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Zhongguancun Science Park: A SWOT Analysis*

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ZHONGGUANCUN SCIENCE PARK:
A SWOT ANALYSIS

Abstract

The IT revolution has resulted in a new wave of Science Parks in Asian Countries. Zhongguancun Science Park (ZSP) is the pioneer of Chinese Science Parks, with a 12-year history. This paper uses a SWOT analysis to study ZSP. First, we identified 7 key factors for a successful Science Park. In terms of these 7 factors, we analyze strengths, weaknesses, opportunities, and threats of ZSP, and put forward policy recommendations. Finally, the paper summarizes the experiences and lessons of ZSP, pointing out that: (1) a special trading stage that ZSP went through during the market transformation process; (2) Abundant high-tech personnel and vast domestic market are the most important factors supporting the development of ZSP; (3) An imperfect market system as the principal obstacle; (4) The main role of Science Park in a developing country that is to absorb, digest, and deliver the global advanced technology.

I. Introduction

Since the first Science Park[1] was created on the campus of Stanford University more than 40 years ago, Science Parks have been founded in many parts of the world. At the beginning of the 1980s, Asian governments began to construct Science Parks, such as Hsinchu Science-based Industrial Park and Singapore Science Park. Zhongguancun Science Park (ZSP) was established in May 1988.[2] It is the first and also the largest Science Park in China.[3]

In response to the demands of Information Technology (IT), and to retain the country's competitive edge, there has been an upsurge of Science Parks in Asian countries. Malaysia made by far the most ambitious commitment to providing the infrastructure for high-tech service industries by developing its Multimedia Super Corridor (MSC)[4] in 1996. Hong Kong government aims to make the territory an Asian high-tech hub by promoting grand projects such as the $13 billion Cyberport

information technology park and Silicon Harbour, a $1.2 billion semiconductor complex (Saywell, 1999). Singapore launched Asia's most advanced physical infrastructure — Singapore One in 1998.

Over the past two decades, China has achieved consistently high growth rates of well over 8 percent in GDP and the market system is improving. However, the need to upgrade the industrial structure and technology level, enhance competitive advantages, and sustain higher economic growth rate are important challenges for the Chinese government. Recognizing that high and new technology will be the future-enabling tool to increase the efficiency, productivity and competitiveness of the economy, the government has focused on creating Science Parks to foster high technology. Under the domestic demands and international background, Beijing Municipal Government put forward a new plan for Zhongguancun Science Park in 1999,[5] and plans to invest over 200 billion yuan (about US$ 24 billion) in Zhongguancun in the coming ten years.

As the first Science Park established in China, ZSP has developed over the past 12 years. Being the symbol of Chinese high technology, ZSP undertakes the task to absorb and deliver global advanced technology, foster emerging industries, and play a demonstration role to other domestic Science Parks. Thus, it is necessary to study ZSP's strengths, weaknesses, opportunities and threats, summarize its experiences and lessons, and probe into its prospects. The experiences and lessons have relevance not only to Chinese Science Parks, but also to Asian Science Parks in general.

II. Background: Development of ZSP

Zhongguancun is the name of a place in the Haidian District, northwest of Beijing, but currently the name connotes a high-tech Science Park similar to the Silicon Valley in the U.S. Since May 1988 when the State Council approved to establish Haidian Experimental Zone for the development of high and new technology, Zhongguancun has grown up from an "Electronic Street"[6] to a leading Science Park in China. The developmental history of ZSP is shown in Table 1.

Table 1. Chronology of ZSP

1980 October	Chen Chunxian founded the first non-state high-tech corporation, the Advanced Technology Development Service, in Zhongguancun
1983-1984	The four pioneer corporations of Zhongguancun, viz. Kehai Corporation, Jinghai Corporation, Stone Corporation, and Xintong Corporation were established successively
1985	Legend Group was founded in Zhongguancun
1988 May	The State Council approved to establish Beijing Experimental Zone (Haidian Experimental Zone was established)
1988 May	Beijing Municipal Government issued "Beijing Experimental Zone Temporal Regulation"
1991	Beijing Shangdi Information Industry Base was set up. It was the first incubator in ZSP
1992	Fengtai Science & Technology Park and Changping Science & Technology Park were established
1994	ZSP took shape as one zone including some Parks
1997	ZSP sponsored the First Annual Zhongguancun Computer Fair
1997 September	ZSP became the first group network member of APEC Science Parks
1998	The Overseas Students Pioneer Park was established
1998 May	ZSP sponsored the Second Annual Zhongguancun Computer Fair
1999 May	Beijing Municipal Government put forward the new plan on ZSP
1999 June	The State Council approved "Request for instruction on actualizing the strategy of flourishing country by science and education, and accelerating the construction of ZSP"
1999 August	Administration Commission of ZSP was set up
1999 October	The three major companies, Beijing Science Park Construction Co Ltd, Beijing Science Park Bidding Co Ltd, and Beijing Zhongguancun Science Guarantee Co Ltd were established to hasten the construction of ZSP

Relying on abundant human resources, domestic advanced technology, and convenient infrastructures, etc., ZSP has become a leading domestic Science Park.

In the past ten years, ZSP has gained over 30% annual economic growth rate. In 1999, its total revenue including technology, industry, and trade amounted to 637.32 hundred million yuan (about US$7.68 billion); Gross Domestic Product (GDP) reached 181.71 hundred million yuan (US$2.19 billion). These were 41.1% and 26.7% more than those of the previous year respectively. The detailed figures are shown in Table 2.

Table 2. Economic Growth Rate of ZSP

(100 million RMB)

Economic index	1999	1998	Improvement
GDP	181.71	143.38	26.7%
Total revenue of technology, industry, and trade	637.32	451.66	41.1%
Industrial output (Current Price)	385.20	220.21	74.9%
Industrial output (1990 Consistent Prices)	468.40	305.69	53.2%
Taxes and surcharges	20.11	15.76	27.6%

Source: *Beijing Experimental Zone News*, 15 January 2000.

ZSP's industry structure is as follows: electronic information industry accounts for 68.2%; optics-machinery-electronics integration industry takes up 10.1%; new materials, new energy and environmental protection industries constitute 11.5%; bioengineering and new medicine industries make up some 8.8%; and the others' share is 1.4%. IT industries of ZSP hold a big domestic market share. The sale volumes of hardware, software and IT service took up 5.5%, 40.0%, and 46.9% respectively of the total in China in 1997.[7]

At present, there are more than 6,000 new technology enterprises in ZSP. There are 7 top enterprises with total revenue over ten hundred million yuan (about US$1.2 hundred million), and 60 enterprises with its total revenues exceeding one hundred million yuan (about US$ 12 million), as well as 52 enterprises, whose tax payments surpassed 5 million yuan (about US$ 0.6 million).[8] For example, Stone Group Corporation, Legend Group Corporation, BD Founder Group, Qinghua Violet Group and China Daheng Corporation are very well known in China, and some of them have grown into transnational companies. A considerable number of high-tech products have gained strengths in international competition. For example, PCs manufactured by Legend Group Corporation and BD Founder Group have acquired a substantial share of

the fiercely competitive computer market in China. Legend's microcomputers have been exported to the United States since 1997.

