Pudong. China had a rapidly expanding industrial complex, an ambitious workforce, and what one observer called "an aggressive public-private effort to court foreign investment," fueling the country's transformation into an economic superpower.[23] Premier Deng Xiaoping's economic reforms of the late 1970s created government-sponsored tax breaks and other development incentives, funded research, and enacted laws to tackle IP issues, triggering investments of about $450 billion annually.[24] China's 2001 entry into the World Trade Organization (WTO) solidified the country's efforts to redraft and enforce laws encouraging foreign investment and development. China offered foreign companies tax breaks, a competitive educational system, and low labor costs. In 2002, the average worker in China made roughly $365 a month.[25] However, risks and barriers remained: for example, China imposed tariffs, restricted foreign companies to certain sales regions, mandated sales caps, and required some companies to enter joint-ventures with Chinese companies.[26] Additionally, many acknowledged that good relations were built over time: government officials needed to be courted, personal connections needed to be established within the bureaucracy, and hiring locals and working closely with regional universities and companies was critical.

U.S. regulations and concerns over IP security had kept Intel and other high technology companies from locating its fabs in China. Intel's non-U.S. competitors were not similarly constrained, and by 2005, 5% of the industry's state-of-the-art ~300mm fabs under construction, being equipped, or newly announced, were located in China; an additional 33% were in Taiwan.[27] China was eager to secure additional higher technology Intel plants within their borders, and some thought it would soon be possible to locate a fab for earlier-generation Intel wafer technology in China. China had actively worked to enhance conditions for global manufacturing. In the past, customs could take as long as three days (72 hours) to clear products, but by 2002, goods were processed within 10 hours; six hours for IT products (in contrast, Malaysia processed imports and exports in eight hours).[28] China extended tax benefits to foreign companies as well; several did not pay taxes for the first two years of operations, and subsequently paid only half the standard 15% for the next three years.[29] Companies in some free trade zone technology parks were excluded from export tax and VAT (value added tax). The government actively sought guidance from outside partners as well, with the CEOs of such companies as Nokia, Ericsson and Matsushita Electric serving on the Business Leaders Advisory Council to the mayor of Beijing.[30]

Intel had been courted by China as a site for its plants for many years, and the company had made early investments in China, dating back to its first AT plant built in Shanghai in 1994. In 2003, Intel invested $200 million setting up a second AT center in Chengdu that would employ 675 workers, with a planned second wave of capital expansion of $175 million that would also increase the workforce.[31] The site was on track to go live in 2005. Additionally, along with its Beijing Lab, Intel partnered with Tsinghua and Fudan Universities. This time Krzanich's team looked further north, focusing on Dalian, a large Northeastern China seaport and international shipping and logistics hub. Dalian was one of China's more heavily industrialized areas, home to machine manufacturing, petrochemical and oil refineries, and electronics companies. Trendler recalled, "Dalian was very competitive."

India: Chennai

Finding a suitable AT location in India was high on the team's list. Krzanich recalled, "The government really wanted it to work; our chairman was interested—India was eager." In 2000, the government had passed an act setting up special economic zones (SEZs) to provide internationally competitive and "hassle free" environments for exports. In May 2005, the comprehensive Special Economic Zones Act was passed by parliament.

A federal republic made up of 29 states and six union territories, India had a national bicameral legislature,[b] with the United Progressive Alliance Coalition, led by the Indian National Congress, in power in 2005. The large coalition relied on support from regional parties and the Left Front parties (mostly Communist). Some considered the regime unstable, and progress on much-needed economic reforms was slow. Unemployment stood at around 10%. Infrastructure was still under-capitalized, and educational services were strained by a growing population. The government committed over Rs. 932 billion to create a network of roads, with an additional Rs. 800 billion dedicated to a rural infrastructure development fund, and Rs. 183 billion allocated for education.[32] In an attempt to stimulate growth, customs tariffs, corporate and income tax had been reduced.

India was a strong option for Intel's AT for many reasons, including a government based on a constitution and English common law, low labor costs, language and education standards, highly educated engineering talent, and a growing middle class market. But the country presented a complex maze of regulations, tax structures and multiple layers of government entities, which meant navigating local, state and country-level ministries for a range of issues.

