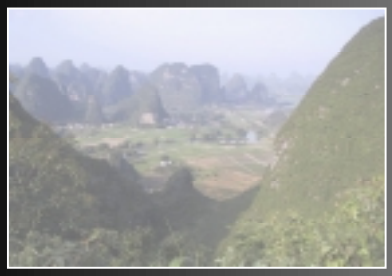

InnoChina

A Study on the Policies, Structures and Training Programmes Which Have Evolved to Encourage Innovation in the Science & Technology Sector of the People's Republic of China

NOVEMBER 2002

This project has been completed by:

Sociedade Portuguesa de Inovação – Consultadoria Empresarial e Fomento da Inovação

Through the support of the European Commission, under the:

INCO A5 – Emerging Economy and Industrialized Countries Programme

Acknowledgements

SPI is very grateful to all the organisations and individuals that have helped in the course of this work, by sharing with us their knowledge and experience; in particular, we are grateful to Chen Jia Chang, Chen Jin, Guo Haiyan, Huang Can, Kong Deyong, Catherine Raffour, Geoffrey Oldham, J. Borges Gouveia, Jeff Butler and Maximilian Von Zedtwitz, for their active involvement in the project Seminar.

Porto, June 2002

Executive Summary

The purpose of this project is to promote international cooperation between Europe and China in the area of S&T innovation. This project report entails a detailed study on the state of S&T in China, principally the policies, measures, structures and training programmes that have evolved to encourage innovation, a comparison of compatibility with the science innovation base of Europe, and consideration of opportunities for international collaboration.

China Overview

China set a priority on science and technology (S&T) more than twenty years ago. Endeavours to build strength in this area have resulted in rapid improvements, marked by the quadrupling of Gross National Product since 1978. Much progress has been achieved, but lingering problems remain, such as transparency, market openness and corruption.

Europe's diplomatic relations with China were established in 1975, and the past decade has witnessed generally satisfactory relations. Europe was instrumental in helping China to address the reforms needed for the country's negotiations for WTO accession, which were finally resolved in 2001. China recognizes that the EU has provided the country with an invaluable service and has welcomed this intervention. However, there is some concern that Europe's aid to China could backfire - as China continues to develop it eventually could become a considerable competitor.

China's National Innovation System

National innovation systems are made up of various inter-related components that form the framework for all innovation activity. This project's review of China's innovation system considers the policies, measures, structures and training programmes at the national level.

Government policies in S&T over the previous two decades have been directed at developing self-sufficiency in R&D, developing the country's science base, increasing R&D activities, and bringing international technology and expertise to China.

Measures are activities undertaken to achieve a given agenda. In China, these efforts have centred on promoting innovation through supporting private enterprises as they improve their abilities to innovate. The measures addressed in this study are those that fall under the categories of innovation programmes and incentives and rules relating to collaboration.

China uses programmes extensively. These programmes generally address specific social, economic or technological issues. It is clear that there should be more interaction and cooperation between these programmes, but also that they have been critically important to development of the science base.

The second area of measures assessed is that of incentives and rules. The country's administrators have put a great deal of energy into finding incentives for both foreign and domestic firms developing S&T innovations, including incentives for importing technology and research activities from abroad. China has relied heavily on imported technologies to keep up with scientific developments.

China has taken many steps to create and enforce the appropriate legal structures, or rules. Intellectual property rights protection, patent laws and antitrust legislation are relatively new concepts, but each have been the object of regulatory reform. Other areas where the rules have changed include establishing foreign enterprises and making foreign investment. Entry into the WTO will usher in broader changes in the rules of competition in China, particularly concerning market openness and governmental interference.

The organisation and components of China's R&D system make up support structures. The main common support structures are business incubators (also referred to as innovation

centres) and high-technology parks or zones. The establishment of such structures has proven effective in the more densely populated coastal regions, and is now being broadened to support more rural areas.

Using training programmes to increase China's capabilities and competitive advantages appears to be beginning, often with foreign assistance. Though recent years have witnessed an elevation in enrolments, a shortage remains in China of individuals with high levels of education, and rural education remains a challenge. Overall, education in China could be reformed in system, support, structure and concept. Among other adjustments is the prospect that by 2004 5-10% of courses at colleges and universities will be conducted in English, including courses in information technology, biotechnology, finance and law.

Innovation in Europe and China

From a public policy stance, Europe's objectives in innovation relate fundamentally to competitiveness and social and economic development. A stated intention of Europe's Innovation Programme is to "keep abreast of innovation policy developments" through: "1) fostering an innovation culture, 2) establishing a framework conducive to innovation, and 3) gearing research more closely to innovation at both the national and Community level."

China's aim is also to promote social and economic development, but starting from a lower base and broader population. Technologically, China seeks to obtain technologies that are more readily available in Europe.

Components of the innovation system in Europe are normally managed at the country level, though the EU helps in their direction through programmes and funding. A primary application of Europe's innovation system is in addressing integration of the Community's diverse membership – integration across cultures, languages and regions. Networking knowledge and efficiently using the strengths of its members is a top priority,

China also has regional innovation systems, but also administrates a unified national system. Initiatives have been aimed at economic renovation, and the country has had to face a comprehensive overhaul of the economy, while balancing reforms against a historically incongruous political ideology. In S&T, China has established objectives on: the adequacy of available personnel, the development of rural areas, the direction and internationalisation of research efforts, and the improvement of innovation networking and research funding.

Collaboration

Europe's benefit in working with China in S&T includes: helping the country address developmental challenges, achieving political and economic goals, and gaining access to a large market. Conversely, China can gain access to advanced technologies, input from highly skilled scientists and researchers, financial support on projects with shared costs, and strengthened political ties. Also, both Europe and China have sought international collaborations to elevate their international competitiveness.

Despite China's reform-driven progress, weaknesses remain, including the enforcement of law, guidelines for testing, standards and product quality, a lack of capital among Chinese researchers, a lack of skilled personnel and inadequacy in the dissemination of information.

S&T ranks high among the current opportunities in China. Some observers have concluded that S&T-based industries are the top sectors offering foreigners opportunities in China. These include telecommunications, information technology and biotechnology. Opportunities for S&T collaborative work are generally centred in urban areas - the principal cities involved in research are Beijing, Shanghai, Guangdong, Shenzehn and Wuhan.

As China continues to progress in its development, the benefit of having established connections with the country will increase. Working in collaboration now can serve to assist the country's improvements, and to build valuable relationships that can promote future alliances and elevate competitive positioning.