In 1990, the Chinese government opened the domestic PC market. In 1998, there were over 1,100 joint ventures, cooperative ventures, and wholly foreign-owned enterprises in ZSP, accounting for approximately 20% of the total number of the enterprises. The total value of investment by overseas enterprises reached more than US$1.64 billion. The foreign-invested enterprises dominated the IT industry in China, especially in PC manufacturing and software. The output value of the foreign-invested enterprises took up 81.2% of the total output value of the hardware enterprises in China. In the software market, US firms have long dominated. However, with the growing capital, technology, and managerial experience, the competitiveness of the Chinese enterprises in ZSP is increasing.

By following global advanced technologies, ZSP has promoted the technological transformation and structural readjustment of traditional industries. To date, the new technology enterprises in ZSP have established, in different parts of China, more than 400 branches and have also developed diversified collaborative relations with over 600 traditional enterprises, with annual transfer of hundreds of technological achievements.

III. SWOT Analysis for ZSP

SWOT (strengths, weaknesses, opportunities, and threats) analysis is one of the most effective tools to assess the strategic situation and identify strategic options for organisations or firms. A strength is a resource that the organisation can use effectively to achieve its objectives. A weakness is a limitation, fault, or defect in the organisation that will keep it from achieving its objectives. An opportunity is any favourable situation in the organisation's environment. And a threat is any unfavourable situation in the organization's environment that is potentially damaging to its strategy (Rowe, 1994). In this section, we use SWOT to analyse the characteristics of Zhongguancun, and put forward policy recommendations.

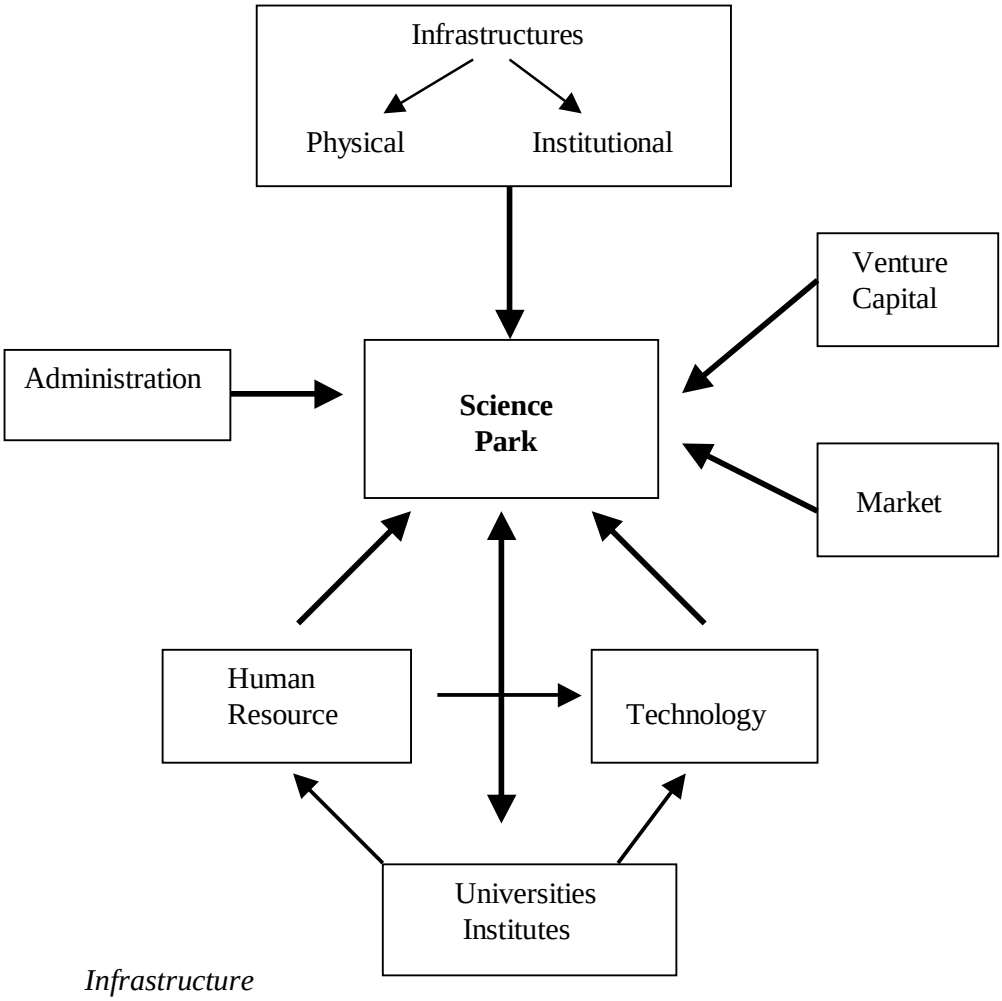
1. Key Factors for a Successful Science Park

A Science Park is a kind of special industry park. According to a popular definition given by the United Kingdom Science Park Association, "a science park is a property-

based initiative, which has formal operational links with a university or other higher educational or research institution; designed to encourage the formation and growth of knowledge-based business and other organizations on site; has a management function, which is actively engaged in the transfer of technology and business skills to the organizations on site". [9]

Many factors may influence the success and efficiency of a Science Park. On the basis of the above definition of Science Park, and combining the experiences of many Science Parks in the world, we choose seven factors as the criteria for analysis (see Figure1).

Figure 1. Key Factors Impacting a Science Park



Infrastructure

Infrastructure includes physical infrastructure and institutional infrastructure.

Physical infrastructure consists of transportation, telecommunications, real estate, etc. Convenient transportation and cheap real estate are important conditions; however, IT infrastructures are especially important because of the nature of high-tech industry.

Institutional infrastructure mainly consists of the policy environment and the legal environment. They are important external environments influencing Science Parks, particularly in Asian Countries. Most Science Parks in Asia are initiated by governments; so preferential policy plays a role to attract high-tech personnel, domestic and foreign capital, and enterprises. Because of institutional shortcomings, some developing countries must improve their legal system to protect and promote the development of high technologies. In the field of IT, proprietary knowledge is often a company's main business asset. In such cases, laws relating to intellectual property rights are critical.

Human resource and technology

Because "encouraging the formation and the growth of knowledge-based business and other organizations" is the object of the Science Park, human resource and technology will play key role in the development of Science Parks.

As is generally recognized, a pool of highly skilled, richly experienced, and well-rewarded personnel from home and overseas is one of the most important factors contributing to the development of a Science Park (Chin Chung, 1996). It is true for the U.S., where numerous American-trained Asian engineers and programmers work in the Silicon Valley, and have enhanced greatly its competitiveness in the PC and semiconductor industries.

High and new technologies such as IT technology, biotech, and new material and energy technology are main technologies promoted by most Science Parks. The technological level directly influences the development of Science Park.

Universities and Institutes

The experiences of successful Science Parks show that they are linked to premier science or engineering universities. Within the U.S., notable developments are centred around Boston, Stanford, and the North Carolina Research Triangle Park. Invariably, they are linked to premier science or engineering universities like Boston's MIT and California's Stanford University (Robert Chia & Wong, 1989). By providing not only abundant personnel, but also innovative technologies, universities or institutes spur the development of Science Park. Thus, the interaction between universities and high-tech enterprises enhances the educational and technological level of the entire Science Park.