The team had narrowed in on a business park offered by the government in Chennai (in the state of Tamil Nadu). Tidel Park was located about 12 kilometers from the International Airport and already home to several major international companies. The team talked to other MNCs operating locally, including a Ford factory in the Chennai area, who reported that dealing with local unions played a role in successful operations. Despite site infrastructure offerings, which included power from two independent feeders from public utilities and was further supported by a claim for a 100% standby power plant,[33] most companies built their own cogeneration (cogent) plants onsite to guarantee quality, reliable power. Additionally, Chennai suffered from regional water shortages, and although capacity had been secured for the small technology park, it was not sufficient for future

[b] India's national legislature comprised the upper house, or Rajya Sabha, and the lower house, the Lok Sabha. The Rajya Sabha was comprised of elected members of parliament and the legislative assemblies of states and union territories, and 12 additional members appointed by the president. The Lok Sabha was comprised of members elected from single-member constituencies (79 seats reserved for scheduled castes, 40 for scheduled tribes) and two representatives of Anglo-Indians, appointed by the president.

growth of the area, and water would need to be brought to the site from about 20 miles away. Intel's negotiations with the local Tamil Nadu government had progressed by early March, and the officials were very eager, as Krzanich said, "They promised to build a pipe for the water, and reassured us our power concerns would be addressed. They told us we could work with the government on our concerns." Trendler added, "The Minister from Tamil Nadu, who we were negotiating with locally, was an up-and-coming guy. He made it clear, 'We want to get Intel here.'" The next step was to meet with the federal government.

Thailand: Amata Industrial Estate Parks

Some regions in Thailand presented a good opportunity for a new plant as there were several technology and healthcare companies in the region. Doing business in Thailand was considered relatively easy, with less burdensome business regulations; it was ranked in the top 20 economies on the World Bank's 2005 Ease of Doing Business Report.[34] The workforce was well-educated with a literacy rate of close to 90%. However, with very low unemployment (reported at 2.1%),[35] some reported a shortage of skills in the economy, especially in emerging high-skilled industries such as IT and medicine,[36] and labor costs were generally higher than in China, Vietnam or Cambodia. Thailand's Board of Investment typically offered a wide range of incentives to attract foreign investments, including tax incentives and non-tax privileges. Infrastructure was poor in rural areas, but the government was working to improve road surfaces throughout the country, especially in tourist districts. Rail was underdeveloped, and had not seen upgrades since the 1980s. In 2005, the government planned to commit $37.5 billion towards infrastructure and public service improvements, with $12.7 billion aimed at developing mass transit, and about $8.69 billion to be spent on education.[37] Many considered the government unstable, however, with southern Thailand experiencing unrest, and the Thai Rak Thai government coming under criticism from human rights organizations. Additionally the region was subject to natural disasters such as flooding.

The government's preferred choice for a site was one of developer Amata Industrial Estate's industrial parks. Several of these had been occupied for decades by foreign manufacturers from around world, including companies from the automotive, electronics, and consumer goods industries. AMD had operated an AT facility near Bangkok since 2003. Initially, Intel considered two sites: Amata Nakorn Industrial Estate and Amata City Industrial Estate, both outside of Bangkok. Amata Nakorn was about 57 kilometers east of Bangkok, about 46 kilometers from the Laem Chabang Deep Sea Port, 85 kilometers from Bangkok International Airport and 42 kilometers from the New Bangkok International Airport. Amata City was about 114 kilometers from Bangkok; about 142 kilometers from the international airport (99 kilometers from the new international airport) and about 27 kilometers from the port. Early negotiations with the government made it clear, however, that Thailand would not negotiate cash grants. Intel narrowed their consideration to Amata Nakorn.