Next Steps

Through the activities undertaken in the course of this project, several concerns were brought to light as those that should receive further attention and that could be addressed through government programmes sponsoring developmental projects. Those concerns are:

- The lack of linkages between European and Chinese networks. Linkages between their respective networks are both needed and appropriate in the interest of facilitating science and technology collaborations.

- The lack of accurate measurement of innovation activity levels and the transfer of applicable innovations from the laboratory to industrial application within China. Building the measures is a step towards assessing the effectiveness and, thus, focusing efforts on necessary changes.

- The need to promote and transfer science and technology from the densely populated eastern coastal regions to the sparsely populated western regions of China. Europe's experience with the development of Eastern Europe can be of great benefit to China in this regard.

- The need to educate businesses on the standards demanded by the WTO upon China's accession. The endorsement of training in various related topics is strongly recommended and justified.

Addressing these concerns would thus be directly instrumental in the country's development and in the fostering of collaborative work between Europe and China in science and technology innovation projects.

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1. Introduction and Objectives

The importance of Science and Technology (S&T) innovation in the People's Republic of China (PRC) has increasingly been impressed both upon policy makers in China, and the international community. In both cases it is recognized that economic developments in the world will be strongly influenced by international relations and by S&T innovations in the coming years, just as they have been in the past.

The PRC set a priority on S&T more than twenty years ago. Endeavours to build strength in this area have resulted in rapid improvements and economic growth. Innovation-focused programmes have resulted in the initiation of thousands of projects, the development of numerous incubators and S&T parks and the creation of thousands of new companies. These have significantly contributed to the quadrupling of Gross National Product (GNP) between 1978 and the turn of the century[1].

Given these circumstances, international collaborations with China are of vital importance in terms of competitive positioning in both the short and long terms. This is especially applicable in S&T innovation, as rapid progress in technologies has made the ability of countries to keep abreast of advances increasingly important.

It is these conditions that have led to the development of the current project, aimed at promoting international cooperation between Europe and China in the area of S&T innovation. This is achieved through the following detailed study on the state of S&T in China, principally the policies, measures, structures and training programmes that have evolved to encourage innovation. The study specific objectives are to develop an understanding of:

- Policies implemented to emphasize the importance of scientific innovation;
- Measures, initiatives that encourage such innovation;
- Structures, which provide the means for innovation activity; and
- Training programmes specific to supporting innovation activity.

The project provides a thorough assessment of the circumstances in China pertinent to international collaborations in S&T. The outcomes of this work include:

- An ***innovation study report*** containing analyses of policies, measures, programmes, incentives, supporting structures and training programmes with conclusions on the strengths, weaknesses and impact the initiatives have on innovation activities in the S&T sector;
- A ***seminar for the promotion of international co-operation*** within the European Community (EC) that will promote Research and Technology Development (RTD) co-operation internationally, and consequently reinforce EC capacities in the fields of science and technology (S&T). This seminar will focus on the development of collaborations.

The results will be disseminated in the form of a seminar, as noted above, which will promote international collaborations in innovation activities between the EC and the PRC. The project report will be made available to interested parties by way of paper copies and the Internet.

2. China Overview

China, with a population of 1,26 billion and an increasingly accessible market, has become of particular appeal to outside interests. Behind this attraction as a partner for international collaborations is a long history of changes and developments. Understanding the influences on the country will help facilitate such collaborations by providing necessary awareness of the culture and social climate.

Source: CIA World Factbook 2001

2.1 Political Reform

The political history and structure of China have had a powerful influence on the country's economic and social development. Decision-making has traditionally followed the central planning model for administrative concerns, including political and economic issues. This has been relaxed to some degree over the past two decades, particularly in regard to the economy.

Policy changes have resulted in numerous improvements, but these have sometimes been accompanied by negative consequences. For example, government spending has fuelled reforms, but high levels of public sector bureaucracy have confronted the opening of the economy, making it difficult for foreign enterprises to operate efficiently inside the country. Obtaining current and reliable information is often a challenge. Also, the presence of foreign enterprises has revealed inequalities in the government's tax policies for foreign and domestic firms.

Such domestic protectionism is evidence that the government may have been willing to open its doors to the outside, but only as long as domestic companies weren't exposed to onerous levels of competition. It is this approach that has kept China's "market openness" ranking low. In a 2000 study by the Centre for Asia and the Emerging Economies at Tuck Business School, China ranked 43rd out of 44 developing countries on market openness[2]. While reforms have brought progress, there is still room for further change. China's entry into the

World Trade Organisation (WTO) should significantly improve foreign access to Chinese markets, as the government is obligated to honour its WTO commitments to reform.

There are indications that China continues to suffer from a high level of corruption. According to Transparency International's 2001 Corruption Perceptions Index China placed 91st among 125 countries, with a CPI Score of 3,5 (10 = highly clean, 0 = highly corrupt)[3]. In the past there has been a lack of the rule of law in China, and notably a lack of antitrust legislation. The repercussions of this include the misallocation of funds and government corruption. As reported by Wayne M. Morrison of Congressional Research Services: "In many cases, government 'connections,' not market forces, are the main determinant of successful firms in China."[4] Such market deterrents must be addressed if China is to maximize the economic potential of opening to the outside world.

Receptivity to external stimuli has been an ongoing process in China's economic reformation. In 1973 the government of China announced The Four Modernizations in an attempt to move toward renovation[5]. The four target areas of this agenda were agriculture, industry, national defence, and science and technology. The focus on S&T was specifically emphasized at the First National Conference on Science and Technology in 1978. In the following years the new administration, under Deng Xiaoping, began actively promoting S&T and moving away from centralized decision-making on economic issues. The focus on innovation is a more recent development in China's political reform, beginning around the mid-1980's.

Ming Dynasty Vase

Reforms in the PRC have been clearly directed by the State Council and the Chinese Communist Party (CCP), including most notably The Decision on the Reform of the Science and Technology Management System in 1985, and The Decision on Accelerating Scientific and Technological Progress in 1995. It is these edicts that have paved the way for new S&T collaborations in China.

These developments show that China's approach to science and technology has progressed. While politically there may be a consensus as to the country's economic goals, finding the balance between protecting domestic interests and developing a true market economy is a continuing process. Independent consulting firm InterChina further confirms this:

> "The main political issue, and also the main obstacle to China's economic development, is the existence of powerful interest groups linked to state owned enterprises, ministries, local governments or a combination of these. These groups are very skilled in the use of political / ideological arguments for the sake of protecting their own interests and the status quo, with the final aim of self-enrichment." [6]

The outlook for the gradual resolution of such challenges is hopeful. Accession to the WTO in itself marks an important milestone in this regard, reflecting agreements with both the United States (US) and the EU.