Venture capital

In terms of the experience of successful Science Parks, such as Silicon Valley, venture capital is a very important factor to support a Science Park. Venture capital is an intermediate external investment in small-and-medium-sized companies, that offers the prospect of above-average earnings growth coupled with above-average levels of investment risk. Typically, venture capital is aimed at new technologies or innovative products in microelectronics, computers and biotechnology. Besides capital, some venture capitalists also contribute time and expertise needed to help set up their investee companies, as well as assist in the commercialization and marketing of these firms' innovative products. As such, venture capital is, in many cases, a partnership that combines financial, marketing, technical and managerial expertise of the investor and the entrepreneur. The investment process consists of raising a fund, then screening, selecting, structuring and monitoring investments. Finally, the investment must be sold ("realized") and the capital repaid to investors.

Market

On the one hand, a mature market can spur technology and absorb the products of high-tech, such as the US domestic market. On the other hand, advanced technology could widen the market, for example, the Chinese market has great potential which is influenced by improving technology. Generally speaking, without a large or potential

market, a Science Park is difficult to boom.

Administrative institution

A Science Park usually has a management function that is actively engaged in the transfer of technology and business skills to organizations on site. An effective administration can aid the development of a Science Park.

2. Strengths of ZSP

According to the key factors stated above, the main strengths of ZSP are as follows:

Superior physical infrastructure in China

As the capital of China, Beijing boasts the most advanced infrastructure facilities. It is the transportation hub of railway and aviation in China. The airport expressway stretches from Capital International Airport to the downtown area. Beijing has nearly 12,000 kilometers of standard urban-rural roads. The Second Ring Road, with three lanes each way, goes round Beijing Old City area. The Third Ring Road, which goes through the Embassy Area in the east, many famous universities and colleges in the north, and Beijing West Railway Station in the west, is a vital communications line. Traffic can move smoothly along the Fourth Ring Road. Beijing is also a central point for international post and telecommunications. International calls can be made to more than 200 countries and regions. Direct mail service has been established with 207 cities in more than 127 countries and regions worldwide.

Besides the advantages of Beijing municipal infrastructure, the information infrastructure in ZSP is one of the best in China. The construction of a fiber optic network which started in 1998, will provide broadband connections to offices and homes. With more than 12 million users, Cable TV can provide broadband multimedia service to homes too. In ZSP, the Computer and Communication Network System of Beijing Experimental Zone has been built to implement the management modernization of the experimental zone government. The websites, www.zgcpark.com, www.zgcscience.com and expert.zhongguancun.com.cn, let businesses and universities

in the park share information on research achievements, market demands, and is accessible to a large pool of experts in Beijing.

In order to carry out the new plan of ZSP, its infrastructure is being improved further. West Zhongguancun Zone, that covers an area of 51.44 hectares, is being reconstructed. As a high-tech commercial center, the zone will be divided according to different functions: finance, science, technology and trade, administrative offices, culture and recreation, etc. To ensure the increasing demand for telecommunication, a new telephone station handling 60,000 telephones will be built. Apart from telephone service, the new post office will provide other communication services such as ISDN, DDN, Internet, conference television, multimedia visual broadcasting, distant medical treatment.[10]

Preferential policies and improving legal environment

In order to develop the high-tech experimental zone, Beijing Municipal Government issued "Beijing Municipal Government Temporal Rule" in May 1988, which is the foundation of policy incentives for high-tech enterprises and science parks. After the new plan on ZSP was put forward in 1999, more preferential policies have been announced. These incentives can be summarized as follows:

(1) Preferential policies on tax

- The income tax of a new technology enterprise shall be levied at a reduced rate of 15%. If output value of its exports amounts to 40%, or more than 40% of its total output value of the year, the income tax shall be levied at a reduced rate of 10%.
- The new technological enterprises shall be exempted from income tax within 3 years of the date of its establishment. From the fourth to sixth year, its income tax rate may be reduced by half on the basis of the rates specified before.[11]
- Since 1999, if a project realizes the achievement of high and new technology, the local income of income tax within 3 years of the date of its first sale will be returned to the enterprise.
- Since 1999, increased local income of income tax within 4 years will be returned to high and new technological enterprises which have operated for 10 years in a new technology experimental zone, on the basis of the last year.

- The increased local income of income tax of key high and new technological enterprises recognised by government or high and new technological enterprises, whose sale income of new product amounts to 40%, or more than 40% of its total sale income, will be returned on the basis of the last year.
- Since 1999, the increased local income of income tax with 3 years will be returned to software enterprises or system integration enterprises on the basis of the last year.[12]

(2) Preferential policies on import and export

- Upon approval by the Customs, bonded warehouses and bonded factories may be set up in experimental zones. The export products shall be exempted from export duties.
- The imported raw and processed materials and spare parts for export shall be exempted from import duties.

(3) Other financial Incentives

Besides preferential taxes, there are other financial incentives to support ZSP or high and new technology enterprises. For example:

- Beijing Municipal Government has set up a "Technology Innovation Fund" to support high and new technology enterprises. The fund will be invested in market research, project exploitation, venture capital, and loan guarantee.
- High and new technology enterprises that have completed stock company reorganization can apply to issue stocks and bonds without limitation on rating or scale.[13]
- Enterprises in ZSP can open foreign exchange account on current account.[14]
- Reward for intermediaries who help Haidian District attract foreign funds to invest in programs as high and new technology enterprises, commercial consultation services, health, education and information program, etc.[15]

(4) Non-financial Incentives

- Since 1988, researchers and professors in institutes or universities have been encouraged to have a part-time job or to find a job in high and new technology enterprises, or set up their own enterprises.
- Qualified personnel inducted from other places in the country by high and new technology enterprises can get "Beijing employment resident card."[16]

Besides policy incentives, the development of a Science Park needs legal protection. Because the convergence of high and new technology has led to the emergence of new industries, products and services, traditional laws cannot match the information age. In order to protect and promote high and new technology, in particular the IT industry, and provide an effective legal environment, the Chinese government has issued certain laws and regulations. A legal framework that includes a copyright law, computer software and Internet laws, and intellectual property laws has been formed in China.

The Copyright Law was promulgated on September 7, 1990. It grants the creator the exclusive right to reproduce, prepare derivative works, distribute, perform and display the work publicly. As a supplement to the Copyright Law, some regulations and provisions were issued in succession. They include the following:

- Regulations for the Implementation of the Copyright Law (Promulgated May 30, 1991, Effective June 1, 1991)
- Provisions on the Implementation of the International Copyright Treaties (September 30,1992)
- Resolution of the Standing Committee of the National People's Congress on Punishing the Crimes of Copyright Infringement (July 5, 1994)
- Regulations on the Administration of Audio-Visual Products (August 25, 1994).

China has three main computer software and Internet laws. The first is Regulations for the Protection of Computer Software, promulgated on June 4, 1991. This aims to protect the rights and interests of creators of computer software, to adjust the relationships of interest during the development, dissemination and use of computer software, and to encourage the development and circulation of computer software. In these regulations the software copyright holders has the right of publication, developer's right of authorship, the right of licensing use and receiving remuneration, and the right of transfer. The second is Revised Provisional Regulations Governing the Management of Chinese Computer Information Networks Connected to International Networks, which was originally promulgated on February 1, 1996 and revised by the State Council on May 20, 1997. These regulations are formulated to strengthen the management of computer information networks connected to international networks and safeguard the

healthy development of the international computer information exchange. The third is Computer Information Network and Internet Security, Protection and Management Regulations, which was promulgated by the Ministry of Public Security on December 30, 1997. These regulations have been established on the basis of the "PRC Computer Information Network Protection Regulations", the "PRC Temporary Regulations on Computer Information Networks and the Internet" and other laws and administrative regulations.