Vietnam: Ho Chi Minh City

Vietnam had come onto the team's radar as a potential site for a plant several times in the past. The French colonized the Indochina Peninsula, including Vietnam, in the 19th century; in the mid-20th century, the First Indochina War eventually forced the French out, and left a divided Vietnam (North and South). In 1975, after three decades of war, Vietnam was unified. In 2005, Vietnam was a one-party Communist state, with the government located in the northern city of Hanoi. By 2005, the country was westernizing, especially in the south, which the government was allowing to grow "unfettered," according to Krzanich. The economy was one of the fastest growing in the region, with annual growth of about 7%.[38] Yet the workforce was young and undeveloped, and was only just coming out of school, so there was little established in the way of an experienced workforce, especially leadership talent. Increasingly students studied English over Russian, but language skills were not always reliable. Factory wages were about $60 to $80 a month, less than in China.[39] Engineers earned about $400 to $500 a month.[40] The workforce was motivated with a good work ethic; one observer noted, "There are a lot of young people here, and they don't mind working hard. They'll work until the job is done, even if it means staying beyond assigned work hours."[41]

The region was not prone to floods, hurricanes or earthquakes, and presented a low natural disaster risk. The government was eager to pursue industrializing opportunities, and actively courted large multinationals to set up operations. "They were very aggressive," Krzanich recalled. "They wanted to have us come. We saw similarities to how things got done in China." Exports were rising, especially shrimp, silk, and timber, and the country was attracting new investments in cars and electronics. However, infrastructure upgrades still lagged, and it was, as Krzanich noted, "a very immature environment." Reports noted that corruption and cronyism were still fairly widespread, and the World Bank had issued warnings about fraud in Vietnam's large-scale program of privatizing state-owned enterprises.

The team originally considered two options assigned by the government: the Hoa Lac Hi-Tech Park in Hanoi in the north, and the Saigon Hi-Tech Park, located in Ho Chi Minh City (formerly Saigon) in the south. Culturally, the team noted a marked difference between Hanoi and Ho Chi Minh City: "We felt it was different in Hanoi. It didn't have the same spirit of entrepreneurialism we'd felt in Ho Chi Min City," said Krzanich. Trendler added, "They were much more old world in Hanoi. When the discussion of a grant came up, one response was 'What's that?' We were not as convinced they had the kind of international manufacturing, logistics and operational experience we required." The initial site visits helped narrow the choice to the Saigon Hi-Tech Park.

In Vietnam, technology parks were run by an operational manager (or head), who had unilateral decision-making power, was a government official, and a Communist party member. The technology park head and the city mayor formed a duopoly in all negotiations. The team talked with other MNCs operating in Vietnam, as well as the American Chamber of Commerce who put Krzanich's team in touch with a global shipper and several Japanese manufacturers.[c] One issue that surfaced was the lack of mature leadership talent, in part due to the decades of war, and in part, due to the Communist regimes' approaches to education. "More than 50% of the population was under 25," Krzanich noted, "and 25% were male because of this long history of war. That was what was left of the population." Developing this level of talent was challenging, he recalled, "We wanted to talk about the leadership challenges we would face locally, could we develop Vietnamese leaders? They told us there are two ways to develop good leadership. You can take the guys getting out of graduate school, send them to the U.S. for a while, grow them, develop them and get leadership that way. Or you can go back into your U.S. organization, find Vietnamese who left, and see who you can repatriate."

The mayor of Ho Chi Minh City was Harvard educated, a young, entrepreneurially minded business man. Trendler recalled, "He was fluent in English, very aware of what was going on in China and other Asian locations, and was clearly ready to make it work in his city to offer a competitive situation." The technology park's operational manager took the team on a tour of the site, where a large creek ran through its center. The manager noted the creek beautified the site, and provided good feng-shui, but the Intel team was concerned. "We needed them to move that creek,"

[c] The team noted that the Japanese reported poor relations with their Vietnamese workers, but Intel felt these could be explained through Japan-Vietnam cultural differences.

Krzanich recalled. "I didn't want it on our site if it was to get polluted upstream, or ever flooded, I didn't want us to get blamed for it." Given the concerns over the creek, the technology park manager offered a second site, where a small community stood. "He told us we could consider this property; that he would move the village and it would take only six months." Without feeling good about either option, the team was nevertheless impressed with what they saw in Ho Chi Minh City.

The Short List

By mid-2005, the team had narrowed their list to four sites: Chennia in India; Dalian in China; near Bangkok in Thailand, and Ho Chi Min City in Vietnam. The team had assessed all the data and incorporated their on-site findings and assigned rankings based on parameters of tolerance for each criteria. Krzanich had his presentation for the board ready; he wondered: Had his team made the right choices and captured the relevant data for future considerations—politically, environmentally, financially, technologically, operationally and in terms of unforeseen industry changes? Was their weighting of the criteria right? What could come in the future that might impact those weighting decisions? Krzanich wondered: Where will the board choose?