It must be noted that S&T innovation in China is not only driven by political means, but also by the results gained through these means. There is a cyclical cause-and-effect relationship. As reforms have achieved many of their economic and social aims, their results have served, in turn, as an impetus and justification for further reforms. Reforms have changed the economic conditions of the country, and challenges - such as the introduction of higher levels of competition - have brought about the need to respond to new issues.

2.2 Economy

The economic reforms endorsed by China's administration have not been without effect. Since 1978 gross domestic product (GDP) has quadrupled, and though slowing it continues to grow. In 2000 GDP grew by 7.9 percent, and the following year by 7.3 percent[7]. This growth trend appears to be winding down, following phenomenal expansion through the 1990's. Over the past 20 years exports have risen 15 percent annually, and imports 13 percent. By the year 2000 China was the world's 2nd largest economy by GNP - measured in purchasing power parity.[8]

In spite of the evident growth in China's economy, the numbers alone can be misleading. For one thing, they are sometimes considered inflated. One recent report noted: "Official growth statistics have long been exaggerated, for a number of reasons. For one, local officials cook the books to make their region look good. For another, China still produces goods that pile up as inventories and are never sold. Yet their production gets added to GDP, when it should be subtracted. The problem is that no one knows by quite how much official GDP is overstated…. [but] at least the trend in GDP is fairly reliable…" [9] Naturally, this perception can be a significant deterrent to international collaborations.

Many foreign companies jumped at the opportunity to invest in China a decade ago, when GDP growth appeared astronomical. This eagerness failed to take into account that GDP growth percentages were relative to a low starting point, and the fact that income and demand vary greatly by region[10]. Due to transparency problems it is difficult to assess the accuracy of much of China's economic data.

"The dragon's backbone", China

Another consideration for foreign investors is that despite expansion the GNP per capita in 1999 was still nearly 25 percent below the average for the East Asia & Pacific Region - the current average income is still slightly less than USD 1.000/person. The economy was so severely suppressed through most of the 20th century that it was not until 1993 that the level of international trade grew to match its 1928 level. However, short-term forecasts indicate that trade growth may slow in the coming years, although not dramatically. While the rate of economic growth in China has been tremendous, it is less surprising in light of the level to which the economy had dropped.

The repercussions of a sustained closed economy brought the reforms China began to endorse in the 1970's. These changes, of necessity, have been far reaching. An overview of the progress of reforms is offered in Table 1.

Included in China's reform objectives is the privatisation of State Owned Enterprises (SOEs). According to the World Bank, there were 1.836.300 SOEs in China in 1998, employing more than 90 million people and accounting for roughly 60 percent of public sector revenues[11]. Though this number has fluctuated somewhat over the previous decade, the number of SOEs has fallen since 1995. Nonetheless, such enterprises still control more than 70 percent of all fixed assets in China, and weaken the motivation for market competitors to promote innovation.

In the near future many state-controlled sectors in China will be opened, including banking and telecommunications. This should reduce bureaucracy and boost the efficiency in these sectors, but change is sure to be slow. Foreign competitors will be obliged to wade through

the bureaucracy and legalities in a system where regulations have not been clear nor consistently enforced.

Table 1: Timeline of China's reforms

Overview of reform progress	
1973	- Announcement of the Four Modernizations
1978	- Deng Xiaoping establishes the Open Door Policy
1980	- China becomes a member of the IMF
1983	- Patent law enacted
1986	- China applies to join GATT
1992	- Patent law revised, China joins World Intellectual Property Organization (WIPO)
1994	- IPR court established
1997	- Announcement of the restructuring of the state enterprise sector, including some privatisation
2000	- Conclusion of bilateral market access agreement with the EU (most commitments to be implemented by 2005)
2001	- China becomes a WTO member

Sources: European Delegation in China and the Ministry of Science and Technology

Development of the west is an increasingly important agenda of economic initiatives, as marked by the endorsement of the "Go West" policy by the National People's Congress' (NPC) in 2000. For development in the west to take place, the PRC will need to ensure the installation of suitable support infrastructures.

The labour force in China totals 700 million. Unemployment remains a challenge, however, as the unemployment level in urban areas is reportedly 10 percent (2000 estimate)[12], and probably much higher in rural regions. This situation has somewhat improved in recent years, following the government's post-1998 initiatives to increase employment opportunities. Poverty is a continuing problem. There are still 230 million people living on less than EUR ,88 (USD 1) per day, and about 670 million living on less than USD 2 per day. This accounts for roughly 70 percent of the total population. The GDP per capita is better understood on a regional basis. In the western regions per capita GDP is only one-third that of the coastal regions.

Though many reforms have been implemented, many more are poised to follow. This will be led by the country's WTO commitments, making foreign involvement in China easier through reducing barriers and opening new sectors to foreigners. This new competition will impose efficiency requirements on China's emerging private sector, and cultivate an S&T innovation-centred economy.

2.3 Europe/China Relations

China's long absence from the international forum isolated the country from the benefits of foreign relations. Changes in this posture came in the mid-1970's, toward the end of the Cultural Revolution. Europe's diplomatic relations with China were established in 1975 with a visit from European Commissioner Sir Christopher Soames. In the same year China approved a new constitution, lessening the Chinese Communist Party's (CCP) control over its citizens. Subsequently, a trade agreement was reached in 1978, resulting in the creation of an EU-China Joint Committee. Progress in Europe's relations with China was temporarily stalled for a time following the 1989 crisis at Beijing's Tiananmen Square. However, normal relations were again established in 1992, and the past decade has witnessed generally satisfactory relations between Europe and China.

Europe was instrumental in helping China to address the reforms needed for the country's negotiations for WTO accession, which were finally resolved in 2001. The EU's commitment has helped the country progress more quickly than it could have done alone. This commitment is reflected in the many activities that the EU has carried out in China (see Table 2 on the following page). The European Commission's currently stated objectives for China include:

> "To integrate China in the world economy by bringing it more fully into the world trading system, and by supporting the process of economic and social reform that is continuing in China." [13]

There is some concern that Europe's aid to China could eventually backfire - as China continues to develop it eventually could become a considerable competitor. In this case Europe's developmental initiatives will have damaged, not aided its position.

