

# **Innovation in China**

The Chinese software industry

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# 1 Twenty years of software development in China

A look back at history from my perspective

The development of the global software industry has exceeded the expectations of nearly all analysts. In a period of less than half a century, software has grown into an industry with a value of nearly one trillion US dollars, covering virtually every aspect of our lives all over the world. Software is completely changing our production methods, our life styles and even our patterns of thought. It provides a fundamental element in the ongoing competition between those countries which are built on knowledge-based economies.

China's software industry, which began in the 1950s, first adhered to a policy of independent innovation within the context of the socio-economic environment prevailing at that time. In the 1980s, in line with China's Economic Reform and Opening-up policy, the industry began to open up to the outside world. More than 20 years of "Nalai-ism" (an expression which may be prosaically defined as using the fruits of others' experiences) has seen China's software industry mature and develop and a number of outstanding enterprises have begun to appear. With the promotion of globalization following China's entry into the World Trade Organization (WTO) in 2001, the Chinese software industry is now enjoying new development opportunities and is at the same time facing numerous challenges. During such a critical phase, the question of how to boost development has been a common concern for China's government, software industry and academic circles.

After working at SAP (Systems, Applications and Products in Data Processing) Headquarters in Germany and SAP Labs US in Silicon Valley for two years, I came to China in 1994 and set about establishing SAP Office China. Since then I have devoted myself to the cause of the Chinese software industry and experienced its development at first hand. In this first chapter I hope to take you on a journey in which we shall review the achievements of the industry from a macro point of view of internationalization before going on to discuss the options the industry must choose from in order to realize a further quantum leap in development.

## Software all around us

The beginnings of the global software industry can be traced back to the end of the 1940s. The first numerical computer, the Electronic Numerical Integrator and

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Calculator (ENIAC, for short), first made its appearance in Pennsylvania, USA, in February 1946. It covered an area of 170 square meters, weighed 30 tons and consumed 150 kilowatts of power. It was really beyond the imagination of people at that time that this gargantuan machine would have such a far-reaching influence on the history of humankind.

Since 1946, the computer industry has experienced over 60 years of evolution, during which the software industry, which developed from the global computer industry, has made a substantial fortune and has become one of the most lucrative industries in the world. Moreover, software has developed into an integral part of a series of products essential for our daily work and lives. It has become both the core and the soul of these products. Still further, carefully designed computer software can act like an extension of the human brain. With the help of software, it is possible to improve the world and to enter the digital era.

### *An amazing industry*

After half a century of development, the global software industry has achieved an enormous presence. According to a recent report, the global software industry had earned US\$823.9 billion up to 2005 and it continues to grow at a fast pace.<sup>1</sup> Many international enterprises such as Microsoft, SAP, Oracle and Google and personalities known to all such as Bill Gates have made their appearance. During a period of little more than 30 years, software giants have generated hundreds of billions of dollars in revenue. Bill Gates, chairman of the board and chief software designer of Microsoft, has been number one on the Forbes List of Billionaires for 12 consecutive years, exceeding industry giants from the iron and steel, petroleum and other businesses. It is estimated that Bill Gates earned up to US\$6,659 per minute in 2005. In the same year, the average income of an American per minute was just 8 cents, i.e. 80,000 times less than that of Bill Gates. In 1998, when listed on Wall Street, SAP, the largest global enterprise management and e-business solution provider, was hailed the largest listed stock in the 206-year history of the New York Stock Exchange.<sup>2</sup> The success of these transnational software enterprises makes the software industry extremely fascinating. Not surprisingly, in the last two decades many young people realized their dream of being part of the software industry.

### *Software code in products*

Software has not only created a large industry but it has also developed at an amazing speed, playing an increasingly important role; it is now an integral part, indeed the core, of many articles in daily use. High value-added goods are usually equipped with sophisticated software.

When taking a flight on a Boeing 777, it may not surprise the passengers to learn that a software control system comprising more than four million lines of code is at the base of its operation. More and more software is incorporated into

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modern vehicles, including cars. In 1998, BMW produced a series of advertisements for global screening. These showed an Apollo 11 spacecraft blasting into the sky. The slogan underneath read: "When you start up a BMW 7 Series, you activate 20 Mbytes of computing power. That's more than on Apollo 11's mission to the Moon."<sup>3</sup> The captivating picture and catchy words revealed that software and traditional manufacturing, such as that of automobiles, were integrated perfectly. Software code in cars is a definite necessity. It is used by increasing number of car manufacturers to provide a competitive edge in product differentiation and to offer comfort to both driver and passengers. The advertisements for the BMW 7 Series attempted to display the product's luxury status by focusing on its sophisticated software code and in so doing providing a means of differentiating it from the competition.

#### *A tool for changing the world*

Like Watt's innovative work on the steam engine in the mid-eighteenth century and cars produced by Henry Ford using the first mass-production methodologies at the turn of the twentieth century, software is causing a fundamental change in production methods and life style and is becoming a new tool for transforming the world.

Manufacturers such as Boeing and BMW not only incorporate more and more software in their products to make them more intelligent, but they also rely increasingly on professional software tools such as Computer Aided Design and Computer Aided Manufacturing. With the help of these software tools they can promote an efficient design and manufacturing process, shorten the development cycle and reduce costs significantly. An increasing number of enterprises are realizing not only effective management, but also upstream and downstream the integration of their supply chains by using powerful management software tools such as those developed by SAP and similar companies. As well as bringing about a fundamental change in the way business is conducted, management software has led to the creation of new industries such as the Internet and e-commerce. These new industries are creating new profits and are in the process of becoming the new business legends of the twenty-first century.

The prospect of life without software would be rather bleak. In the absence of mobile telephony, e-mail and many of the other comforts of modern civilization, things would revert to a more primitive state.

#### *A new focus for the competition between nations*

Software has an unparalleled strategic importance for the whole world: from the United States, the leader of the global information industry, to Ireland, once called the European Village and a Third World country among developed nations; from the subtropical regions of India, a country with an ancient civilization in South Asia, to Israel in the vast desert of the Middle East; from Japan and South Korea, leading the economic growth miracle of East Asia, to China now

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undergoing globalization and experiencing rapid growth. All nations regard the software industry as the soul of a developing IT industry. It is seen as the engine for promoting economic growth and social progress. Countries support the strategic development of a software industry as a way to strengthen their international competitiveness and to safeguard information assets.

In order to attain dominance in international competition, countries throughout the world have launched policies to promote the development of their own software industries. Since the mid-1980s, when Sanjay Gandhi was Prime Minister of India, the Indian government has launched a series of initiatives to support the Indian software industry such as the Policy on Computer Software Export, Software Development and Training, the Software Technology Park scheme and the Indian Information Technology campaign. A Software Development Bureau was set up to organize and coordinate the development of the national software industry. Since then, government and industry circles have co-promoted the Indian software industry's rapid development rapidly on the basis of software outsourcing services. The Chinese government also pays considerable attention to the development of its software industry and has initiated a series of policies. In the year 2000, the State Council of the People's Republic of China issued Policies for the Promotion of Software and Integrated Circuit Industries, which were followed by the Action Plan for the Rejuvenation of the Software Industry in 2002. These constitute a macro policy instruction and action plan for China's government to promote the development of its software industry. As a country, we feel the commitment and sense of urgency emanating from central and local government in promoting the national software industry.

The above-mentioned examples are just a small part of the development of the global software industry. However, as the old Chinese saying goes: "From the tiny acorn the mighty oak does grow." Regions and countries all over the world pay considerable attention to the development of their own software industries. It is an exciting process to engage in or to simply observe.