Exhibit 1 Select Information on the Semiconductor Industry in 2005

The integrated circuits, or chips, were made up of transistors attached to a slice of silicon, called a wafer. As technology improved throughout the 20^{th} and into the 21^{st} century, the size of transistors shrank, meaning more transistors could be fit onto the same sized chip, a phenomenon—Moore's Law—described by Intel founder Gordon Moore in 1965. Moore's law stated that the number of transistors on a chip doubled every 18 months to 24 months, and this law continued to hold true through 2005. Intel and other chip manufacturers were resorting to new technologies to maintain this pace, while analysts predicted that the law would not hold true beyond 2015 or 2020. Chips typically had transistors in only two dimensions, although in 2002, Intel had announced the development of 3-D transistor design which would allow engineers to put even more transistors onto the same size chip by "building up," using three-dimensional architecture.

The semiconductor industry was composed of several product segments, the largest being chip manufacturers, including manufacturers of microprocessors, DRAMs, and other chips. Within this segment, companies could be categorized based on the degree of vertical integration:

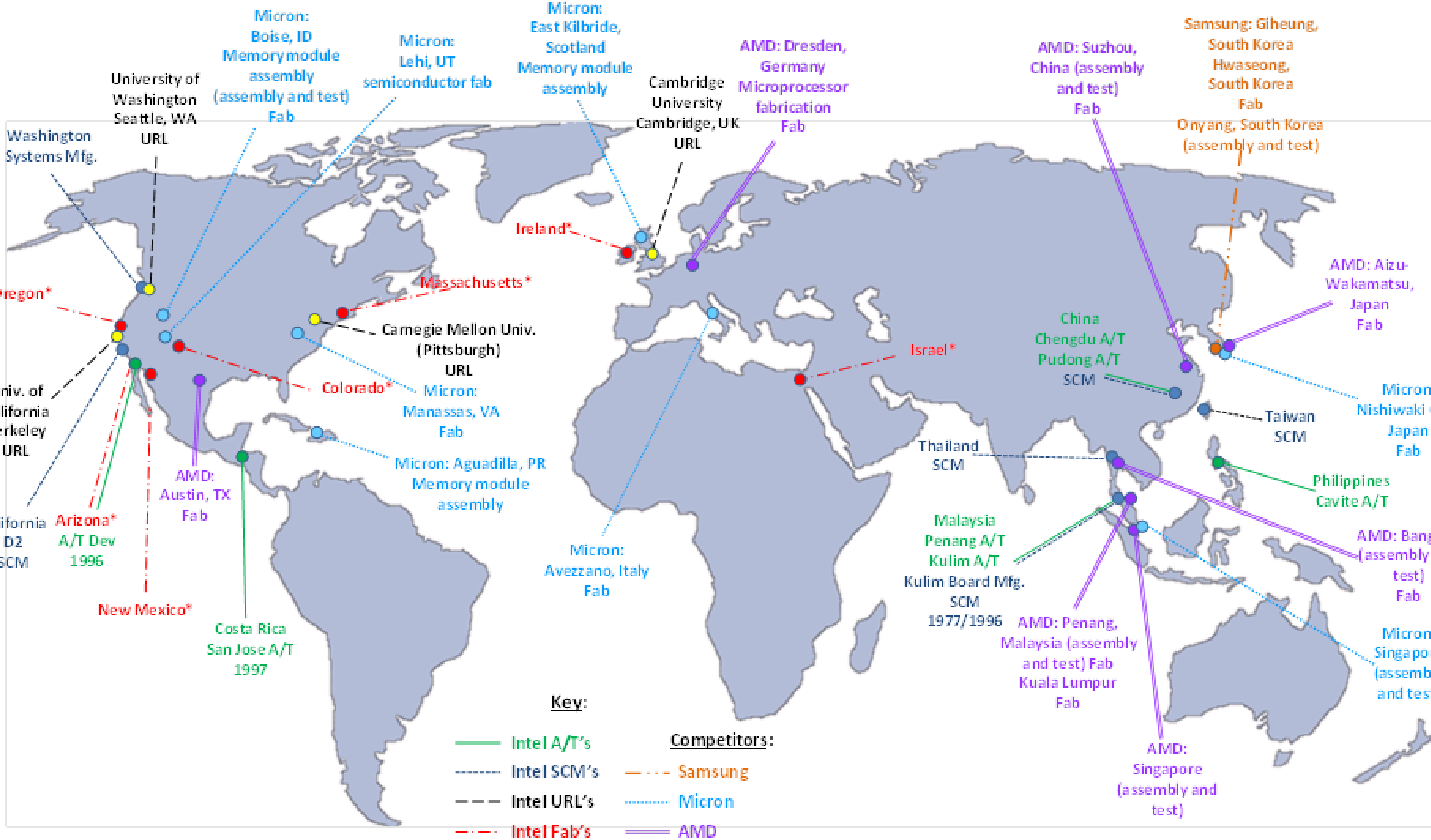
- Integrated device manufacturers (IDMs) were vertically integrated companies that designed and manufactured chips in their own fabrication facilities, known as "fabs." Examples of IDMs included Intel and TI.
- Fabless design companies focused on designing chips. These companies outsourced production of chips to specialty producers, known as foundries. Examples of fabless companies included Nvidia and Qualcomm.
- Foundries manufactured chips designed by other companies. Their large facilities were able to accommodate many different designs simultaneously. Examples of foundries included TSMC and GlobalFoundries, Inc.