For its part, China recognizes that the EU has provided the country with an invaluable service and has welcomed this intervention. In the Fourth EU – China Summit Meeting held in September of 2001, Chinese leaders thanked their European counterparts for the EU's "long-standing support", and welcomed additional co-operative efforts.[14]

Total trade between the EU and China is now twenty times higher than it was in 1978, and China is Europe's 3rd most important external trading partner[15]. Within the EU, Germany and the United Kingdom in particular rely heavily on trade with China. Additionally, the EU is one of the leading sources of foreign investment in China.

Hong Kong

Cooperation with China has not overlooked the importance of S&T. Over the past two decades the EU has overseen more than 100 S&T projects involving partnerships with China. The EU-China S&T Agreement of 1998 has further opened the door for S&T collaborations, which can now expect the support of both the European Commission Delegation in China and the Chinese Ministry of Science and Technology (MOST).

In the interest of cultivating China's potential, the EU has developed additional initiatives to overcome issues concerning both S&T and general business areas. These include programmes directed towards human resource development, the rule of law and good governance, economic and social reform, and the environment.

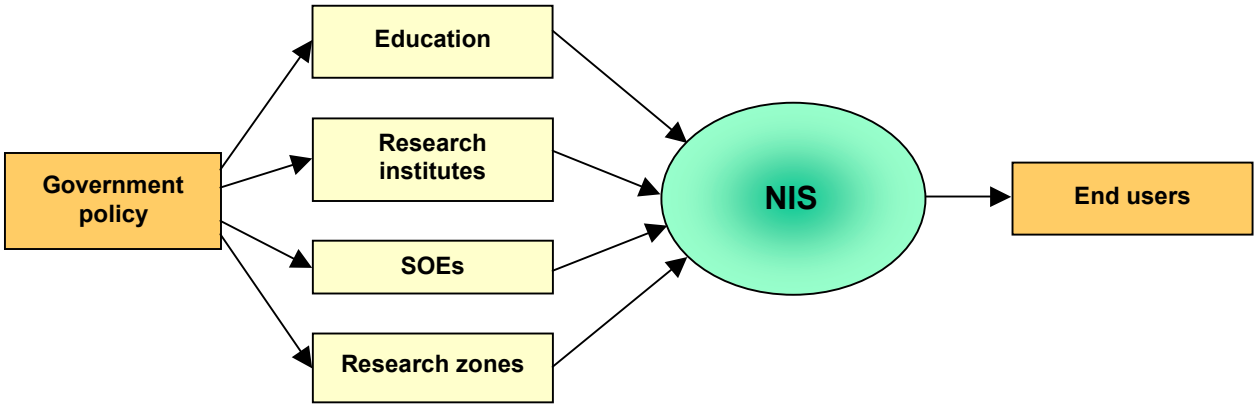
Table 2: The European Commission in China

EU-China Co-Operation Projects/Programmes	
General	Small Project Facility
Human Resource Development	China Europe International Business School
	Higher Education Project
	Junior Managers Programme
	China Europe Public Administration Project
	Vocational Training
	Basic Education
	Scholarships 2000
	STD/AIDS Training Project
Rule of Law and Good Governance	Human Rights Small Project Facility
	Village Governance
	Public Procurement
	Statistics
	Intellectual Property Rights Co-operation Programme
	Legal and Judicial Co-operation
Economic & Social Reform	WTO Accession Project
	Social Security Reform
	Financial Services
	Enterprise Reform
	Civil Aviation
Environment	Liaoning Integrated Environment Project
	Environmental Management Co-Operation Project
	Honghe Poverty Alleviation Project
	Vehicle Emission Control
	Solid Waste Disposal Project with UNDP
Rural & Agricultural Projects	Pa-Nam Integrated Poverty Alleviation Project
	Ningxia Irrigation/Drainage Project
	Qinghai Livestock Project
	Qinghai Potato Development Project
	Water Buffalo Development Project
	Dairy Development Project
	China-Europe Centre for Agriculture
Pending	Natural Forest Management Project
	Energy and Environment
	European Studies Programme
Source: European Commission Delegation in China, www.ecd.org.cn	

3. China's National Innovation System

National innovation systems (NIS) are made up of various inter-related components that form the framework for all innovation activity. These include the universities and academic institutions that prepare scientists and researchers for innovative pursuits, state-owned enterprises (SOEs) and industrial research institutes active in research and development (R&D), and public and private end-users of innovations. The interaction of the basic components of innovations systems are depicted in Diagram 1, below:

Diagram 1: National Innovation Systems (NIS)



An NIS is shaped by public policies that are instrumental in establishing the degree of priority a country places on scientific innovation. Following policies are the measures, or activities, that are designed to promote the agendas established through policies. These include the various programmes that are frequently implemented as a means of supporting policy decisions. They generally aim at sponsoring projects by independent parties in specific fields. Gaining the involvement of participants in innovation activity is subject to the conditions pertaining to incentives and rules. This is a second area addressed through measures, and is another important consideration in the analysis of national innovation systems.

Efforts to achieve innovations clearly require facilities and the necessary research environment. Such structural support is another component of innovation systems. Typical forms include the allocation of an area as economic or research "zone". Within these zones S&T parks are often established, offering researchers the opportunity to share a supportive environment and network within their fields. These parks will sometimes include business incubators, where start-up companies in related industries will be advantaged through the availability of resources which they would otherwise not have access to.

A key consideration of innovation systems is their contribution to the long-term future of the drive to innovate. In this regard the educational system is critical in preparing the next generation of researchers. Through providing appropriate training programmes an NIS is to sustain innovation efforts.

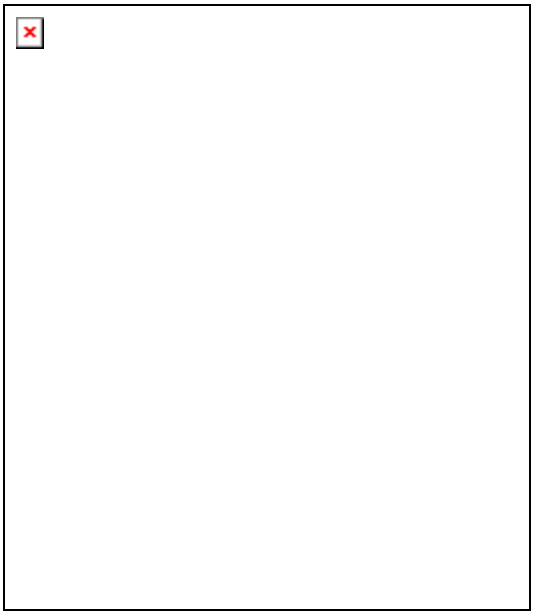
In the following sections, these components of China's NIS will be examined in greater detail.