Besides the laws mentioned above, other intellectual property laws include Patent Law (September, 1992), Trademark Law (February, 1993), Intellectual Property Protection in China (June 1994), and Action Plan for Effective Protection and Enforcement of Intellectual Property Rights (February, 1995).

In December 1999, China's national legislature, The Standing Committee of the National People's Congress, amended its Corporate Law to soften the terms for the fund-thirsty high-tech enterprises to go public.[17]

Knowledge-intensive zone

Zhongguancun is the knowledge-intensive center in China. There are 68 key universities and colleges in this area, such as Qinghua University and Beijing University, and 213 scientific research institutes including Chinese Academy of Sciences. The academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering in ZSP constitute 36% of the all academicians in China.[18] All first generation entrepreneurs and engineers of Legend Group Corporation, BD Founder Group, and Qinghua Violet Group came from the Institute of Computer (Chinese Academy of Sciences), Beijing University, and Qinghua University, respectively. These institutes and universities have directly participated in producing, spreading and applying knowledge and technology in ZSP. At the same time, enterprises have offered research funding for these institutes and universities.

Abundant human resources and relatively advanced technology

Education in Haidian District is rather advanced and exerts considerable influence in Beijing and China. Its basic education is ahead of the whole country.

Haidian District has realized the nine-year compulsory education and aims to eliminate illiteracy among young and middle-age people. Sixty-eight universities and colleges produce high quality graduates for ZSP every year. Among a population of 1.46 million long-term residents in Haidian District, 360,000 have received higher education, i.e., 25% of the district's total population.[19] Thus, ZSP not only has an abundant educated labor force but also high quality personnel. Among the 135,297 people working in ZSP at the end of 1997, more than 55% had university degrees, with 35.7% having Bachelor's degrees, 19.3% having Master's degrees or Ph.D. degrees. Some 19.3% of the work force graduated from junior colleges and 11.8% from vocational schools.[20]

Universities and Institutes, in particular prestigious Qinghua University, Beijing University, and Chinese Academy of Science, provide new and high technologies in ZSP. Large numbers of engineers, entrepreneurs, and new technologists come from the Universities or Institutes in Zhongguancun. For example, Wang Xuan, who invented a computerized typesetting and printing system (that made considerable profits for Founder Group), was a professor of Beijing University. Now, University Pioneer Parks are being encouraged in ZSP. Those such as Qinghua Pioneer Park and Beijing University Biology City will facilitate transfer of research achievements and technology innovation.

New technology enterprises in ZSP have employees with a keen sense of technical innovation also, and are enthusiastic about innovative activities. Of all the employees of Zhongguancun, 24% are engaged in R&D activities. The funds used for such activities account for 5.8% of the annual gross revenue of ZSP, which is far higher than other areas in China. Among technological products of ZSP, more than 2,200 new technologies and new products have been turned into commercial use, 345 of which have obtained state patents. ZSP has begun to make its mark in terms of intellectual property rights.[21]

Although the high and new technology in the United States is far ahead of the world, ZSP has advantages in indigenous technology and some special areas. For example, the electronic publishing system of Founder Group achieves the highest standard in Chinese characters publishing systems. The key component of the system is Founder's raster image processor with built-in accelerated Chinese characters and

graphics generator processor and the image screening processor. In supporting software and application software areas, some Chinese technologies hold advantages too. Some examples are spread sheets, accounting software, word processors, desk-top publishing, CAD/CAM, Chinese operation system, anti-virus cards, and so on.

Vast domestic market

Stable economic growth and a large population make China a prominent market in the world. The vast domestic market has played a key role in supporting the high-tech industries. Compared to leading technologies in the world, the Chinese new and high technological level still falls behind. However, by developing technologies that fit in with the demands of domestic market, the Chinese high-tech industries have survived and are robust.

The high and new technology, specially IT technology, is not only expanding rapidly as an independent industry, but also penetrating into every sector of the country's economy. In doing so the products of high and new technology have a huge market in China. Because IT industry takes the lead in ZSP, we shall mainly focus on the IT market in this paper.

Expanding rapidly from its humble beginnings, the Chinese computer market has grown tremendously over the past two decades. During the 1991-1997 period, the rate for sales volume jumped by more than 40% every year.[22] As the overall economic growth rate decreased in 1998, the growth rate of computer sales slowed down to 13.8% (see Table 3). In 1999, the total sales volume of PCs was estimated at 170 billion yuan (about US$ 20 billion), an increase of 14.9% from last year. In 2000, the figure is expected to increase by 17.6% to reach 200 billion yuan (about US$ 24 billion).[23]

Table 3. Total Sales and Increase of Computer Market in China (1996-1998)

	1996	1997	1998
Total sales(hundred million US$)	110.8	156.6	178.3
Increase(%)	49.6	41.3	13.8

Source: China Software Industrial Association (1998), "Chinese Software Industry and Market".

Results of a survey show that Chinese urban families now possess some 4.2 million PCs, with an average possession rate of 4%. In major cities such as Beijing, Shanghai, Guangzhou, and Shenzhen, the rate reaches or even exceeds 10%, but in the vast rural areas where nearly 80% of the population live, the rate is almost zero.[24] In other words, there is still an enormous potential in the urban market, while the vast rural market is almost untapped.

The software market is growing at a rapid pace, along with the Chinese PC market. The total Chinese software market is growing by 20-30 percent per year. With increased enforcement of copyright laws after 1992, legal sales have improved. In 1998 the rate of increase of software and information service was 23.2% and 26.4% respectively, which is higher than the 13.8% rise in the computer market (details are shown in Table 4). It means the importance of software and information services is growing in the IT market.

Table 4. Software and Information Services Market in China (1996-1998)

		1996	1997	1998
Software	Total sales (hundred million US$)	11.1	13.5	16.8
	Increase(%)	35.3	21.7	23.2
Information Services	Total sales (hundred million US$)	13.6	17.8	22.5
	Increase(%)	46.8	31	26.4
	Total sales (hundred million US$)	24.7	31.3	39.2
	Increase(%)	41.4	26.8	25

Source: China Software Industrial Association (1998), "Chinese Software Industry and Market".

The software market is predicted to create a 20 billion-plus yuan (about US$ 2.4 billion) demand in 2000. Application software will occupy 60% of the market while systems software will clinch 10%, leaving the remaining 30% to supporting software.

Beijing is China's largest market for technologies and electronic information products with a good market build-up effect. Many enterprises in Zhongguancun are known for good quality products and their scientific and technological products are

reputable in the market. The famous "Electronic Street" in Zhongguancun is the largest collection and distributing center of electronic products in northern China. The software sales of ZSP constituted 40% of the total sales in the whole country in 1997 and 43% in 1998.

In the 1980s, the Chinese government kept foreign companies from directly selling and serving their products in China; instead, they had to use Chinese agents and distributors. A considerable number of enterprises in Zhongguancun took advantage of the opportunity and established a nation-wide network for sales and service. With the aid of the sales profit and sales network, some enterprises made their own brand-name products and captured a growing market. For example, through selling many PCs made by AST, the U.S. brand that was finally brought by Korea's Samsung, Legend Group accumulated income to design and manufacture Legend's own brand-name PCs. Now, Legend PCs are the best-selling machines in China. Legend Group sold 1.25 million PCs in 1999, an increase of 80 percent from 1998. Its total PC sales volume occupied 8.5 percent of the Asia Pacific market (excluding Japan), and ranked first.