IDMs typically focused on one major product line. For example, whereas Intel focused on microprocessors, Samsung focused on DRAMs. This allowed each firm to customize its fabs to suit its needs and implement the technological advances it developed quickly.

A fab's primary capital investment was spent in the manufacturing tools on the production floor. Each tool performed one step, and some production processes involved as many as 300 steps; an individual tool could cost several million dollars.

Source: Casewriter research; Willy Shih and Jia Cheng, "Semiconductor Manufacturing International Company in 2011," HBS No. 611-053, (Boston, MA: Harvard Business Publishing, 2011).

xhibit 2a Plant Locations: Intel and Select Competitors (2005)



ource: Company documents and casewriter research.

otes: In 2000, 26% of Intel sales revenues came from Asia-Pacific, 41% from the Americas, 24% from Europe, and 9% from Japan. In 2004, 50% came from Asia-Pacific, 20% from the Americas, 13% from Europe and 10% from Japan. Legend: A/T = assembly and test plant; SCM = systems contract manufacturing (i.e. motherboards, serverboards, and select networking products); D = development fab (i.e. a fab used to develop products and manufacturing processes) and URL = university research lab.

*See below for dates of fab openings.

Exhibit 2b Locations and Dates of Intel Fab Openings

Location	Fab (Date)
Arizona—Chandler	Fab 12 (1996); Fab 22 (2001)
Colorado—Colorado Springs	Fab 23 (2001)
Israel—Jerusalem	Fab 8 (1985)
Israel—Kiryat Gat	Fab 18 (1999)
Ireland—Leixlip	Fab 10 (1993); Fab 14 (1998); Fab 23 (2003)
New Mexico—Rio Rancho	Fab 11/11x (2002)
Massachusetts—Hudson	Fab 17 (1998)
Oregon—Hillsboro	Fab 20 (1996)
Oregon—Ronler Acres	D1C (2001); D1D (2003)

Source: Company documents.

Exhibit 3 Combined Income Statement and Balance Sheet, Intel Corp. (in $ millions)