3.1 S&T Overview

Prior to the reform focus of 1978, pursuit of industrial innovations in China was discouraged because it brought about unwanted delays in production. Innovations in S&T were primarily reserved for military technologies, and led to achievements in this area, such as the country's attainment of atomic and hydrogen bomb production. The influence of production-focused policies is reflected in the SOE Anshan steel mill, which still operates on equipment the Japanese installed in the 1930's.

Since its inception in 1949, the Chinese Academy of Sciences (CAS) – see Box 1 - has been the centre of the promotion of sciences in China. After 1978, China began bringing western educated scientists back into the country, and resumed sending students abroad to study. In this way the country was able to import knowledge and technologies from abroad, and begin updating its systems. In 1984 the Chinese National Natural Science Foundation was established, giving scientists the opportunity to do their own research. In 1998 the State Science and Technology Commission changed its name to the Ministry of Science and Technology (MOST) – see Box 2 - and became a principal participant in China's technological endeavours.

Today, S&T in China has become a focal point around which many reforms are centred. While many technologies have come to China through the investments of foreign interests, China aims to develop viable S&T innovations of its own. In this endeavour, China has welcomed collaborations with foreign enterprises. The country has introduced policies, measures, support structures and training programmes aimed at further promoting this agenda, as described in the following sections.



Stone City, Nanjing

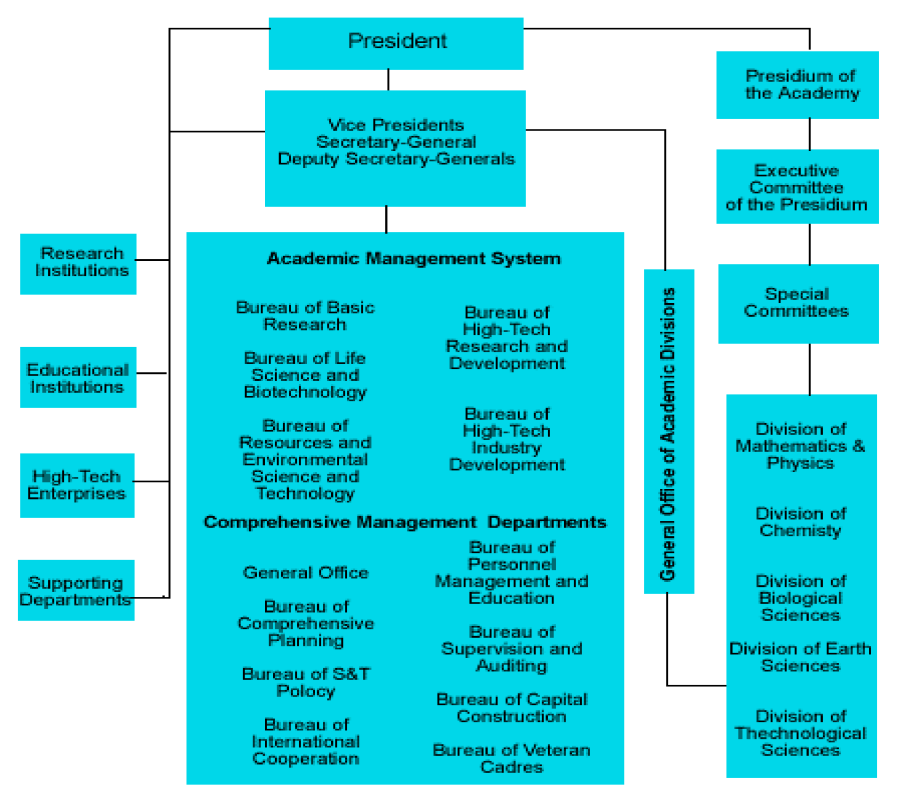
Box 1: Overview of the Chinese Academy of Science

THE CHINESE ACADEMY OF SCIENCE

Description:

The Chinese Academy of Sciences was founded in 1949 as the successor of the Central Academy of Sciences and the Beijing Academy of Sciences. CAS now includes 5 academic divisions, 108 research institutes and more than 500 Science and technology enterprises. It is the country's highest institution for R&D research in natural and technological science and high-tech innovation. CAS is the primary body influencing science and technology policy in China.

CAS Structure:



CAS Mission and Purpose:

> "To conduct research in basic and technological sciences; to undertake nationwide integrated surveys on natural resources and ecological environment; to provide the country with scientific data and advice for governmental decision-making, and to undertake government- assigned projects with regard to key science and technology problems in the process of social and economic development; to initiate personnel training; an d to promote China's high-tech enterprises by its active involvement in these areas."

Cooperation Internationally:

CAS strongly supports work with international partners. The Academy has carried out many such activities in the forms of joint investigations, joint ventures, joint laboratories, joint young scientist workshops, training courses, and bilateral and multi-lateral seminars. To date CAS has signed cooperative agreements with more than 40 countries. Additionally, CAS has worked to develop its personnel through international exchanges, sending more than 7000 individuals abroad in 1999 alone. CAS recognizes the value of international cooperation and is a vital contributor to China's support of these efforts.

Source: Mission and Functions of the Chinese Academy of Science, Chinese Academy of Science. http://www.casbic.ac.cn/index.html

Box 2: Overview of the Ministry of Science and Technology

THE MINISTRY OF SCIENCE AND TECHNOLOGY

"A central government agency under the State Council, responsible for the nation's science and technology activities."

MOST's Missions include:

- Formulate strategies for S&T development and guidelines, policies, laws and regulations to accelerate social and economic development through S&T; including,
- To research and decide the priorities for S&T development;
- To promote the construction of an NIS;
- Formulate annual, medium and long-term plans for civilian S&T development;
- Establish the guiding principles, policies and measures of S&T system reform;
- Develop measures to increase input into S&T through multiple channels;
- Reinforce the industrialization of high and new technology, and the development and dissemination of applied technology;
- Develop and direct guidelines for S&T development programmes, such as the Torch Programme, Spark Program, S&T Achievements Dissemination Programme, etc.;
- Administer the national high and new technology industry development zones;
- Develop policy recommendations for the deployment of human resources in S&T, and to establish the incentives and environment needed to achieve progress in S&T;
- Conduct research and establish the guiding principles and policies on international S&T cooperation and exchange.