#### **Twenty years of extraordinary development**

##### *The beginnings from a personal perspective*

Since leaving SAP Headquarters in Germany for China in 1994, I have spent time researching the development of China's software industry so as to map out its evolution. Its beginnings can be traced back to the 1950s. Although many of us are quite unfamiliar with that period, articles written by the forefathers of the industry such as Yang Fuqing, Xu Jiafu and Wang Xuan as well as other relevant extracts from the IT media give us an impression of the spirit prevailing during the years in which the industry started and evolved.

Based on this, I can say that from the middle of the 1950s to the end of the 1970s the Chinese software industry enjoyed a series of achievements in such fields as analysis programming, compiler and operating system. Furthermore, it made important contributions to the development of China's defense, science

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and technology sectors. However, limited by the stability of domestic computer hardware platforms and the developmental level of China's economy as a whole, innovative software failed to enter the market and realize mass business applications. Even at the beginning of the 1980s, software was hardly established as an independent industry in China.

When talking with Chinese IT journalists and senior professionals of the industry, 1984 was frequently mentioned as an important year and a milestone in the history of China's software industry. The China Software Industry Association was founded on September 6 of that year, an event which indicated that software had become an independent industry rather than constituting merely a branch of the electronic or computer industry. It was then that the development of the Chinese software industry took off.

### *China opens its door to the world*

#### *The golden age of the global software industry*

Nowadays, the term "global village" is familiar to all. In the 1980s, China's software industry started its true industrialization. At the same time, America was going through significant changes which would have a far-reaching impact on the development of the global computer industry. IBM's Personal Computer with Open Architecture replaced Apple II, it supplanted the dominant mainframe and minicomputer and it became the most common universal computing platform in the world, leading also in terms of design and application systems. The rise of personal computers introduced the use of computers to small- and medium-size enterprises as well as to individuals, and use was no longer restricted to the army, the government and large enterprises.

The sales volume of personal computers maintains a double-digit growth and forms a large software installation base. It provides a major market opportunity for the development of operating systems and various types of application software.

Based on the PC computing platform, many mass market-oriented universal software companies have appeared. Microsoft was established by Bill Gates and Paul Allen in 1975; Lotus was set up by Mitch Kaper in 1982. These, together with Adobe, AutoDesk, Intuit and Novell, are the most famous and have performed wonders, one after another, in the capital market. SAP, co-established by five IBM software engineers including Hasso Plattner in 1972, is an independent enterprise software and solution provider. It transfers large-scale enterprise application software from traditional computer-operating system platforms to new computing platforms such as Unix, IBM OS/2 and Windows NT. In this respect, the rapidly growing computer market benefits enterprise software providers such as SAP. According to statistics from research firm IDC, during the 1980s the global software industry grew at a breathtaking rate of 20 percent every year.

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### *Compatible development within the global software industry*

While the global software industry was witnessing a golden period of development thanks to the wide-ranging application of personal computers, China, under the command of Deng Xiaoping, had just recovered from the ten-year-long Cultural Revolution. Now, industrial reforms and an Economic Reform and Opening-up initiative were launched as basic national policies and the closed door was opened to the whole world. This process of opening up exposed the huge gap between China and the developed countries in terms of the size of both its hardware and software computer industry. This disparity shocked China's decision-making authorities and scientists. By insisting on Economic Reform and Opening-up as a basic policy and by encouraging new ideas through discussion and debate, China gradually abandoned its existing course in favor of one focusing on the development of domestic micro-computers and personal computers which would be compatible with international mainstream software and hardware products.

According to the limited news reports on the beginning of China's software industry, it began its learning process through "Nalai-ism," i.e. the process of borrowing foreign products and translating them into Chinese, together with developing technologies based on Chinese information processing. At the beginning of the 1980s, a number of Chinese universities and research institutes translated foreign software products and put these onto the domestic market. These universities and institutes, with basic ideas of the market and the user in mind, later became the pathfinders for the commercialization and industrialization of China's software industry. Since then the Chinese software industry has gradually grown, moving from the initial phase of isolation and closed-door development to a 20-year-long stage of opening up, borrowing and learning.

### *The emergence of software companies in China*

#### *The first local software companies*

The rapid development of China's economy triggered a huge internal demand for computers and software applications. To meet this market demand, the first group of market-oriented software companies in China made their appearance.

China's software industry witnessed its first wave of business start-ups in the middle of the 1980s. At that time, the number of software and information service companies mushroomed and developed rapidly due to favorable policies and a strong market demand. In 1985, several state-owned companies were born, such as the China Computer Service Company (now the China National Software & Service Co. Ltd), the China Computer and Software Company and the China Computer System Integration Company. On the heels of these state-owned companies, a clutch of local software enterprises were founded. These featured strong market operating ability and fundamentally influenced the development of China's software industry. Among them can be mentioned Kingsoft, UFIDA Software, Neusoft Group and Kingdee Software.

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Every time I read about the history of China's software industry I cannot help but associate it with the dynamic early history of the American software industry at the end of the 1960s and the beginning of the 1970s. It was at this time that the "Big Blue" IBM declared that it would no longer continue the practice of supplying bundled software and hardware, and a group of companies committed to providing software and information services made their appearance.

*The first multinational software companies*

The rapid development of China's software market not only led to the creation of a first batch of local software enterprises, but it also attracted a number of multinational software giants like Microsoft and SAP. These gradually realized that China, with the largest population in the world and rapid economic development, represented a substantial potential for business. In order to have a voice on the competitive Chinese market in the future, these far-sighted international software enterprises marched into China to set up retail and research and development (R&D) branches. In the 1990s, SAP formally established a presence in China on the basis of initial cooperation with China's state-owned enterprises. I was sent to China by SAP German Headquarters at that time and my close involvement with the development of China's software industry began. I had been working in this industry for 15 years, formally establishing SAP China Co. Ltd in 1995, SAP China Research and Development Center in 1997, and in 2003 helping to develop this center, which was listed in the SAP Global Labs System, into SAP Labs China. During this time, Microsoft set up its business office in Beijing in 1992, founding Microsoft China Co. Ltd in 1995, followed by, in succession, Microsoft Global R&D Center, Microsoft Global Technical Engineering Center, Microsoft Research Asia and Microsoft Advanced Technology Center. Beijing Oracle Software System Co. Ltd was established by Oracle Co. in 1991. This was followed by the China Research Center later on. After 15 years of development, these international software giants, which were the first to penetrate the Chinese market, have prospered and their businesses in China have expanded. Nowadays, almost all international software giants have a presence in the Chinese market. Most of them have established bases in China and have moved on from simply retailing and providing technical support to local enterprises to establishing R&D academies.

*Learning and growing through competition and cooperation*

During my time working in China I have often been invited to attend various software industry summits and small-scale symposia. On occasion I have asked my peers such questions as "Do you think it's good for you or not that multinational enterprises like SAP have entered the Chinese market?" The answers have varied widely. Some have pointed out their concerns that powerful multinational software giants might snatch market shares and poach highly qualified individuals. However, the majority have had a rather positive attitude. They believed



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that although the appearance of new branches of multinational software giants like Microsoft and SAP would lead to fiercer market competition, this would also provide a good opportunity for local enterprises to learn through competition and cooperation. It would become easier for local enterprises to familiarize themselves with the latest technologies in global software development. In addition, there would be more opportunities for them to learn and refer to the valuable experience accumulated by those giants who have survived in the face of ruthless market competition. Meanwhile, by offering high salaries it would be possible for local enterprises to recruit promising software talent who always keep an eye on the international market. Particularly in the last 12 years, the relationship between local enterprises and global giants has developed from simple and direct competition in the early days to more mature relationships typified by competition-cooperation. Many local enterprises and multinationals have created close strategic relationships on the basis of labor division, cooperation and mutual supplementarity, and in doing so have formed a commensal industrial ecological chain. Excellent examples include Microsoft's cooperation with local enterprises such as the Neusoft Group and Powerise Software, and SAP's cooperation with Tsinghua Unisplendour Corp and Digital China. In this kind of closely cooperating industrial ecological chain, local companies have more chances to learn from and refer to the experience of mature international software companies in terms of strategy development, operational management, development of new products, project management, algorithm design and testing. On the other hand, multinational enterprises can acquire the local competitive advantage they lack.