	Dec-00	Dec-01	Dec-02	Dec-03	Dec-04	Jun-05
Sales	33,726	26,539	26,764	30,141	34,209	36,734
Cost of Goods Sold	9,429	9,649	8,389	8,253	9,591	11,259
Gross Profit	24,297	16,890	18,375	21,888	24,618	25,475
SG&A	8,986	8,260	8,543	8,736	9,466	9,797
EBITDA	15,311	8,630	9,832	13,152	15,152	15,678
Depreciation & Amortization	4,807	6,052	5,042	4,972	4,860	4,724
EBIT	10,504	2,578	4,790	8,180	10,292	10,954
Other Income/Expenses	4,793	(273)	(418)	(614)	225	452
Pretax Income	15,141	2,183	4,204	7,442	10,417	11,358
Total Income Taxes	4,606	892	1,087	1,801	2,901	3,113
Net Income	**10,535**	**1,291**	**3,117**	**5,641**	**7,516**	**8,245**
Assets						
Cash and Equivalents	13,823	11,550	12,587	16,164	17,172	14,824
Other Current Assets	4,129	2,607	2,574	2,960	2,999	3,448
Inventories	2,241	2,253	2,276	2,519	2,621	2,739
Current Assets - Other	957	1,223	1,488	1,239	1,266	1,179
Current Assets - Total	21,150	17,633	18,925	22,882	24,058	22,190
Net PP&E	15,013	18,121	17,847	16,661	15,768	16,624
Other Investments	3,712	1,474	2,056	3,077	3,726	-
Intangibles	5,941	5,127	5,164	4,364	4,396	-
Other Assets	2,129	2,040	232	159	195	7,699
Total Assets	**47,945**	**44,395**	**44,224**	**47,143**	**48,143**	**46,513**
Liabilities						
Total Current Liabilities	8,650	6,570	6,595	6,879	8,006	7,780
Long Term Debt	707	1,050	929	936	703	430
Deferred Taxes	1,266	945	1,232	1,482	855	689
Total Equity	**37,322**	**35,830**	**35,468**	**37,846**	**38,579**	**37,614**
Total Liabilities	**47,945**	**44,395**	**44,224**	**47,143**	**48,143**	**46,513**

Source: Compiled from Standard & Poor's Compustat Data, accessed October 2005.

Exhibit 4 Intel's Site Criteria and Parameters (2005)

Criteria	Parameters of Tolerance
Power reliability	No power voltage sags; 100% reliability
Power quality	No voltage sags; 100% constant voltage through transmission lines
Electricity rate price	Range: $.20 kwh (high); $.15 kwh (mid); $.10 kwh (low)
Power infrastructure cost	Zero cost for new substation and redundancy is preferred
Power infrastructure timing	Ready for start of construction
Power available capacity	40 MVA[a] meets needs; 80 MVA exceeds needs
Water infrastructure cost	Zero cost for water rights and waterlines to site
Water infrastructure timing	Ready for plant construction start
Sewer infrastructure cost	Zero cost for POTW (public operated treatment works) and all waterlines to site
Sewer infrastructure timing	Ready for construction start

Source: Company documents.

Note: a. MVA = Megavolt ampere.

xhibit 5 Key Commercial Indicators and World Development Indicators (2005)

	China	India	Thailand	Vietnam
nvesting: foreign-investment indicators				
level of foreign direct investment, 2004	US $54.9 bn	US $6.6 bn	US $4.01 bn	US $1.61 bn
FDI as a percent of GDP 2004	2.80%	0.80%	2.30%	3.60%
Main sources of foreign investment, Jan-Sept 2005	Japan, South Korea, U.S.	U.S, Germany, Singapore	Japan, U.S., Europe	Luxembourg, Hong Kong, Taiwan
Sectors with highest foreign investment 2005	Manufacturing, wholesale and retailing, leasing	electrical equipment; telecomm; services	chemical plastic and paper; service and infrastructure; electronics	Transport and telecomm; heavy industry; light industry
Perception of Corruption Ranking and CPI Score[a]	78 / 3.2	92 / 2.9	60 / 3.8	114 / 2.6
icensing: intellectual-property indicators				
Estimated level of software piracy, 2004	90%	72%	80%	92%
Protection of intellectual property	poor	moderate	poor	moderate
Patent applications filed by residents, 2002	40,346	220	505	2
Patent applications filed by non-residents, 2002	140,910	91,704	817	90,135
rading: cross-border indicators				
Value of world merchandise exports, 2004	US $593.33 bn	US $95 bn	US $110.1 bn	US $25.63 bn
Share of world merchandise exports, 2004	8.93%	0.90%	1.05%	0.39%
Value of world merchandise imports, 2004	US $561.23 bn	US $135 bn	US $118.2 bn	US $31.09 bn
Share of world merchandise imports, 2004	8.03%	1.30%	1.10%	0.45%
Exports as a percent of GDP, 2004	34.00%	21.20%	130.00%	65.90%
Imports as a percent of GDP, 2004	31.40%	23.90%	132.80%	73.50%
Mean tariff rate for all goods, 2004	9.80%	28.30%	11.50%	13.75%
-commerce indicators				
Personal computers per 1,000 person, 2004	45.05	14.60	37.50	22.08
Internet users, 2004	99.38m	24.32m	8.7m	3.72m
ORLD DEVELOPMENT INDICATORS				
Tariff rate, applied, simple mean, mfct'd products %	9.3	15.88	10.12	12.31
Tariff rate, most favored nation, simple mean, mfct'd products %	9.55	17.39	10.71	16.62
Cost to export (US$ per container)	335	864	848	468
Cost to import (US$ per container)	375	1244	1042	586
Total tax rate (% of commercial profits)	80	65.5	37.7	40
Public spending on education, total (% of governmental spending	n/a	n/a	23.99	n/a
Health expenditure per capita, PPP (constant 2005 international $)	191.42	90.11	239.56	126.44
Energy use (kg of oil equiv.) / $1,000 of GDP (constant 2005 PPP)	316.24	213.69	215.67	286.13
GDP per unit of energy use (constant 2005 PPP $/ kg of oil equiv.)	3.16	4.68	4.64	3.49
Investment in energy w/ pvt participation (current US$)	1,706,260,000	909,830,000	1,609,000,000	81,600,000
Investment in telecom w/ pvt participation (current US$)	6,628,900,000	5,665,750,000	944,600,000	n/a
Investment in transport w/ pvt participation (current US$)	1,007,319,000	1,526,510,000	241,600,000	n/a
Investment in water & sanitation w/ pvt participation (current US$)	n/a	n/a	n/a	92,000,000