MOST's Department of International Cooperation:

- To conduct research on guidelines, policies, and regulations concerning international science and technology exchange and cooperation.
- To organize the implement of the plans of government bilateral and multilateral science and technology cooperation and exchange as well as with relevant international organizations, the official agreements of science and technology cooperation, and to examine and coordinate major projects of non-official science and technology cooperation and exchange.
- To organize the implementation of scientific and technological aid from foreign governments and international organizations to China , as well as from China to foreign countries.
- To direct the work of the Chinese science and technology agencies in foreign countries, to liaison S&T agencies of foreign countries and international organizations in China , and S&T affairs with Hong Kong, Macao and Taiwan.

Source: Missions and Departments of MOST, Ministry of Science and Technology.
http://www.most.gov.cn/English/index.htm

3.2 Policies Supporting S&T Innovation

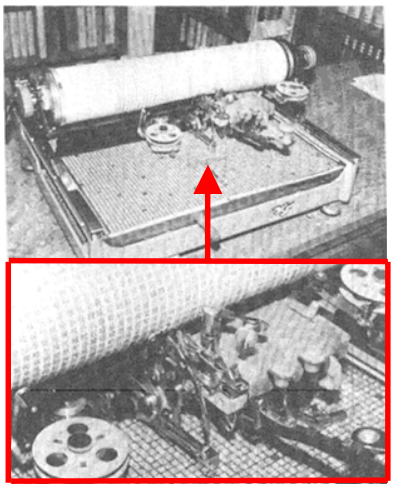
There is no doubt that public policy in the PRC is committed to S&T innovation. Government policies in S&T over the previous two decades have been marked by the following agendas:

- Development of a self-sufficient R&D sector, gradually eliminating government funding and requiring R&D institutes to support themselves through efficient and profitable activities.
- Broadening and strengthening the science base and develop the high-technology sector through policy-supported activities (or "measures").
- Increasing R&D efforts through implementing programmes that promote R&D in key areas.
- Bringing international technology companies into the Chinese market through providing a system of incentives.

A clear example is found in the 1999 decision of the CCP's Central Committee and the State Council on Strengthening Technological Innovation and Developing High-Technology and Realizing Industrialization. The Committee set forward several clear goals of the PRC for the future, consistent with those of the recent era of reform.

These goals pertain to a deep and comprehensive renovation of technological innovation. They aim to build and reinforce science, technology and innovation in the industrial and social fabric of the country, and include extensive reforms in the public sector, particularly with reference to SOEs.

In this respect China is promoting the transformation of state-controlled research institutes into private enterprises, effectively mandating that their activities and operations must be pragmatic and profitable. With few exceptions such SOEs have long histories of operating at losses, and yet have been sheltered from bankruptcy proceedings. China has begun an initiative for all large SOEs to develop their own R&D centres focused on new product and new technology development. It is hoped that these centres will now become the driving force to make SOEs responsive to market demands and adaptive to technological change. It is noteworthy that this is an unprecedented departure from the country's stance of 30 years ago, and is clear evidence of China's progress in adopting a socialist market economy.



Early Chinese typewriter

Similarly, the Committee's decision included promoting private enterprises to enhance their innovative activities, a critical step for companies that are becoming increasingly vulnerable to foreign competition. The decision set forward several methods as pragmatic means of carrying out the intended strategy. The development of high-technology zones was endorsed, as was the support of science-based private businesses. Incentives by way of tax policy improvements, preferential treatment, awards and bolstered intellectual property rights were included.

Another important change is found in the effort to establish a stronger network of S&T organizations and institutions. In this regard, a forum was established in 1996 to guide the country's long-term development policies. The forum involves the ministers of the leading

science, education and economic agencies, and has approved the launching of several key supporting programmes.

It is the policy objective reflected in these initiatives, and the Knowledge Innovation Programme, discussed in Box 3, below, that is responsible for the transformation of innovations in S&T in China that is now taking place. It has opened the doors for international collaborations in the area, and has been responsible to a large extent for the scientific and economic progress the country has made to date.

Box 3: The Knowledge Innovation Programme

The Knowledge Innovation Programme

Officially initiated in June of 1998, the Knowledge Innovation Programme aims "to upgrade the country's S&T competitiveness and to meet the challenges of economic globalization and a knowledge-based economy in the 21st century."

This programme is directed at improving the aspects of CAS that are related to S&T innovation. This includes:

- Restructuring CAS institutes to reduce bureaucracy and increase efficiency;
- Addressing human resource development issues, including incentives and benefits;
- Developing "a good environment and atmosphere" conducive to creativity and innovative thinking in S&T, including reconstruction of the facilities of CAS institutes;
- Improving the working conditions in CAS institutes to stimulate creativity and achievement.

This programme illustrates the new, innovation-focused direction of political reform in China.

Source: Chinese Academy of Sciences, Bureau of International Cooperation.

www.cas.ac.cn

The progress achieved through these efforts is easily substantiated. For instance, 242 of the larger scientific research institutes under the control of the government have now been successfully transformed, mostly into private companies and a few into technical services institutions. Among these, 10 are now traded publicly on the stock market. China's economy is evolving into an enterprise system, responsive to market demands, and capable of flexible and innovative operations.

3.3 Measures Supporting S&T Innovation

Measures are activities undertaken to achieve a given agenda. Chinese authorities have taken many practical steps in recent years to develop innovation-focused activities with the objective of creating a higher national level of competition. These efforts have centred on promoting innovation through supporting private enterprises as they improve their abilities to innovate. The measures addressed in this study are those that fall under the categories of innovation programmes and incentives and rules relating to collaboration.

A Hong Kong park

The innovation measures taken in China share in the aim of creating an environment of fair competition. The support these measures provide are commonly in the form of finances, preferential treatment, achievement awards or promoting the privatisation of businesses or innovations. In addition to providing incentives, China seeks to remove obstacles through undertaking such measures as the harmonization of the legal code and rule of law concerning intellectual property rights protection.

A primary motivator for the advancement of S&T innovation is the benefit researchers receive for their work. Thus, China's measures have raised the salaries and welfare of such professionals. This has been done for scientists and engineers, primarily within SOEs, in the form of financial allowances. In some instances support has extended so far as to provide home, car, and children's education allowances. Private sector competitors have been outgunned in this respect, claiming that the salaries offered by the public sector to young graduates are not sustainable by private competitors. In this sense, the government's quest for innovation may have overshadowed the ideal of fair competition.