To give a simple example, through "Nalai-ism" and learning, local enterprises including Neusoft have achieved CMM5 certification, which is the highest degree of Software Capability Maturity Model awarded out by the American Carnegie Mellon University Software Engineering Institute. This proves, to some extent, that China's local software enterprises have made great progress in respect of software development and project management.

This progress aside, the leading local enterprises have also gained rich experience in brand operation and product R&D, and acquired market-oriented innovative abilities. They have been able to survive fierce competition and to grow in size. According to investigations carried out by myself based on the members of the Chinese Software Industry Association in 2005, there were 29 software enterprises in total, including embedded software enterprises, boasting an annual sales revenue of over RMB1 billion. These local software enterprises form the backbone of a new round of development of China's software industry.

As far as I am concerned, the most meaningful achievement in the Chinese software industry is that, thanks to 20 years of "Nalai-ism" and learning, the leading local companies have been able to maintain a global perspective. This is a necessary prerequisite for growing into a multinational company. Instead of engaging almost exclusively in the domestic market as they did in the 1980s, many far-sighted Chinese software enterprises now set their sights further afield and focus internationally, trying to better allocate resources for the global

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market. They actively pursue an outgoing market model and aim at international growth, prime examples being Lenovo in the field of personal computers and Huawei and ZTE in communication equipment. This globalization of perspective suggests that China's software enterprises are maturing and will positively and profoundly influence the future development of the Chinese software industry.

### *The software industry is taking shape*

#### *Supporting measures for the development of backbone industries*

Driven by competition or cooperation with multinational companies, Chinese software enterprises keep developing and are making continuous progress. Meanwhile, the macro-environment is also improving. The Chinese government has gradually begun to recognize the vital role the software industry is playing in the economic development of the country, and regards it as a strategic industry affecting China's international competitiveness. In the last 20 years, the Chinese government has introduced a series of policies in order to facilitate the development of the software industry.

I will review these policies in chronological order. In August 1986, China's Ministry of the Electronics Industry compiled an analysis of the domestic software industry for the State Council, the Report on Establishing and Developing the National Software Industry. In 1991, the Outline of the Ten-Year Program and eighth Five-Year Plan for the National Economic and Social Development of the PRC which was approved by the National People's Congress, stated: "We have to put our efforts not only into developing hardware, but also into developing software, establishing computer groups, and constructing sites for developing software and applications." In 1992, the Regulations on the Protection of Computer Software in China were implemented. In 1997, the first National Informationization Work Conference was held, during which it was agreed that a Software Exposition should take place annually in China. In 2000, the State Council published Policies on Encouraging the Development of Software and Integrated Circuit Industries (No. 18 [2000] of the State Council, known as "Document no. 18" within the software industry). In 2002, the General Office of the State Council published the Guidelines on Supporting the Software Industry (No. 47 [2000] of the General Office of State Council known as "Document no. 47"). Meanwhile, a series of policies were also published by other bodies, such as the Ministry of Information Industry, the Ministry of Science and Technology, the State Development and Reform Commission and the State Taxation Administration. Based on these documents, we can conclude that every few years the Chinese government issues new policies or guidelines in order to promote the development of the software industry.

The eleventh Five-Year Plan for the Scientific Development of the Information Industry and Middle- and Long-term Programming by 2020 was released by China's Ministry of Information Industry in 2006. This emphasized once more

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the need to support our capability for independent innovation, and highlighted the strategic position of the software industry in the economic development of China. According to the outline, the government aims to support a series of groundbreaking programs during the period of the Five-Year Plan. These programs include the development of such fundamental and core software as a highly reliable network server operating system, a new generation of desktop Linux operating systems, intelligent database management systems, network middleware and integrated application development platforms. Other objectives are the conception of information support software featuring independent intellectual property, safe and independent R&D and the ability to facilitate the rapid development of software technology, including e-government, e-commerce, urban informationization, enterprise informationization, agricultural informationization and service informationization. Further research is planned in order to develop component-embedded operating systems and embedded software platforms used in such fields as intelligent mobile phones, digital home appliances, automobiles and electronics. Emphasis is placed on combining this software with integrated circuit technology, and extensive research will be carried out on the development of components and component software and on the development of technologies of the components library management. Additional targets are to set up large-scale software-developing utilities with independent intellectual property in order to improve China's software output, to establish a national software engineering research center, to build and complete a software evaluation and serving system, to enhance the research on software engineering technology and to provide technical support to the development of China's software business. Like the author, every insider of the software sector who has experienced or observed its growth in China in recent years will have a keen feeling that the government is strengthening its support for the software industry, and that the macro-environment in China is becoming more favorable to the development of the industry. This trend continues. In this increasingly favorable environment, Chinese branches of multinational giants as well as local software enterprises are growing in confidence and are ready for a much brighter future.

*The rapid expansion of the software industry*

China's software industry is expanding rapidly as a result of the impressive growth of software companies, a favorable macro-environment and a growing Chinese economy as a whole. According to statistics released by the Ministry of Information Industry and the China Software Industry Association, the overall sales volume gained by the software industry in 2006 hit the RMB390 billion mark, US\$3.59 billion of which was from exports.<sup>4</sup> Figure 1.1 illustrates clearly the rapid momentum China's software industry has gained during the tenth Five-Year Plan period, which saw the compound annual growth rate exceeding 30 percent. This is particularly relevant considering the depression the global IT industry experienced at the same time as a result of the bursting of the Internet bubble and the consequent tumble of the Nasdaq Index.

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The expansion rate of China's software industry still exceeds 30 percent per year, which is well above the annual growth rate of China's GDP. This indicates that the software industry has become one of the most dynamic sectors of China's economic development. Although the activity of the software industry as a percentage of the GDP is still relatively small (see Figure 1.1), it is increasing rapidly. Many cities in China boast an abundance of highly qualified human resources. They regard the software industry as an integral part of their local industrial infrastructure and support it by building software parks. After the manufacturing industry, the software industry is expected to become the main driving force for China's economy.

According to the first economic census carried out in December 2004, China's GDP amounted to RMB15.9 trillion, rather than the RMB13.6 trillion which was recorded in previous statistics of the same year (see Table 1.1). A conformity study of statistics performed by the Ministry of Information Industry following an economic census showed that the value of China's electronics and information industry reached RMB3.07 trillion in 2004 (and not RMB2.65 trillion as previously thought), of which RMB278 billion was attributed to the software industry and US\$2.8 billion to software exports. The growth rate of the Chinese software industry had hit a new high.