Some enterprises in Zhongguancun hold dominant market shares by employing special or advanced technology. For instance, with the advanced electronic publishing system, Founder Group dominates more than 80% of the market on the Chinese characters press and printing industries at home and abroad; and has become the largest software developer and system supplier of Chinese electronic publishing system in the world. Jiangmin New Technology Co. Ltd. sells KV series anti-virus tools written by Wang Jiangmin. The KV 300 killer software package has sold one million units, holding an 80% market share in China. The accounting programme of User Friend Group holds the largest market share of accounting programme in China.[25]

The computer information service market in China consists of systems integration (83%), network service (8%), special service (8%), and database (1%). Among the top 9 systems integration suppliers, 8 suppliers are in Zhongguancun; they are Legend, Founder, Taiji, Nantian, Huasheng, changcheng, Chinese Software, and Yaxin.[26] Internet services and e-business also have good prospects in China. The Chinese government revealed that the number of registered users in China quadrupled

in 1999 to nearly 9 million. However, the actual number of users is difficult to gauge because many Chinese users share accounts to offset high line fees and other costs.[27]

Benefiting from the growing domestic market, the "Electronic Street" has become a leading Science Park in China. The first generation enterprises in Zhongguancun accumulated capital through trading, and until now trade is one of the important functions of Zhongguancun.

Effective Administration Commission of ZSP

Administration Commission of ZSP (ACZ) has 8 departments; they are office, development department, international cooperation department, information department, statistics department, research office, regulation coordination department, and personnel department. Services include planning, investment service, labour management, business service, and environmental protection. In recent years, ACZ has played an active role in the development of Zhongguancun.

For example, in order to expand the channel for fund-starved enterprises to develop new technology, the ACZ holds meetings to recommend and introduce new technology twice a year. At the meeting, enterprises introduce their projects to financial organizations to get supporting funds. Since the end of 1998, two sessions of recommendation and introduction have been held, which were attended by 58 enterprises and 113 financial organizations. At these meetings the enterprises obtained a loan of 40.1 million yuan (US$ 4.8 million). In addition, the ACZ has signed a "Financial Cooperation Agreement" with Bank of China, Beijing City Branch, which provides a loan of 3 billion yuan (US$ 360 million) to support the development of enterprises in ZSP.

3. Weaknesses of ZSP

Although ZSP has been around for more than 12 years, establishing a Science Park in China is still problematic. As a developing country, the overall economic strength and technological level in China is behind developed countries, and the market system, which is being constructed and improved, is immature. Differences in regulatory, legal, and institutional arrangements still have an impact on the development of high

technology. Therefore the ZSP cannot be a world-class Science Park at present. Compared to other Science Parks in the world, the major weaknesses of ZSP are as follows:

Relatively less-developed IT infrastructure

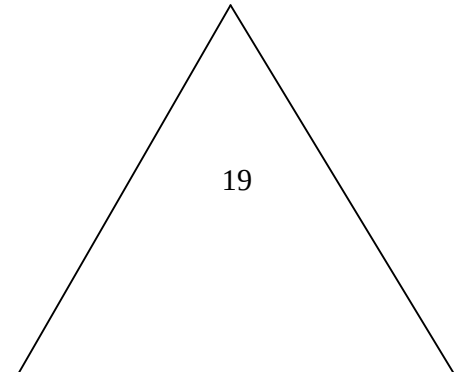
Beijing Municipal has speeded up the construction of IT infrastructure, but it is still behind many other Science Parks in Asia. The high-speed fiber optic network with ATM has not yet been completed. For individual dial-up subscribers, the slow speed and high fees are an impediment to Internet access. Comparatively, some Asian Science Parks have been quicker in building IT infrastructure. For instance, the Singapore One broadband network, launched in 1998, brings fast digital transmission capacity to homes and offices, allowing delivery of rich multimedia services, such as video on demand (Bickers, 1999).

Opening the gates of the domestic telecommunication industry is a shortcut to improve IT infrastructure and cut telecoms price. Hong Kong liberalized its telecoms industry relatively quickly in Asia, and Singapore opened its local telecoms market on April 1, 2000.[28] Because Chinese telecoms industry is too immature, the Chinese government is in a dilemma as to whether to liberalize the domestic telecoms market.

Lack of high-quality personnel in some fields

Although ZSP has an abundant educated workforce, creative personnel are lacking in certain fields for two reasons: on the one hand, the educational system in China does not emphasize creative thinking and problem-solving skills; on the other hand, the fostering mechanism for innovation is imperfect in ZSP. For example, share options, a much-discussed factor in Silicon Valley's success, is difficult to apply in ZSP because there is no legal framework for the formation and operation of stock option plans (Lo, 2000). Besides creative personnel and seasoned professionals with in-depth entrepreneurial, management, financial and investment experience are also in shortage.

Figure 2. PC Technological Ladder in the World



Lack of global advanced technology

The distribution of global high technology now looks like a pyramid (see Figure 2). For example, in the IT industry, the U.S. is in the global leading position with most advanced technologies, especially systems software and special chip design. Japan and the EU follow closely, having taken over most of the key component markets. Lower down the value chain, Taiwan, South Korea and Singapore are now assuming the role of prominent hardware manufacturers and ODM (Original Design Manufacturer) and OEM (Original Equipment Manufacturer) subcontractors, that are capable of replenishing new peripherals and devices as the market progresses. At the bottom of the global production network stand China, the remaining ASEAN countries, and a host of other developing countries that are targetted for production redeployment by first-tier, second-tier, and third-tier PC firms. Such transplants presently consist of standardized peripheral, low-end PC hardware, and some application software designs.

The global situation described above influenced the technological pattern in ZSP. Foreign enterprises, in particular transnational corporations, utilize the core technologies in hardware and software, importing most PC's key components, such as microprocessing chips, central processing units and hard disks, IT manufacturers in ZSP take the role of assemblers, and their profit margin is small. China almost totally relies on the US in the areas of fundamental software or system software (like operating

systems, database management systems); Chinese firms mainly provide Chinese platform for US products. Only in some areas, such as Chinese-language word processing and desktop publishing software and some application software, have Chinese companies took a commanding lead.

Scarcity of venture capital

Although Chinese venture capital is burgeoning, both venture capital and venture capitalists are still a scarcity. According to the statistics given by Chinese Science Technology Finance Association in July 1999, there are 92 trust companies, guarantee funds and co-operatives in China, which call themselves venture capital investors. They have altogether about 7.4 billion yuan (US$ 891 million) in funds at their disposal (beside foreign venture capital). But the venture capital funds are less than 1 billion yuan (US$ 120 million).[29] China launched its first venture capital investment company China Venturetech Investment Corporation in 1986, but it became bankrupt in 1998 as a result of rampant investment amid an off-track venture capital market.[30] Some venture capital corporations were established recently, such as Beijing Venture Capital Co., Ltd., which was founded in October, 1998 after the authorization of Beijing Municipal Government, with a registered capital of 50 million yuan (US$ 6 million).

In the 1980s, few venture capitalists supported the development of new high-tech enterprises in ZSP. Most enterprises were financed by themselves. With connection to universities or institutes, some enterprises got seed capital from them, such as Legend Group and Founder Group, which then accumulated capital by trading and manufacturing. For small and middle size enterprises, personal funds played the role of seed capital. Recently, some high-tech enterprises begin to get venture capital from the government or foreign venture capital corporations. For example, Stone Rich Sight obtained international venture capital in late 1997.