In the coming years China can be expected to continue its drastic reform measures. At the National S&T Working Conference in October of 2000, China set forward its five-year targets:

- Upgrade basic research to the level of China becoming one of the top ten countries in the world in this area.
- Increase S&T investment to 1.5 percent of GDP or more by 2005. Progress private R&D investment to the level that more than half of all R&D investment comes from private industry.
- Increase the number of scientists and engineers engaged in R&D to 900,000 by the year 2005.

China recognizes new technology-based firms are a source and principal means of elevating S&T innovation. The start-up and development of technology-based firms, and their resulting benefits, has been, in part, responsible for this.

A series of far-reaching measures to promote medium-sized and small scientific and technological enterprises have been taken. The most significant among these are described below:

1. Technological Innovation Experimental Project: The objective of this project is to establish 34 Technological Innovation Experimental Cities (TIECs). TIECs incorporate technological innovation in their general scientific and technological planning, establish

regional technological innovation systems and environments, cultivate local technological innovation abilities, promote economic development in their areas, and attain scientific and technological progress and economic development.

The knowledge and technological ability of experimental cities is on the rise, and the flow of information has accelerated. Many organizations and the venture capital system have already been linked up. These developments will promote future technological innovations

2. China Innovation Resource Net: The China Innovation Resource Net seeks to establish an innovation network throughout the country. This is to be accomplished through promoting cooperation among innovation projects. Additionally, this is the network behind the financial support provided through the Ministry of Science and Technology (MOST). China Innovation Resource Net is also the technological innovation network supporting the State's Technological Innovation Experimental Project. The Net integrates the innovation resources of the government, at the regional, enterprise and university levels, to achieve the industrialization of technological innovation.
http://www.innovation.gov.cn


The Lingering Garden, Suzhou

3. Establishment of High Technology Innovation Service Centres (i.e. Business Incubators): These have provided the environment and conditions needed to help innovators transform their inventions and achievements as quickly as possible into marketable commodities. They also provide comprehensive services to help cultivate successful enterprises, and to help new small and medium sized enterprises (SMEs) to mature and grow.

4. Establishment of Enterprise Technical Innovation Service Centres: China plans to set up more than 40 Technological Innovation Centres in the capitals of provinces. These centres aim to provide services to support the technological innovations of Small Technology-based Firms (STFs), including providing information on laws and regulations, industry trends and financing. In this way the centres will help STFs as they research and develop new technologies and products, and transform their results into marketable products or services. The centres can also offer services for company registration, business consultancy, patent application, training programmes and the coordination of research partnership.

5. Development of New and High Technology Zones: The government began to create such zones more than a decade ago. They are governed by rules and policies draw up by the Department of State. These zones have become important components in China's S&T strategy, and have been the foundation upon which S&T innovations are industrialized.

6. Development of various sources of capital to support technology-based firms: There are many funds available in China. The primary sources of funding available for the support of S&T innovation are:

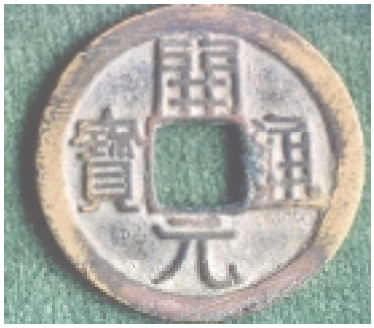
a. **Innovation Fund for Small, Technology-based Firms (STFs)[16]:** The primary objective of this fund is to support innovation in STFs, thus

helping them to attract project investments from local governments, enterprises, financial institutions and venture capital firms. There are now approximately 80.000 STFs in China, employing 5 million people and earning annual revenues of around China Yuan Renminbi (RMB) 1.038 billion, or approximately EUR 140 million. The annual income growth rate of STFs was determined to be between 30 percent and 60 percent through 1999.

Since its inception, the fund's chief beneficiaries have been high-technology sectors such as software and biomedicine. Other benefits have included a contribution in renovating traditional industries, supporting export-oriented technology projects and research projects undertaken by Chinese students returning from abroad.
http://www.innofund.gov.cn/english/index.htm

b. **Torch Fund**. "The China Torch Fund" was established in 1995 to advance technological development, specifically in enterprises supported by the Torch Programme. It aims to strengthen the abilities of these enterprises to compete in the global market

7. Venture Capital and Loans: Among China's goals is the establishment of a viable financial system, and particularly a venture capital system, to support technology-based SME's. The current security market is acting in support of high tech enterprises. By August 1999 there were already 162 high technology companies listed on the stock market, accounting for 17.8 percent of all companies listed. These companies have raised nearly RMB 47.8 billion (EUR 6.6 billion). The average profits per share, and the net assets income, compared with the average among listed companies, are 64 percent and 45.5 percent higher respectively. Given these results, it is no surprise that China is now paying great attention to the formation of the PRC, Investment Fund Law. China needs to draft better legislation in this area concerning S&T venture capital.



coin from the Tang Dynasty

Through these measures China hopes to foster capital markets conducive to the development of new and high tech industries, establish venture capital mechanisms and develop venture capital companies and venture capital funds. Medium-sized and small technology-based enterprises are a vital new force in the industrialization of new and high technologies, and a vital key in promoting innovation in China

8. Promotion of technology-based enterprises among scientists, institutes, engineers and university graduates: This is done through offering individuals the opportunity to retain the benefits of their innovations in the form of equity capital. This is believed to be an especially enticing offer for Chinese students abroad that have gained the technical and managerial training to administrate technology-based enterprises. Such new enterprises enjoy the preferential treatment normally allowed SOEs. Some local governments have set up special industrial and technology zones for these enterprises as well.

9. Awards: The government has also offered specific awards, as well as stock ownership, as incentives for research results. At the top of this list is the Top National S&T Award, regarded as "China's Nobel Prize". Additional awards include the National Natural Science Award, National Technology Invention Award, National S&T Advance Award and the International Cooperation Award. The criteria for receipt of these honours includes "major breakthroughs at scientific and technological frontiers, outstanding contributions to scientific

and technological development or creation of large economic and social benefits in the course of technological innovation." [17]

The 1999 Yearbook of the National Bureau of Statistics of China reports that in 1980 there were 2.687 "major achievements" in S&T. This number has since increased ten-fold, and reached a peak in the mid 1990's (which, incidentally, was also the period of China's highest GDP growth rates). Additionally, more than 100 prizes were awarded for inventions in 1980, a number that has remained relatively static since. Today, with a focus on promoting international collaborations in S&T, the number of recipients of the International S&T Cooperation Award has recently been expanded.