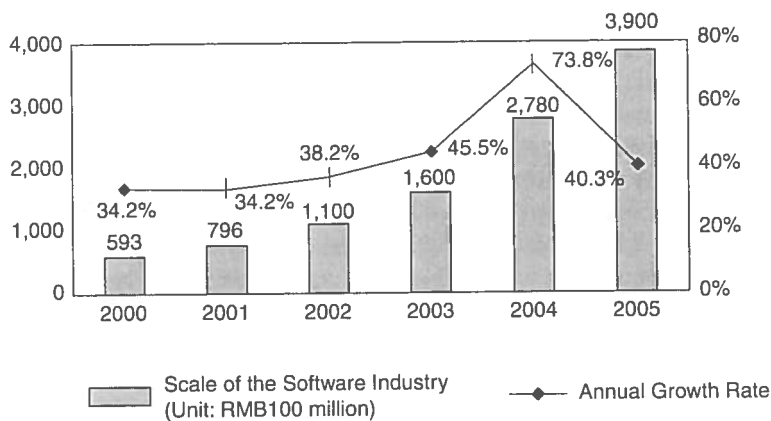


Figure 1.1 Scale and growth rate of China's software industry from 2000 to 2005 (source: China Software Industry Association, 2006).

Table 1.1 The scale of the software industry expressed as a percentage of China's GDP (2004 and 2005)

Year	Software industry (trillion RMB)	GDP (trillion RMB)	Percentage
2004	0.278	15.9	1.7
2005	0.39	18.2	2.1

Source: China Software Industry Association, 2006.

*A cloud on the horizon*

China's software industry's astonishing achievements throughout a difficult 20-year period surprised the whole world. However, despite these achievements, a direct comparison between the Chinese and the global software industries reveals a less positive picture. First, the gap between the accomplishments of China's software industry in the last two decades and the expectation the Chinese government and the industry insiders had for the same period of time is still considerable. Recently, the question on how to overcome these flaws in order to realize a new round of growth has raised concern among Chinese government bodies, industry insiders and researchers. From a macro point of view, China's main issue is that although its software industry is of significant scale, it is still less competitive than that of developed countries. Meanwhile, from a micro point of view, China's local software enterprises lack the necessary innovative ability and sustainability. Most enterprises have insufficient technical expertise and they have less say than their foreign counterparts in deciding important international standards. I personally believe that these flaws, both macro and micro, have the potential to become a bottleneck preventing the industry's development in the long run.

*The software industry's weak international competitiveness*

In order to understand the flaws in the development of China's software industry, we must take a look at the macro statistical data. In 2004 and 2005, the overall sales of China's software industry amounted to RMB278 billion and RMB390 billion, respectively, of which software exports totaled US\$2.8 billion and US\$3.59 billion, respectively. However, in the same period, the scale of China's electronics and information industry reached RMB3.07 trillion and RMB3.84 trillion, respectively, of which exports totaled US\$207.5 billion and US\$268.2 billion, respectively. This shows that the software industry accounted for only around 10 percent of the entire electronics and information industry.<sup>5</sup> However, judging from the overall momentum the global IT industry has gained, the software industry is playing an increasingly important role in the electronics and information industry. In some countries with developed IT industries, such as the United States, software products are approaching and at times even surpassing the share that hardware products have in the IT industry. In terms of the status the software industry enjoys in the national Chinese economy, it accounts for only 2 percent of the GDP, while in countries like the United States this percentage is generally around 5 percent. This simple comparison illustrates the gap between China's software industry and that of developed countries. It still has a long way to go if it wants to become the driving force behind China's IT industry and its intellectual economy.

Where the global market is concerned, many macro-economists employ the export scale as a key index in weighing the international competitiveness of a country's industry. Based on this index, the international competitiveness of

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China's software industry is rather weak. As mentioned above, according to the statistics of the China Software Industry Association, exports of Chinese software in 2005 amounted to only US\$3.59 billion, accounting for a mere 7.6 percent of the total. Another point the Chinese government and industry should be aware of is the decrease in software exports in recent years. On the one hand, there is a thriving demand on China's domestic software market. On the other hand, the international competitiveness of China's software industry remains rather feeble. This is also shown by a careful analysis of its exports. The pressure exerted in order to enhance the innovative and groundbreaking ability of the software industry can be sensed. Currently, a large part of the exported software products and services consists of embedded software bundled with hardware products. In other words, most of China's software export is indirectly accomplished through the export of hardware products, rather than through the software's own competitiveness. The remaining volume is mainly custom software development, software OEM (Original Equipment Manufacturing), and software services, while the export of own-branded software products accounts for a very low percentage of the total.

In recent times, many of China's software enterprises have employed the Indian model and expanded software outsourcing projects. However, these projects are quite unsatisfactory. Most of them, mainly such basic work as coding, data input and software localization, are at the low end of the software industry chain in terms of international labor division and are of little added value. Statistics show that at present nearly 60 percent of China's software products and services are exported to Japan. Most of China's enterprises that enter the Japanese market do so as minor subcontractors. Their jobs are confined to the low end, such as coding. Only a limited number are attempting to expand their businesses into more profitable outsourcing projects and to contact end-users. The majority of China's local software enterprises depend mainly on cooperation with Chinese branches set up by multinational software companies to acquire indirectly multinational software outsourcing projects. At the same time, only a few of them can build strategic cooperative relationships and cooperate directly with multinational software companies. Rarely can one Chinese software company conduct business in the United States by itself.

In the global software market, there are few Chinese software products competing with independent intellectual property. Those worth mentioning include the Founder typeset system, HanWang handwriting recognition, ZWCAD, Evermore Integrated Office, Jiangmin Antivirus and Rising Antivirus. Not only is the variety of exported software products limited, but also the scale of exports of the majority of software products is quite small. All of this suggests an obvious gap between China's software industry and that of other countries in terms of global market share and marketing.

Even in China's domestic market, there are various problems hiding behind the rapid expansion of market size and prosperity. Nearly two-thirds of the market shares for packaged software are held by multinational software companies such as Microsoft, Adobe and IBM. At the same time, the high-end



software market with products such as operating systems and large-scale databases is almost completely monopolized by multinational companies. In terms of core technology the products of Chinese software enterprises still lack innovation and original design. In addition, domestic software enterprises such as UFIDA Software and Kingdee Software have insufficient capabilities to compete with foreign companies like SAP and Oracle in the field of large commercial software such as ERP (Enterprise Resource Planning).

*Low profitability and sustainability of software enterprises*

The reason for the software industry's weak international competitiveness lies in the fact that Chinese enterprises are generally small and dispersed. According to the statistics of the China Software Industry Association, in China there were, in 2006, 12,000 enterprises involved in software R&D, consultation, analysis, design, programming, testing, maintenance, training and service.<sup>6</sup> Most of these were small-scale companies – only 60 employed more than 1,000 staff,<sup>7</sup> while the biggest company had no more than three to four thousand workers. In contrast, in the United States, the top four software companies had more than 10,000 staff each. The number of Microsoft staff exceeds 40,000 worldwide and SAP has 36,600 staff in over 50 countries. Due to the large differences in numbers of staff and productivity per capita between Chinese software enterprises and multinationals, the disparity in terms of sales income is enormous. The total income of the top ten Chinese software enterprises in 2005 accounted for only 3.5 percent of the total income of the top ten American software enterprises in 2004 (including both software and service income, shown in Table 1.2). In the same period, in India (which is a developing country), the value of software exported by 17 enterprises exceeded US\$100 million, and the total sales of the top ten software enterprises reached US\$6.765 billion. The software sales of the leading enterprises such as Tata Consultancy Services (TCS), Infosys Technologies and Wipro Ltd all exceeded US\$1 billion.