Some factors hinder the development of venture capital in China. The first shortcoming is a lack of worthwhile projects to invest. Although in some areas China has world-leading technologies, the overall technological level is low. First-class technological innovations are in shortage. Without abundance of new and high

technologies, venture capital cannot take root. The second question mark is the imperfect financial and legal system. There is no second board stock market such as NASDAQ to let venture capitalists harvest the fruits of their investments. Venture Capital Law and Investment Law are still lacking in this regard. The third obstacle is a shortage of venture capitalists. Beyond funding start-ups, venture capitalists should size up new technologies and applications, and then nurture them through the difficult early years as small businesses.

At present, a large share of Chinese venture capital funds comes from the government. For instance, the Beijing Municipal Government now manages five venture capital companies, with a total fund of 1.1 billion RMB (US$132.5 million).[31] Because venture capital investment is a market undertaking, the government should turn over management of the funds to the private sector. Therefore, it needs to foster Chinese venture capitalists immediately.

4. Opportunities of ZSP

Technological leapfrogging

Soete (1985) pointed out that developing countries with adequate industrial infrastructure and skill levels may benefit from the "windows of opportunity" provided by a new technological paradigm, especially at an early stage of diffusion, when barriers to entry are relatively low and markets are in a state of upheaval. The current technological innovation is providing such an opportunity for China.

Recent developments in digital technology and the widespread use of the Internet have brought about a rapid convergence between computer, communications, and consumer electronics products, thereby redirecting the global IT industry toward a multimedia and network-centric age. The current global structure of technology and production is entering a new phase of change. The U.S. has a winning edge in telecommunications technologies, network technologies, etc.; Japan is likely to remain dominant in the realm of consumer electronics. While the first two tier countries upgrade their technologies, the third-tier countries, including Taiwan and other NIEs are attempting a strong entry into the key components and system software segments of the industry (Chin Chung, 1996). These developments give China an opportunity to

upgrade its information technology. China can surpass its present status as a "assembler" of PC products to become a prominent hardware manufacturer with ODM and OEM capability.

Following the global advanced technologies and "indigenizing" them is an important road to upgrade technology in ZSP. On the one hand, transnational corporations from overseas, investing R&D activities in ZSP, can bring in new technologies and train indigenous qualified personnel. Following IBM's establishment of an R&D center in ZSP on September 21, 1996, a substantial number of famous transnational corporations such as Northern Telecom, SUN, Nokia, Microsoft, etc. have established R&D centers in Beijing.[32]

On the other hand, some large firms based in ZSP have located their R&D activities abroad, to follow the advanced technologies in the world. For example, Legend Group has established three R&D institutes separately in Silicon Valley, Hong Kong and Beijing. The R&D Center in Silicon Valley collects information and follows new technologies, makes market forecasts, and passes the information back to Hong Kong R&D Center. The Hong Kong R&D Center demonstrates the implementing conditions of new technologies and its market prospects. Finally, specialists and engineers in Beijing R&D Center exploit the selected new technologies for production. These R&D Centers help Legend Group keep pace with the advanced technologies in the world.

Reforming education and "reverse brain drain"

Chinese educators have taken note of the problem in the educational system, and education reform, beginning from primary school, is in progress. Meanwhile, China is working on a programme to make information technology an obligatory course for secondary and primary school students in the first decade of the new century. According to a strategy for IT education put forward by the Ministry for Education, the program is to be carried out in three steps: mainly popularization and application of computer multimedia technology in schools during the first step; organizing schools to go online to make use of the resources on the Internet during the second step; and opening of distance education during the third step.[33]

For promoting an active university-industry interaction and nurturing innovative personnel, some University Incubators have been established. Qinghua University holds a "Pioneer Contest" every year to select innovation achievements that will be incubated in Qinghua Pioneer Park. This action inspires creative personnel and achievements in the university.

While waiting for a new generation of creative thinkers and seasoned professionals to come up, the "reverse brain drain", the return of students and entrepreneurs who had been educated in US and elsewhere, has become an important source of top-notch professionals in ZSP. These "returnees" have the experience and the technology to really help ZSP lift itself up by its own bootstraps. With tens of thousands of Chinese now working in Silicon Valley and other US high-tech centers, the potential boost for ZSP through reverse brain drain is huge. A set of policies encouraging overseas students to start their own enterprises in Zhongguancun has been adopted. For example, the Overseas Students Pioneer Park was established in 1998, and a special office of ZSP will be set up in Silicon Valley to attract "reverse brain drain".

Foreign venture capital

A growing number of foreign venture capitalists showed interest to invest in Chinese high-tech enterprises, especially Zhongguancun, in recent years. According to the "IT Manager World", there are about US$300 million worth of foreign venture capital funds in China. More and more high-tech enterprises in Zhongguancun, such as Stone Rich Sight, Sina, and Chinanet, etc., have received foreign venture capital. Foreign venture capital cannot only give fund-starved start-ups access to funds, but also can help them improve management and business operations.

5. Threats to ZSP

Relatively weak Infrastructure compared to some Science Parks

When ZSP was established as a Science Park in 1988, there was no construction planning for the entire park. Physical infrastructure has been improved gradually in the developing process. But some new Science Parks in China or other developing countries draw construction experiences from successful Science Parks, and have superior infrastructure for high-tech enterprises. For example, the MSC put forward excellent infrastructure for the park to absorb foreign high-tech enterprises. Besides a human-friendly working and living environment, the MSC is supported by advanced IT infrastructures. In the MSC, a 2.5 to 10 Gbs optic fiber backbone with ATM-based switches will be able to handle all kinds of multimedia (voice, data and video) communication traffic. There will be direct high-capacity fiber links to Japan, US, Europe and SE Asia; a 100% digital open multimedia network for seamless international interconnection. Now the MSC backbone network and MSC connectivity to national network have been completed.[34]

Regarding policy incentives, some Science Parks have more favourable terms. The package of financial incentives offered in the MSC is substantial, with zero income tax for up to 10 years, or a 100-percent Investment Tax Allowance. Additionally, no duties will be levied on the import of multimedia equipment (Mahathir, 1998). As a Science Park in a developing country, the MSC has competitive advantages in physical and policy infrastructures.

Competing for high-tech talents

A large pool of well-educated personnel are the most important resource in ZSP, but competing to attract high-tech personnel is very fierce in China. Many cities give preferential policies to draw in personnel. For instance, Shenzhen issues a minimum of 10,000 residency permits, free of charge, each year to degree-holders, while in Beijing these permits are harder to get.

Besides domestic competition for talents, some Asian countries or places, such as Singapore and Hong Kong, are recruiting high-tech brains from China. For example, the Hong Kong government plans to introduce a scheme that will allow mainland IT

experts and their families to migrate to Hong Kong free from the quota restrictions that apply to other labor imports (Saywell, 1999).

In addition, managing reverse "brain drain" is hard work. After all, China's still developing infrastructure and imperfect market system serve to discourage students from leaving the developed countries which offer a better standard of working and living conditions.

Technology predicament

The current technological revolution may strengthen the polarization between developed countries and developing countries. Developed countries, headed by America, lead the technological revolution and have huge innovative capabilities; thus developing countries must invest more heavily in tangible capital and intangible capital, i.e. human resource and knowledge relevant to leading technologies. In other words, without abundant capital and solid technological fundamentals, following and catching up with advanced technology is very hard for a developing country.