ource: Adapted from World Development Indicators; EIU Country Commerce Reports China, Thailand, India, Vietnam, March 2006, via Economist Intelligence Unit, accessed April 2012, and Transparency International's Corruption Perceptions Index, http://www.nationsonline.org/oneworld/corruption.htm, accessed June 2012.

ote: a. CPI score relates to perceptions of the degree of corruption as seen by business people and country analysts and ranges between 10 (highly clean) and 0 (highly corrupt).

xhibit 6 Select Data for Potential AT Plant Sites in 2005

	Dalian	Chennai	Bangkok	Ho Chi Minh City
ndustries Present	Digital audio and video, fine chemical, machine tool, refined steel, bearing, pharmaceutical, port facility, new building material, furniture, garment and glassware industries.	Software; Financial Services.	Automotive, Electronic, Consumer Goods and Light Industries.	Light industry; Technology.
ducation and Talent	There are 22 colleges and universities in the vicinity; 189,000 students, 18 academicians from China Academy of Sciences and China Academy of Engineering.	There are 25 universities and 275 engineering colleges in the vicinity.	There are 13 public universities and 15 private and international colleges and universities in the vicinity.	The tech park is located near Ho Chi Minh City National University and The Duk University.
oadways and Access	Linked to Shenyang, Beijing, Changchun and Harbin by expressway.	The park is located on the six-lane Rajiv Gandhi Salai in Taramani and close to the Rajiv Gandhi Salai–Thiruvanmiyur West Avenue Junction, a high-density traffic junction used by about 30,000 vehicles a day.	The industrial estate is located 57 km (35 Mi.) from Bangkok. Road condition: solid steel reinforced concrete roads with footpaths.	The tech park is about 15-17 km from H Chi Minh City's center, Saigon Port and Tan Son Nhat International Airport, on future line 1 of the HCMC metro (to be operational in 2012).
irport	The airport has opened 88 air routes, with 17 international routes (including Japan, Korea, Russia, and Hong Kong).	The tech park is about 12 kilometers from the international airport; connecting 16 countries with 107 flights.	The industrial estate is 85 km from Bangkok International Airport, and 42 km from Bangkok New International Airport.	The tech park is about 17 km from Son Naht International Airport.
ort	Dalian Port annual cargo handling capacity of 145.162 million tons.	Chennai is located on the coast of the Bay of Bengal. In the 2005 season, the Port of Chennai handled a total of 47.2 million tons of cargo.	The site is 46 km from Laem Chabang Deep Sea Port.	The tech park is about 15 to17 km from Saigon Port.
ower	Sufficient supply of power and gas to meet requirements of economic development. Rate of $0.10/kWh.	Power provided from two independent feeders from public utility ensures uninterrupted power supply; further supported by a 100% standby captive power plant. Rate of $0.11/kWh.	PEA (Provincial Electricity Authority) public substation in estate, 22kv, or the Amata Private Power Plant, private. Amata—EGCO Power Capacity: 332MW; supply of power 22kv, available subject to local load factor. Rate of $0.08/kWh.	The tech park's power is supplied from the national grid and the technology park's power plant with maximum capacity of 40 MVA (park management plans to build stand-by gas turbine generator for blackout). Rate = $.06/kWh.
ater sources and eserves	Over a dozen reservoirs, dispersed across Biliu River and Yingna River, provide 600 million cubic meters of water reserve. Daily water supply capacity is 1.3 million tons, with 900,000 tons of water used in 2005. Plans underway to divert water from	Surface water from planned lake (to be completed March 2006) = 2 mil gallons/day (MGD). Ten wells provide groundwater = 1.5 MGD, with 14 additional wells planned providing upgrade to 2 MGD). MIPL has 1.98 mil gallons reservoir	Sri-Yad Dam: capacity = 10 M m^3/year. Reservoirs and lakes capacity = 20 M m^3/year (Outside sources: private ponds, capacity = 20 M m^3/year; back-up sources, Bangpakong River, capacity = 6 M m^3/year). Water rate = $\$0.40/m^3$; waste water rate = $\$0.20/m^3$.	Thu Duc and Binh An water plants and four stand-by water tanks with capacity of 3,500 m^3. Water rate = $\$0.43/m^3$; waste water rate = $\$0.24/m^3$.