In my opinion, software products have a much stronger effect on economies of scale than traditional manufacturing products. The initial development of certain software products can be extremely costly, sometimes amounting to billions of US dollars. However, once developed, the number of times software can be reproduced is unlimited and it can therefore be sold with very low marginal costs. The only costs incurred are those of burning a CD and in recent years, as software distribution through the Internet has gained in popularity, even that cost can be zeroed. The first Windows95 software CD cost Microsoft more than a billion dollars to invent, but the second CD cost just a few dollars to duplicate.<sup>8</sup> However, in order to get back the huge R&D costs and to guarantee the R&D of new products, a software enterprise has to sell the existing product to many customers.

At the present time, the development of Chinese product-oriented software businesses is still limited to the domestic market and sometimes even to the market of a local area and it cannot therefore fully benefit from the scale econo-

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Table 1.2 Comparison between the incomes of large Chinese and US software enterprises (unit: million US dollars)

Sequence	Name of Chinese software enterprises	Software sales in 2005	Name of US software enterprises	Software sales in 2004	Income ratio between the two (%)
1	Huawei Technologies	1,877.3	IBM	61,307.0	3.1
2	Haier Group	939.1	Microsoft	33,969.0	2.8
3	ZTE Corporation	785.2	EDS	20,669.0	3.8
4	UTStarcom	739	Computer Sciences	15,188.1	4.9
5	Digital China	570.6	Accenture	15,113.6	3.8
6	INSIGMA Technology	518.6	Hewlett-Packard	13,778.0	3.8
7	Panda Electronics Group	502.4	Oracle	10,156.0	4.9
8	Founder Group	338.9	Hitachi	9,490.7	3.6
9	Inspur Group	320.8	SAP	9,313.5	3.4
10	Hisense Group	303.1	Capgemini	8,580.9	3.5
	Total	6,895	Total	197,565.8	3.5

Sources: China Software Industry Association, 2006, and *Fortune* magazine, July 25, 2005. Based on an exchange rate of US\$1=RMB8.1.

mies like larger players. On the other hand, companies dealing in software outsourcing and IT services, are limited to code writing, data entry and software localization, i.e. activities which rank at the bottom of the value-added chain of the software industry. This means that the proceeds available from the economies of scale cannot be obtained. This is just OEM without the benefit of intellectual property rights. Thus, under the halo of high-tech and knowledge-based industries, Chinese software companies, unlike their world-renowned counterparts, cannot achieve the high profits potentially arising from technology innovation and global marketing. Statistics show that the average profit of Chinese software companies is just 7 percent, far below the 20 percent or more achieved by the well-known software companies in countries with fully developed software industries such as the United States, Japan, India and countries within the European Union. In turn, the low operating profits of Chinese software companies make greater investments in crucial aspects such as technology R&D and human resources difficult. This limits their ability for innovation even further. From a micro point of view, low profit levels affect the accumulation and circulation of funds of Chinese software companies in a negative way, while from a macro point of view, this becomes a significant problem concerning the sustainable development of the entire industry in China.

In the past 20 years of trial and error, Chinese software companies started from scratch, then developed thanks to "Nalai-ism" and went on to make significant progress in aspects like project management, client development and global perspective. In the process, a group of leading companies sporting a

certain competitive edge have emerged. Driven by market supply and demand, these companies have developed a critical scale and achieved a state of sustained and rapid growth. The factors determining the conditions for the development of the software industry, such as adequate policies and a supply of talent, have improved significantly in the last two decades.

With regard to the rise of the knowledge-based economy and the entrenchment of globalization, how can Chinese software companies progress further? How can they better serve the national development strategy of "boosting industrialization with the aid of information" and enter into the global market to truly become the engine of a new cycle of economic growth in China? How can Chinese software industries build their own intellectual property rights, standards and brands in the global market and seize a strategic position in the new round of software industrialization? To answer these questions, we need to further consider and discuss the development model of the Chinese software industry.

### **Should China adopt a foreign model?**

After China's entry into the WTO, its policy of Economic Reform and Opening-up started penetrating all economic sectors. The Chinese software industry uses the major successful global development models as examples for its own development. It also endeavors to learn from the success multinational software companies have achieved, trying to replicate their methods in China. The characteristic development models of the software industries, particularly of the United States and India, have led to in-depth discussions among Chinese government officials, industrial circles and the academic community.

In Silicon Valley in the USA or in Bangalore in India, it is quite common to meet study groups belonging to the Chinese software industry who have been assigned by central government, local governments, trade associations or individual corporations to research foreign success models. Witnessing these scenes, you can sense the passion these people apply to replicating these successful methods also in China. Whenever I see this, I am greatly moved by the enthusiasm of the government and its people. The great changes China has undergone in the last 20 years make me believe that it is essential to learn from developed countries. However, an old Chinese saying goes that "Oranges grown to the south of the Hui River are real oranges, whereas those grown to the north become tangerines." The question is therefore, can those software industry development methods, being effective in specific countries under specific historical circumstances, be replicated successfully in China? Can China realize a leap forward in the development of its domestic software industry by duplicating another nation's development method?

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### *The non-replicable American model*

#### *The legendary success of the American model*

The United States is the home of the global software technology industry. For almost half a century, the US has been at the forefront of the development of the global software industry. Today, the American software market occupies a 40 percent share of the world market. It is even more noteworthy that, in the field of foundation software such as operating systems and large databases, the products of American businesses have entrenched themselves into monopoly positions in the world market.

Controlling the technical standards for the upper reaches of the industrial chain and with a well-developed global marketing capacity at its disposal, the USA plays a leading role in the world's software industry. The country has created the American model, which is based on original innovation in the field of foundation software. This global marketing model, leading the technical standards and de facto standards, has achieved tremendous success. It not only made the USA the biggest winner during the rapid expansion of the global software industry in the past half-century, but it also ensures that the USA firmly controls the future of the global software industry. As a representative of the American software industry, Microsoft has been the model followed by many businesses in the world. Both *Future Speed* written by Bill Gates, founder of Microsoft, and *Microsoft Secrets* written by Michael A. Cusumano and Richard W. Selby, have been translated into many languages and have become best-sellers.

In my view, the world-leading position of the American software industry is primarily due to its early start. The Department of Defense purchased sophisticated software in the mid-twentieth century which created a strong market demand for the development of the American software industry and accelerated the development of software-related technology and project management levels. The improvement in product R&D capabilities promoted the business demand for software applications even further. A dynamic interaction between supply and demand had been formed. Bearing this in mind it is not surprising that, in a series of landmark changes regarding technology and business models between the 1960s and 1990s, the American companies firmly controlled the global software industry standards. They were able to accrue core technologies and foundation software and so could further strengthen their early leading position.

Let me tell you a few of the success stories of the American software industry. As early as the period between 1949 and 1962, when the global software industry was just at its beginnings, the United States Department of Defense commissioned SDC (System Development Corporation), established by RAND, to design the software for the SAGE computer system, a continental air-defense network. This huge software system, costing as much as US\$8 billion, contained at least one million individual codes. At that time, 700 of the 1,200 programmers in America were working on the SAGE project.<sup>9</sup> SABRE, a computer reservation system for airlines, which was developed by IBM between 1954 and 1964

for American Airlines, was the first large commercial software project. Employing about 200 programmers, it took ten years to finish at a cost of US\$30 million.<sup>10</sup> Large software projects like SAGE and SABRE were the American "Programmers' University." Many programmers who were involved in these projects later spread throughout the United States. Equipped with software development and project management expertise, it was an obvious step for them to found their own software and service companies. By the mid-1960s, when China was still trying to commission universities to manufacture software projects and to use research institutes as software centers, the United States had already created 40–50 large software companies. Add to these the small companies with only 2–3 staff, and the number reaches 3,000 software companies.