At the outset, almost all enterprises of ZSP were short of capital. Thus, many companies in Zhongguancun specialized in selling electronic products, rather than developing new technology. Therefore R&D is a weakness for ZSP. Although some transnational corporations have established R&D centers in ZSP, most of them focus on indigenizing technology, while core research is done in R&D centers of the parent company overseas.[35] Because of low profit margins, most domestic enterprises in ZSP are financially too weak to support major R&D activities. The funds put in for R&D activities annually accounts for only 5.8% of the gross revenue in Zhongguancun, which is far behind the average 15% in developed country.

Rampant piracy

From the late 1980s, especially since China agreed to the Universal Copyright Convention and the Berne Convention in 1992, the Chinese Government has been engaged in an anti-piracy campaign. The government drafted a series of laws and regulations on copyright protection, and the central government has launched yearly nationwide anti-piracy campaigns since 1994.

Despite the enforcement efforts of the Chinese government, the piracy problem is still serious in China. According to the China Software Association, pirated software accounts for about 80 percent of the China's domestic market. About 25 percent of China's software piracy is the product of large-scale, commercial operations that reproduce CD disks in high-tech factories. The rest is the work of computer manufacturers who illegally load programmes on hard drives before the machines are sold, and individuals who make copies for friends.[36] The piracy problem seriously retards further growth and development of the software industry that occupies a growing share in ZSP.

6. *Policy Recommendation*

China is still in the transformation process from a planned economy to a market-oriented economy. Consequently, its market system and legal system are imperfect, hindering the development of high technology and Science Parks. The government should make an extra effort to construct a superior and liberal market environment, and not intervene or participate in market activity directly. For example, venture capital financing is a market activity. Therefore the role of government is to supply supportive and well-developed legal framework, not managing venture capital corporations. In fact, Shanghai Municipal Government has begun to turn over the management of government venture capital funds to the private sector; it is suggested that Beijing Municipal Government should try to do the same.

Intellectual property forms the core of high-tech enterprises. For many technology start-ups, the very existence and continued viability of such companies depend on an effective intellectual property protection regime (Lo, 2000). Although the Chinese government promulgated a set of laws and regulations to protect intellectual property, the present situation is far from ideal. Piracy, in particular software piracy, is still a serious problem in Zhongguancun. The government should enforce legal action and step up propaganda on the issue. The companies or owners of proprietary products should play more active roles — by giving clues and providing hard evidence — in cooperating with the government on fighting piracy. The computer software producers should be encouraged to lower their prices to encourage the Chinese consumers to buy

original software. For example, the Kingsoft Corporation cut the price of its leading product, Kingsoft 2000, from 168 yuan (US$20) to 28 yuan (US$3.4) per copy since October 23, 1999. The anti-piracy campaign — "Storm of Authentic Edition Software" — proved effective. About 830,000 Kingsoft 2000 units were sold within 55 days.[37] The Kingsoft created a marketing mode suited to Chinese conditions, which is to offer the best product at an affordable price. This is an effective measure to encourage the consumers to use the original software and enhance their awareness of protecting intellectual property.

In order to attract high-tech talents and spur technology innovation, an incentive mechanism for high quality personnel should be established in ZSP. In a developed country, intangible assets are accorded the same status as cash or tangible assets in the capitalization process. There is no rigid limitation on the percentage of total equity of a company that may be in the form of intellectual property. However, in China, Article 24 of the Company Law stipulates that intangible property may constitute no more than 20% of the total initial equity contribution to a company. This limitation should be significantly raised or removed altogether, at least in the case of technology companies, to allow the founders and investors themselves to determine the value of any technology or intellectual property contributing to a start-up. Furthermore, in order to provide the necessary incentive for innovation talents, legislation should be passed to legitimize employee stock option plans and to clearly delineate the ways in which such plans may be adopted by companies in China.

The government should increase R&D investment and incentives in ZSP. Some Science Parks abroad, such as Hsinchu Science-based Industrial Park and MSC, offer government grants for the development of innovative technology.[38] The Administration Commission of ZSP could take similar measures to support technology innovation and high-tech enterprises.

Although ZSP has been developed over 12 years, it is not as well known as the more recent MSC. The Administration Commission of ZSP should speed up the completion of the publicity package and promote ZSP overseas. There are about seven websites introducing Zhongguancun, ZSP or Beijing Experimental Zone on the Internet[39], but six of them are in Chinese language, and only one of them in English but

has limited and dated content. This impedes overseas investors and researchers from identifying and understanding Zhongguancun. This situation must be improved quickly.

IV. Conclusion

Since 1988 ZSP was established as an experimental zone for high and new technology and has gone through two stages. In the first stage, trading was its major business and characteristic. At the outset while the market system was being established and the scientific research system was being reformed ZSP lacked capital and technology. Thus, trading was the only means to accumulate capital and learn technology.[40] On the basis of the capital and technology accumulated in the first stage, some enterprises began to manufacture their own brand PC and they captured increasing parts of the domestic PC market. Thus, IT manufacturing becomes the prominent character of the current stage. Having accumulated a certain amount of capital, technology, and personnel, Zhongguancun now has the capability to enter into the third stage — a real Science Park with relatively advanced technology and an innovative function. In the third stage, Zhongguancun could be a highly competitive national technology innovation base, a vanguard in transforming scientific results into products, as well as a center to train high-calibre personnel.

The experience of ZSP shows that choosing a suitable site for a Science Park is very important. A sufficient standard of physical infrastructure is necessary, but proximity to universities or institutes is also crucial. Many famous universities and institutes concentrated in Zhongguancun provide personnel and technology for the development of ZSP. High-quality and relatively low-cost personnel is the key competitive advantage of ZSP, and that is the main feature distinguishing IT manufacturing in ZSP from a conventional export-processing zone. In some Science Parks in Asian developing countries, such as the MSC, the shortage of high-tech personnel and well-educated workforce is a potentially serious weakness.

The vast and growing domestic market is another key factor for ZSP's success. Even without world-leading technologies, ZSP still maintains over a 30% annual rate of economic growth in the past ten years or more. The huge domestic market is fertile soil to cultivate ZSP. Most Science Parks in Asia don't have this kind of advantage; thus

they must target global markets and face stronger competitive pressure. However, competitive force can sometimes turn into a driving force. For example, IT manufacturing firms of Taiwan optimize productive efficiency and reduce operational costs under competitive pressure. Consequently, Taiwan has become an important IT manufacturing base in the world.

ZSP was established under an imperfect market system. When founded in 1988, besides "18 regulations"[41], there were no superior physical facilities or market or institutional environment. Without capital and advanced technology, most enterprises sold PC and computer parts to foreign PC manufacturers. This means that the starting point of ZSP was generally lower than other Science Park, abroad and the potential of high-tech personnel and research capability in Zhongguancun has not been fully utilized, especially in the initial stage. The trade stage of ZSP is a special outcome of institutional transformation in China; it has no reference to other Science Parks in China or overseas Science Parks.

Generally speaking, a Science Park in a developing country cannot become Silicon Valley, although most governments would like to create one. The success of Silicon Valley results from the convergence of world-class talents (including innovative technological personnel and seasoned management professionals), abundant venture capital, and a relatively perfect and flexible market system. At present, it is difficult for a developing country to satisfy these conditions. To a certain extent, Science Parks in developing countries that engages in IT manufacturing is an upgrade from the traditional export-processing zone or industrial zone. Depending on a low-cost workforce and foreign capital, an export processing zone mainly produce labor-intensive and low value-added products. Now, Science Parks in Asian developing countries are taking advantage of low-cost and well-educated workforce, as well as domestic and overseas capital by manufacturing relatively low value-added PC and peripherals, and are positioned at the downstream of global IT industry. Nevertheless, it is necessary to construct Science Parks in a developing country. Concentrating the limited resources of high-tech personnel and capital, a Science Park in a developing country can still follow and distribute advanced technology, this is the main role of ZSP.