	Dalian	Chennai	Bangkok	Ho Chi Minh City
	Dayang River and Yalu River for future development. Rates: water = $0.40/m^3; waste water =$0.36/m^3.	capacity. Additional 3 MGD wastewater treatment plant estimated completion date is September 2006. Water rate = $1.3/m^3; waste water rate = $0.325/m^3.		
elecommunications	Four large telecommunication carriers--China Netcom, China Telecom, China Unicom, China Railcom, have operations in Dalian High-Tech Industrial Park. The whole area has been covered by fiber optic. International gateway bandwidth is 345MB and the backbone network has exceeded 40GB. Dalian High-tech Industrial Zone has also set up a satellite data communication receiving station.	Telecommunications connectivity from seven independent sources including: broadband connectivity; an fiber-optic backbone for Internet and large volume data processing; provisions for ISDN and video conferencing with unlimited bandwidth.	Telecommunications services provided by Telephone Organization of Thailand (TOT) and Thailand Telephone and Telecommunications (TT&T) fiber optic cables; ISDN available.	The tech park has communication and telecom facilities able to supply cost effective, efficient services. Bandwidth supports high-speed Internet access: ISDN, XDSL, FE/GE 100M/1000M, WLAN 11/22Mbps.
ax policies for foreign nvestors	Income tax for foreign manufacturers operating within the Zones is 15% with even lower rates possible: If they stay for more than 10 years, 0% for years one and two, 7.5% for years three to seven; If they export more than 70% of production, corporate rate is 10%; Technically advanced firms are eligible for three years of 10% income tax rate, after the above benefits period expires. Foreign investors who reinvest their profits/dividends in China, for a period of over five years, can be refunded 40% of the tax they have paid for the reinvested amount. Equipment imported by overseas-funded projects is exempt from customs duties and import-based VAT.	Corporate income tax rate in Chennai was 30% with the following exemptions: deduction of 100% of export profits for first five years and 50% for the next five.	Exempt from corporate income tax and withholding tax on dividends for a period of eight fiscal years for projects with capital investment of 10 million baht or more, (excluding cost of land and working capital) obtain ISO 9000 or similar international standard certification within two years of start-up date, otherwise the corporate income tax is reduced by one year. Additional 25% deduction for the cost of installation or construction of facilities. Subsequently, in some cases, 50% reduction for corporate income tax. Raw or essential materials used in the manufacturing of export products exempted from import duty for five years. Exemption from tax on payments of royalties and fees for up to five years.	A 10% corporate income tax for the lifetime of projects, an exemption for fou years and a 50% reduction for the next five years from the year of generating taxable revenue.

ource: Casewriter.

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