In 1964, IBM introduced its 360-series computers, which developed into the first stable standard platform of the mainframe era. From 1969 to 1971, they accounted for about 80 percent of market share.<sup>11</sup> The 360-series heavily promoted the use of computers in the United States and created unprecedented business opportunities for independent software enterprises. Throughout the 1960s, the United States made considerable progress in many frontier areas such as operating systems and programming languages, as well as in feature-rich, reliable utility software packages. As far as the use of computers was concerned, the United States was well ahead of other countries. In the mid-1960s, application software was widely employed in 35 American industries. Almost all of the largest enterprises in different sectors had adopted computers for their routine operations. By 1969, about 50–70 percent of large enterprises were using computers. When IBM announced that it would no longer bundle computer hardware sales with software and services, an additional market for independent software vendors was created and 81 new software companies were set up in 1972.

Looking at the history of the global software industry, we notice that while American companies were already developing large software projects for businesses in Europe, Japan, India or China, no similar large software development activities were happening elsewhere. From the earliest stages on, the United States occupied a unique place in the development of the global software industry.

With IBM's compatible PC becoming the standard for micro-computers, MS-DOS and the operating system Windows have gradually become the dominant operating system software in the world and can now be found on most PCs. As long-term Windows users have gradually formed a dependence on the product, the Windows desktop operating system software has gradually become the de facto standard. Today, tens of thousands of software companies worldwide have developed a large amount of application software based on the Windows operating system platform. IT hardware manufacturers also have built a complete industrial chain based on the Windows operation system platform. In this environment, the architects and owners of related technical standards are always the ones who derive the greatest benefits.

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*Difficulties in copying the American model*

The American software industry has had huge worldwide success so far, which makes the American model very tempting for the Chinese government and software industry to follow. During my research into the early history of China's software industry, I noticed that as early as the mid-1980s when Chinasoft was founded, it called for a role in developing an operating system with Chinese intellectual property rights. In the 1990s, with the rise of Linux worldwide, the construction of operating systems based on open source software with owned intellectual property rights and the construction of a comprehensive software industry had become central themes in China. It can be said that the Chinese software industry has always made efforts to replicate the American model at home. But even now, after 20 years of development, Chinese software companies cannot match the competitiveness of American enterprises. This contrast between an ideal situation and the reality raises the following questions: Is it possible for the American model be replicated by the software industry in China? If so, what advantages would the American model offer to China?

A brief review of the development of the Japanese and European software industry will help us to better understand these issues. From the 1970s to the 1980s, Japan tried to develop its own non-compatible independent information industry based on the domestic market. History proved that this model was not successful. Despite its achievements in the automotive sector, some scholars believe that Japan's early non-compatible development strategies account for its failure on the global IT market. Similarly, EU countries with highly developed economies have a long way to go to reach America's market position. However, based on the global development trend, Europe has chosen a suitable path for its own software industry. It has produced SAP, a giant in the field of global business software management.

The trend of the global IT industry, as well as Japan's failure to build an independent information industry, means that it has proven difficult to reproduce in China the development environment in which the American software industry has boomed since the middle of the last century. Against a backdrop of transnational software monopolies controlling the industry standards of foundation software, China's software industry is attempting to copy the American model and to then develop its own new foundation software. These new operating systems should go on to compete against the systems produced by American businesses – an attempt full of “quixotic heroism.” The chances of success are slim.

Considering these ideas rationally, I believe that China's software industry cannot and should not copy the American model rigidly. Neither should it try to replace it with a new one in order to compete directly with the American software industry. China should carefully analyze the experiences learned from the development model of the American software industry. It should, for instance, learn from the following: how the American government invests heavily in software education and innovative personnel training; how it strictly legislates and enforces



the protection of software intellectual property rights; how American software enterprises interact with other industries when developing software applications; which experiences American enterprises have had in software development and management; and, last but not least, how they apply their world-oriented marketing strategies. However, China should follow its own path, considering the specific conditions existing in the country, and combine America's successful system with the current trend of the international software industry.

### *Should China's software industry adopt the Indian model?*

#### *The craze for copying the Indian model*

When China's software industry began to explore ways to attract prosperity in the era of globalization, it did not only consider the classic development pattern of the USA, but also took into account the Indian model, which had proven to be a great success for global software outsourcing exports.

Over the past 20 years, India, whose infrastructure and overall level of economic development remain quite backward compared to China, has successfully exported software and services to over 100 countries by means of software outsourcing exports. These exports reached a record of US\$28.5 billion in 2005. Trailing only the United States, it ranks second in global software exports. According to published data, in the fiscal year 2001/2002, 255 of the American Fortune 500 companies purchased software or related services from India in the form of BPO (Business Process Outsourcing).<sup>12</sup> The miracle of the Indian software industry has aroused worldwide attention. From the mid-1980s, Forrester and McKinsey and other renowned international consulting firms carried out a special comprehensive study of the Indian software industry. Many scholars from illustrious American universities have repeatedly gone to India to carry out field research. Some scholars even refer to the development of the Indian software industry as the model for developing countries with regard to the knowledge industry. The reputation of the Indian software industry has been improving for some time now. In recent years, the pattern of Indian software outsourcing exports has gradually developed from on-shoring into off-shoring. The single outsourcing contract object has also been greatly promoted. Large software outsourcing enterprises with exports of more than US\$1 billion, such as Tata Consultancy Services (TCS), have emerged.

A large number of well-known domestic software enterprises have adopted the Indian model and their long-term strategies consist in developing software outsourcing exports. Even national software parks such as the ones in Xi'an and Dalian have set their target to developing software outsourcing exports for the USA or Japan. "There is nowhere but India" seems to have become the motto followed by China's software industry.

Over the past decade, heated discussions have taken place on whether China's software industry should copy the Indian model or not. Just like Xuan Zang, a monk in the Tang Dynasty, who traveled to India to bring the Buddhist Sutras to

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China, many have gone to India to learn from the experience of India's software industry development. Experts from China and abroad have been invited to talk about India's successful experience in various software industry seminars. Leaders of Indian software enterprises invited to China to advertise their business philosophy have delivered impassioned speeches. The Beijing Municipal Commission of Development and Reform and the Beijing Municipal Science and Technology Committee organized a high-level China-India Software Industry Cooperation Summit in Beijing, focusing on the Indian software industry and its successful experience and how to use it for reference.

*India's particular historical background*

In the face of this trend for the Chinese software industry to copy the Indian model in an attempt to catch up with the Subcontinent's software sector, we should first try to grasp the essence of the Indian model and ask: Is it possible for China to copy the Indian model? In my opinion, the question is not really whether China should copy the Indian pattern, but whether it can find a path more suitable for its own situation.

To better understand the ins and outs of India's software industry, let us briefly review its history. India's software industry began to soar in the 1980s. In 1984, India's Congress Party leader, Rajiv Gandhi, who served as Prime Minister of India, coined the slogan "Let an electronic revolution bring India into the twenty-first century" and established the Export, Development and Training Policy for Computer Software. Thus, Rajiv Gandhi is called the "Computer Prime Minister." In 1986, the Indian government announced the introduction of a computer software policy aimed at creating favorable conditions for the development of the software industry, such as funding, personnel training, simplified procedures for investment and import and reduction or exemption of domestic excise taxes. Since Rajiv Gandhi, successive Indian governments have all regarded the development of the software industry as one of the government's key political issues and have strongly supported it.