NOTES

1. Many names have been used for science parks, such as research parks, science and technology parks, innovation centers, high and new technology experimental zone, and so on. Despite the slight differences that may exist among these different names, the term "science park" is used in this report to include all these similar parks and zones.
2. In May 1988, Beijing Experimental Zone for high and new technology was founded. It included five zones, namely Haidian Experimental Zone, Fengtai Science and Technology Park, Chinagping Science and Technology Park, Electronic Town, and Bejing economy and technology development zone. Beijing Experiment Zone is the predecessor of Zhongguancun Science Park. Among the five zones, Haidian Experimental Zone is the largest and most important zone. Most of high-tech enterprises concentrated in its center — Zhongguancun, so Zhongguancun became the nickname of Beijing Science Park.
3. Since 1988, the State Council has approved the founding of 52 National High and New Technology Industrial Zones in China. See ATIP95.89, "China's Science Parks".
4. MSC will occupy a 15-by-50km area spreading south of Kuala Lumpur. The government is wiring the zone with super-fast communications links to facilitate foreign and domestic technology companies. Malaysia hopes to create the ideal environment that will attract world-class companies to use it as a regional multicultural information age hub. Its long-tern objective is to encourage the development of a highly competitive cluster of Malaysian multimedia and IT companies that will eventually become world class. (See Mahathir Mohanmad, 1998.)
5. After the new plan on Zhongguancun Science Park was published, all the Science Parks in Beijing are generally called Zhongguancun Science Park. The new ZSP consists of three zones: center zone, development zone and radial

zone. The center zone, which has an area about 75 square kilometers, is bounded by the Xiwai Big Street in the south, the Planned Road No1 in the north, Jingmi Drawing Canal in the west, and Badaling Expressway in the east. The core of the center zone includes Chinese Academy of Science, Beijing University, Qinghua University, and west zone of Zhongguancun (science & technology business center, sale center, and business & culture service center). The development zone is a 280 square kilometers zone extending north from programming the first ring road. The base of the development zone is Shangdi Information Industry Base. What Xisanqi New Material Base, Huilongguan Zone as a residence zone for teachers of universities and researchers, and Yongfeng Science Park and Space Town will be constructed in the development zone. The radial zone will consist of "one ring and two roads". The ring includes high science and technology zones, for example, Electronic Town, Beijing Economic Technological Development Area, Fengtai Science Park, and Chanping Science Park. One road is Badaling Expressway extending to Shahe, Changpin, and Nankou and the other is Jingmi Highway extending to Shunyi, Huairou, and Miyun. See Beijing Municipal Government, Ministry of Science and Technology (PRC), "Request for instruction on actualizing the strategy of flourishing country by science and education, and accelerating the construction of Zhongguancun Science Park", Beijing Policy file [1999] No.35.

6. Zhongguancun became an "Electronic Street" in the early 1980s when some technology researchers began to run non-state technology firms. But at the beginning, most of them sold electronic products, so Zhongguancun got the nickname "Electronic Street".
7. Luoliyuan, Zhaomulan, "Intellectual Economy and Zhongguancun", p14.
8. Administration Commission of BEZ, "A Brief Introduction to Beijing Experimental Zone for the Development of New Technology Industries", http://www.bez.gov.cn/english-frame/en3-2-1.htm.
9. D.K.Kahaner, "Developing Science Parks in Asia", http:// www.atip.or.jp/ATIP/public/atip.reports.95/atip95.88r.html

10. Administration Commission of BEZ, “West Zhongguancun Zone and Project for its Controlled Development Detail”.
11. Beijing Municipal Government, “Beijing Experimental Zone Temporal Rule”, May 20, 1988.
12. Beijing Municipal Government, “Policies on Promoting High and New Technological Industry Further in Beijing”, April 26, 1999.
13. ibid.
14. Administration Commission of Zhongguancun Science Park, “Preferential Policies on Foreign Exchange Administration in Zhongguancun Science Park”, November 10, 1999.
15. Committee of Haidian District Government, “Provisions on Encouragement of Foreign Investment by Giving Awards in Haidian District”, August 9, 1999.
16. Beijing Municipal People’s Government Personnel Bureau, “Interim Procedures on Beijing drawing Qualified Personnel and issuing Beijing Employment Resident Card”, Beijing Personnel file[1999] No.38.
17. “China Amends Corporate Law to Support Hi Tech Firms”, Asia Pulse, Dec 29, 1999.
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22. With respect to statistics in China, computer market includes hardware, consumption materials, spare parts, and application products.
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32. ATIP97.058, “Foreign R&D Center in China”.
33. “China to expand information technology in schools”, Asia Pulse, December 29, 1999.
34. “Telecommunications Infrastructure”, http://www.mdc.com.my/cyberjaya/infra.html
35. For example, the R&D directions of IBM R&D Center China are Chinese information (Chinese processing, distinguishing Chinese speech sounds, image processing and model identification, Chinese databases, etc.) and network application (ATM, remote teaching and database software, etc.). Sources from ATIP 97.058, “Foreign R& D Center in China”.
36. According to SPA figures, China’s piracy rate is exceeded only by Vietnam, where 98 percent of software is pirated. See Michael White, “Software piracy rampant in China despite enforcement efforts”, http://www.nando.net/newsroom/n…/info7-17380-noframs.htm
37. Zhao Huanxin, “Price-cutting to fight piracy proves effective”, China Daily, December 12, 1999.
38. In Hsinchu Science-based Industry Park, the park administration offers grants for the development of innovative technology. The maximum grant for each project is NT$5 million, but may not exceed 50% of the cost of the project.
39. There are: http://www.zhongguancun.com.cn, http://www.zhongguancun.com, http://www.zgc.gov.cn, http://www.bez.gov.cn, http://www.zgcpark.com,

http://www.zgcscience.com, and http://expert.zhongguancun.com.cn

40. The first generation enterprises in Zhongguancun learned PC technology by selling PC for foreign manufactures.

41. That is "Beijing Municipal Government Temporal Rule" issued in May 1988.

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Appendix:

The Characteristics of Some Asian Science Parks

Key Factors for Science Parks		ZSP	MSC	Bangalore	SSP	HSIP
Infra-structures	Physical	5	3	5	3	3
	Institutional	3	3	3	3	3
Capital	FDI	3	3	3	3	3
	Venture Capital	5	5	3	3	3
Market	Domestic market	3	5	5	5	5
	Overseas market	5	5	3	3	3
Technology		3	5	3	3	3
Universities or Institutes		3	5	3	3	3
High-tech talents		3	5	3	3	3
Administration		3	3	5	3	3

1. The five Asian Science Parks are ZSP (Zhongguancun Science Parks, China), The MSC (the Multimedia Super Corridor, Malaysia), Bangalore (Bangalore Software Technology Park, India), SSP (Singapore Science Park, Singapore), and HSIP (Hsinchu Science-based Industrial Park, Taiwan).
2. The sign "3" means a Science Park has a strength in the factor listed in the first column, and the sign "5" means a Science Park has a weakness in the corresponding factor.

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