In addition to promotional policies, there were specific international and national conditions prevailing in the mid to late 1980s which encouraged India to choose the developmental strategy of software outsourcing exports. Further, due to the rapid popularization of computers in the 1980s, the United States and other developed countries were facing a shortage of software and of software talent. Large industry users and software companies in the United States were turning their attention to the international market to find a solution for the imbalance of supply and demand. As India's economy was fairly underdeveloped, the domestic demand for software application and information technology was rather limited. At the same time, having been a British colony, the standard of spoken and written English in India was very high, which facilitated communication with European and American customers. Under these circumstances, adopting the model of market-oriented software outsourcing exports to Europe and the USA was the obvious choice for India. It proved to be the right one.



*The essence of the Indian model: software processing*

At SAP Labs China, the so-called “Smiling Curve” – the illustration of value-adding potentials of different components of the value chain in the software industry – is often used to help depict the company’s strategic orientation. I will use this business model to illustrate the essence of the development of the Indian software industry, as shown in Figure 1.2. A complete innovation value chain can be divided into several interrelated key links such as solution innovation, product standard definition, software development, solution deployment, and go-to-market activities. All these links, which are at different levels according to their added value, constitute a Smiling Curve. The highest added value is to be found at the two ends of the curve, with solution innovation and product standard definition at the beginning and promotion and marketing at the end. Software development, coding and testing are at the bottom of the curve, which means they have the lowest added value. Applying the Smiling Curve to the development of the Indian software industry shows that due to its concentration on the development of coding and testing it finds itself in the middle part, i.e. at the bottom of the curve. Although its experience has given India the possibility to enhance its development efficiency and to boost its economic growth, its software outsourcing exports have limited space for improvement. In my view, the path the Indian software industry is following is labor-intensive, rather than knowledge-intensive or capital-intensive.

As the Indian software industry focuses mainly on software processing, such as coding and testing, a large part of its work consists in specific software development projects based on the analysis of user demand and on design outlines given by the contractees from the United States or Europe. The Indian model is far from the target market as well as from the user. Due to this, the Indian soft-

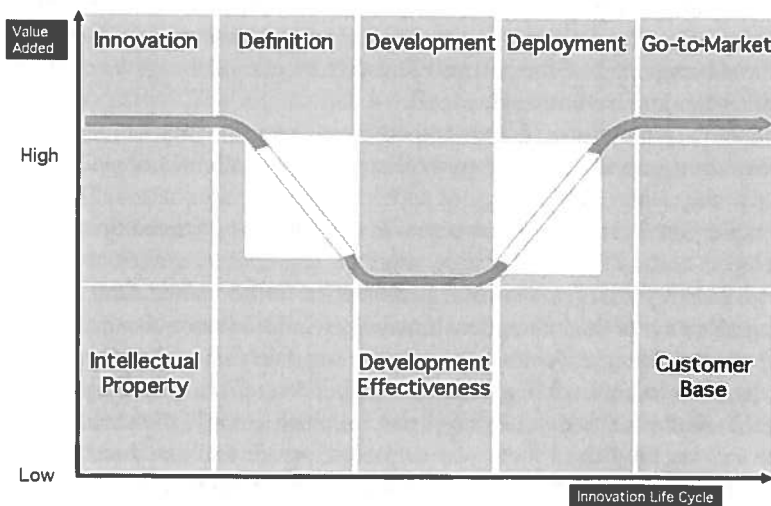


Figure 1.2 Innovation value chain – the Smiling Curve.

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ware industry does not attract high value-added commercial interest either in terms of innovation or in terms of promotion and marketing. This results in an imbalance of Indian software development and affects the sustainability of the Indian software industry in the future.

This disequilibrium stems mainly from the fact that although the Indian software industry has gathered rich experience in writing code and in software development process management (and tens of software enterprises have won the highest class CMM5), it lacks the capacities to qualify for the indispensable high value-added stage of the software industry chain as well as the knowledge on how to transform user demand into software design and then offer the software products to the global market. This absence of essential qualities in the development of the software industry restrains India from ascending the Smiling Curve to the highest added value and hence reduces it to a software factory for transnational corporations.

Based on the recent export structure of Indian software, it is not difficult to see the characteristics and problems of this model. Up to now in the export industry, which is nearing US\$30 billion in value, software services have occupied a dominant position. However, software suite products make up only a small part of the total – a situation very different to that in the United States, the largest software exporter in the world. Although it appears that India has achieved a certain degree of globalization due to its vast software exports, in reality it mainly exports software services in the form of outsourcing projects and hence cannot enjoy the enormous commercial advantages brought by economies of scale based on the global marketing of software products. With respect to the division of labor and collaboration on a global level, the Indian software industry plays a labor-intensive part.

#### *China should not follow the Indian model*

Going by the history of Indian software industry development, it would seem that the success of the industry is due to the software export outsourcing model, which is suitable both for the international market and for the domestic one. This model benefits from a strong demand on the international software outsourcing market and from an insufficient demand on the domestic software market, where low-cost labor is readily available. Having been part of the British Empire India has a high standard of written and spoken English, which suits its domestic software industry development pattern. The Indian government has also issued a series of policies to strengthen and promote this model, thereby supporting the success of the Indian software industry over the past 20 years.

However, although the Indian software industry has been very successful until now, as far as the Smiling Curve is concerned it remains at the lower added-value end of the curve, i.e. the coding and testing stage. This is also labor-intensive, rather than knowledge-based. Both innovation and marketing stages (with higher added value) remain under the control of European and American customers who outsource the software business to Indian software enterprises.

This pattern is vulnerable to the impact of lower labor costs offered by other countries and lacks a sustainable development drive.

I strongly believe that China can learn from the Indian success story. However, this is not to suggest that China should simply copy the Indian model, choosing the path of software export outsourcing and ignoring the current international software industry development environment. I think we should study which of India's decisions concerning its software industry development were right, apply them to the international and the domestic situation, and then find out which way would be suitable for us.

The present international environment for the development of the software industry is fundamentally different from the environment at the time the Indian software industry was born. The industrialization and globalization of the software industry has reshaped the global software industry. In Chapter 2 I will give a detailed analysis of the changing international environment. Besides this, we have to consider that the domestic environment for Chinese software industry development is not the same as in India. First, when the Indian software industry began to develop the domestic demand was limited. The export outsourcing model was initially not only suitable considering the circumstances but it was essentially given by default. However, China is a large country with a population of 1.3 billion and a GDP of RMB21 trillion, and it has a significantly larger domestic demand for software than India. China has large-scale industries such as manufacturing, which is considered to be the largest of its kind in the world. Second, in the past 20 years, China's software industry has undergone so-called "self-innovation." Obviously, China does not have the particular linguistic and cultural advantages which made the Indian software outsourcing model so successful. Therefore, China would have no advantage at all in competing with Indian enterprises in software export outsourcing.

Summarizing, I think that the Indian software industry development model could be a strategic choice for China's individual software enterprises or for its regional software industry parks, which constantly try to find a market niche and an opportunity for differentiation. The reason for this is that all enterprises and software parks have different backgrounds and resources and some might be suitable for developing software outsourcing. However, if China were to give up the success it has achieved thanks to the advantage of its domestic market environment and focus its entire software industry development strategy on software processing, in my opinion it would be a disaster, rather than an opportunity.

### **Innovation: the recipe for success**

#### *China should follow its own path*

#### *Models of other countries cannot be copied*

A brief analysis of the American and Indian software industries shows us that many countries around the world are attracted to the American software industry

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pattern. Although there is hardly any hope of directly copying the American model in China, in nearly half a century China has never given up trying to replicate this model. There are many similarities between China and India, however, such as the fact that both are developing countries and that both have a large population. Therefore, simply copying the Indian model in China would seem possible. However, through a thorough analysis of the essentials of the Indian model, we know that this would in fact appear to be backing the industry into a corner. If China were to choose the Indian model, this would mean that – in the course of the globalization of the software industry – China would merely be at the bottom of the value chain, providing coding services to large multinational software companies. Applying this model, the so-called hi-tech software industry would be reduced to a materials-processing industry with low added value. A sizeable proportion of the highly educated computer and software talent would have to settle for blue-collar jobs in the software-processing workshops which would have international software enterprises as partners. Several years ago, 700 million exported shirts had the value of a single airplane. In the future, this most unfortunate situation could possibly repeat itself, with the only difference that the coding developed by 70,000 workers would be exchanged for one single operating system. Gradually, China's software industry would be deprived of active involvement in such important tasks as developing innovative ideas, establishing standards and marketing its products globally. It would also miss out on the opportunity to occupy an elevated position on the Smiling Curve of the global software industry.

*Experiences gathered with the Made-in-China model*

When talking about copying the Indian model, we should remember the popularity of the Made-in-China label. For some time, China has been the factory of the world. The Chinese have even shown a certain national pride when mentioning this. However, given the developments of recent years in economic globalization, more and more Chinese people notice that the label "Made-in-China" which they were previously proud of is now something to be somewhat embarrassed about. If recent trends continue, China will be further reduced to producing goods using foreign materials and blueprints. Being the World Factory, China finally will only be able to derive poor wages and this by exploitation rather than through profits. It is sufficient to look at the labor shortage in the Yangtze River and Pearl River Delta to see that this is the case. The reason lies in the fact that the products made in many Chinese factories are of low added value. Under the pressure of rising material costs and lower prices offered by customers, the factories have to reduce labor costs, which results in a labor shortage. No matter what proportion of the global economy Made-in-China products amount to, China does not own intellectual property rights and therefore has a very restricted influence on the world's economy. The profit China earns from its extensive foreign trade is very limited. The development of many industries which hoped to succeed by applying the Made-in-China model was put on hold

by the lack of innovation and the missing intellectual property rights. The Chinese Video CD (VCD) player industry had to face many patent disputes, which shed a negative light on the Made-in-China model and ultimately held its development back. After many years of development, and despite being the largest producer of VCD players in the world, China still uses 3C and 6C patents, as it has no intellectual property rights on key parts such as decoding chips and other important technologies. This giant industry, which was once producing over 100 million VCD players per year, is withering. In recent years, thanks to new investments and the use of high-definition technology and standard industry components, the Chinese government and the industry are beginning to seize the market opportunity for high-definition VCD players. In so doing, they are trying to overcome their previous difficulties which stem from the lack of intellectual property rights by realizing the strategic transformation from Made-in-China to Innovated-in-China. The way leading to success might be long, but at least we are heading in the right direction. If China continues along this path, one day it will reach its goal.

China's automotive industry has also applied the principle of using the market for exchanging technology since the introduction of the Economic Reform and Opening-up policy. However, in 20 years of development, due to joint ventures, imported product lines and so on, the automobile production is increasing, while technological capability is developing at a much slower pace. Analyzing the advantages and disadvantages of past development models, some enterprises like Chery and Geely have gradually begun to move towards innovation and intellectual property. By studying and duplicating multinational automotive products, these two enterprises are beginning to find alternative development methods for specific market segments and are taking full advantage of the newly emerging domestic demand for cars to enter the Smiling Curve of the complete automotive industry value chain. For example, Chery has been on the market for five years. At present, the sales volume on the domestic market is among the top ten automobile companies in China. The number of car types owned solely by Chery is 11. Although these enterprises are much smaller than multinational car manufacturers such as Toyota, GM and Ford, thanks to the production of car parts and the assembly of imported bulk parts at the lower end of the Smiling Curve, they are able to form a complete Smiling Curve. This gives hope for a successful transformation from Made-in-China to Innovated-in-China.

The great changes that occurred in China during the 20 years since the Economic Reform and Opening-up policy was launched favor the idea of a model with Chinese characteristics raised by the grand architect of China's modernization, Deng Xiaoping. The Chinese economic model is not a copy of the European or American development method, nor does it follow those of the former Soviet Union or the Eastern European countries. It is a method suitable for China as well as for the current international state of affairs. China's outstanding achievements in its search for a suitable developmental path since Economic Reform and Opening-up have been attracting worldwide attention. Similarly, the fast developing software industry is in need of a development pattern with Chinese characteristics.

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*China's software industry is able to develop following its own path*

To refer to the manufacturing industry when speaking about China's economic development might seem to be diverging from the main topic; however, it will serve to explain that the transition from Made-in-China to Innovated-in-China has become the country's future development trend. Let us return to the development of the software industry. We need to exploit and form a model also in this field, bearing in mind the global industrial development trend and China's current economic situation. One possibility might be to learn from the Indian software production model: to take advantage of China's intensive labor characteristics; to train high-school graduates to create a software blue-collar sector, taking into account the global competition; to develop software export outsourcing, which some domestic software enterprises could see as a feasible strategic choice and market opportunity. However, against a backdrop of single nations competing with each other in a period of globalization, in the time of knowledge economies, if China wants to develop a sustainable software industry it must gain an upper hand in international competition. China should not follow the Indian model, but rather it should pursue self-innovation on the basis of constant research, maintaining an open attitude and aiming at creating a complete Smiling Curve, comprising everything from the creative idea to brand marketing.

Owning a complete innovation value chain, from creation to global marketing, is a goal of China's software industry. But the question is: Do we really have the capability to do it? In my opinion, during half a century of development, China has been able to establish the foundations for setting up a complete Smiling Curve for China's software industry.

Looking at the history of China's software industry, we notice that software production has a long tradition of independent innovation in an isolated environment. In the difficult years from the 1950s to the late 1970s, China developed a series of extremely innovative software products which contributed to the development of "Star-Bombs" and other products for national defense. Apart from their military use, the levels of commercialization and industrialization of these innovative software products were low as there was little demand for them on the domestic market. These products were very creative, however, and showed the Chinese people's capability for self-innovation and software development.

Since the 1980s, and especially the middle of the 1990s, China's software industry has progressed further to create a knowledge base necessary for shaping a complete Smiling Curve. All the years I have been working in China, I have witnessed that China's software industry is growing rapidly. Riding the wave of globalization, it has gradually become familiar with the operation of the global software market, and has accumulated experience in industrialization and commercialization. Many talented individuals from the Chinese software industry have played an important role in global software enterprises like Microsoft and SAP. Chinese students educated and trained in Silicon Valley, which is at the forefront of the global software industry, are now returning to China hoping to fulfill their dreams. Through cooperation with their global customers, China's

domestic enterprises are also beginning to move abroad, and are getting acquainted with the demands of customers from different cultural backgrounds.

On the one hand, the large pool of Chinese software talent with an international education and the capability for innovation constitutes an internal force for the realization of the complete Smiling Curve for China's software industry. On the other hand, the rapid development of the Chinese economy as an external force has stimulated market demand. China's GDP has maintained a rapid growth rate in the 20 years since Economic Reform and Opening-up began. Currently, the Chinese GDP is ranked fourth in the world. The country's tremendously dynamic economy will create a great demand for software and will generate a base for China's software industry to shape a complete Smiling Curve.

Considering these advantages, it would appear unnecessary for China to copy the Indian model. It should, however, find its own development space, based on self-innovation, and try to shape a complete Smiling Curve for China's software industry. Only by doing so can this industry succeed.

Expanding this backward dependent world and understanding the industry

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