Generally, measures to provide incentives have been directed at impressing the importance of research as a standard component of business strategies, and at elevating the level of managerial skills available in the workforce

Statue of Buddha

3.3.1 Programmes Promoting S&T Innovation

Programmes are the first of the two forms of measures addressed in this study. The programmes promoting S&T innovation in the PRC reflect the policy priority of China. Shortly following the policy shift of 1978, China began making extensive use of programmes in promoting its science-based objectives. These programmes generally address specific social, economic or technological issues. Some concern rural and agriculture areas (e.g. the Spark programme), while others are directed toward the facilitation of technology transfer, innovation and the creation of new technology-based firms (e.g. the Torch Programme, and other national schemes for promoting key technological projects). Still other programmes focus on the establishment of technological infrastructure networks, particularly in the form of engineering research centres and productivity centres.

The precursor to China's technology development programmes was the reform efforts of the 1970's, and more specifically the Four Modernizations of 1973. These introduced a national focus in four key areas: agriculture, industry, national defence, and science and technology. This became a starting point for development and a foundation for China's NIS. In subsequent years programmes have been used to advance progress in particular areas.

China has prioritised S&T in these efforts as a key to social and economic development. The history of this development is summarized in Table 3 on the following page. It is evident from this history that China is relying heavily on research and S&T innovations to improve its technological capacity and elevate its competitive advantages.

The Forbidden City

Table 3: Timeline of the implementation of China's S&T programmes

Overview of S&T Programme Development [18]		
YEAR	**PROGRAMME**	**OBJECTIVE**
1973	Announcement of the Four Modernizations	Coordinate and focus national development
early 1970's	Agriculture extension services	Enhance agricultural production
1980's	Technology Innovation Centres	Develop technology infrastructure
1982	National Programme of Key S&T Projects	Resolve long-term national S&T development problems
1984	National Programme of Key Industrial Demonstration Projects	Bridge the gap between R&D and production
1984	National Key Laboratories Programme	Support selected laboratories at public or private facilities
1985	National Engineering Programme	Build modern scientific research facilities
1986	Spark Programme	Support technology transfer to rural areas
1986	863 Programme	Build international viability through technology R&D
1986	National Natural Science Foundation of China (NNSF)	Support basic research through sponsoring directed projects
1988	Torch Programme	Support new technology-based firms with facilities and financing
1990	National S&T Extension Programme	Support the transfer of project technologies to the market
1990	National Engineering Research Centres	Develop research centres specific to engineering sciences
1991	Climbing Programme	Support outstanding scientists in basic research
1992	Industry-University-Research Partnership Programme	Build linkages between various NIS contributors
1993	Productivity Centres	Designate centres to provide training and information to firms
1994	Agenda 21 Programme	Promote environmental protection and natural-resource conservation
1996	Technology Innovation Programme	Provide technical and services support to firms, develop joint industry/university R&D projects
1999	Conversion of Government R&D Institutes into Private Enterprises	Privatisation
1999	High Technology Parks	Identify and support 53 national technology parks

Sources: The World Bank and Journal: Asian Perspective

These programmes have served to establish a sound foundation for the pursuit of S&T innovations, and have proven to be pragmatic and effective means of moving on China's priority in this area.

Some of these programmes have become pillars in China's NIS. Many of the most significant of these are discussed in greater detail below.

1. Spark Programme[19]

The Spark Programme was launched in the mid-1980's, and was the first programme using S&T to promote the economic development of rural areas. The purpose behind Spark is the introduction of *appropriate* technologies for use in rural areas. It is intended that farmers will be led to rely upon S&T for rural development and to aid in agricultural productivity. In recent years the government has decreased this programme's funding (it currently represents just 1.1 percent of all national project spending), and the programme's effectiveness is believed to be declining.

The financial support Spark received from the World Bank a decade ago proved to be a positive investment. Since then the programme has attracted the attention of many developing countries and international organizations. The technologies and products of the programme have been widely exported and have benefited developments in various places throughout the world. The success of the innovations achieved through Spark has created a more sound environment for the investment of foreign capital. The programme continues to pursue more extensive cooperation and exchanges with foreign countries and international organizations.

2. Torch Programme[20]

The Torch Programme was launched in 1988 with the idea of advancing the evolution of the country's technology parks. In this regard the programme is closely tied to China's technology zones. The programme promotes the transference of research results from the laboratory to the market. The development strategy of Torch is to promote science, education, commercialisation and international market openness

The influence of the programme is clear. Through Torch there are now 60 incubator zones assisting individual entrepreneurs. Naturally there are considerable differences between the zones, depending on their location and the degree of support given by local governments.

Projects in the Torch Programme are divided into either regional or national projects, depending on their focus and source of sponsorship. By the end of 1998 there had been nearly 15.000 projects, of which 4.212 had been national projects.

The organization and implementation of China Torch Programme projects has given rise to a number of well-known technically innovative products, and has awarded Chinese researchers with the accompanying property rights. Examples include:

- *The Chinese and Western Character Composing System* of Founder Group,
- *The Microcomputer Product Series* of Legend Holdings Limited,
- *The Large Capacity Digital Programme*, for telephone switching systems, produced by Julong Group, Huawei Group, Datang Group and Zhongxingxin Group,

- The gene engineering medicine *"α-interferon"* of Chuangchun Changsheng Company.

3. National Natural Science Foundation[21]

The National Natural Science Foundation (NNSF) promotes research in the fields of natural science and basic research. Since its establishment in 1986, the NNSF has supported projects involving three categories of research: "general" (mianshang), "key" (zhongdian), and "major" (zhongda) research. The NNSF has funded more than 50.000 general research projects, 779 key projects, and 166 major projects, at a cost of more than RMB 4,5 billion (EUR 600 million). In the late 1990's general research projects on average received approximately RMB 114.000 (more than EUR 15.000), while average awards for key and major research projects were, RMB 79.000 (nearly EUR 11.000) for three year projects, and RMB 4,5 million (around EUR 615.000) for five years, respectively. In 1998, the NNSF awards totalled RMB 837 million (EUR 115.000), a notable gain from the RMB 80 million (EUR 11 million) dispensed during its first year.

Grand Canal, Suzhou

4. Key Technologies R&D Programme[22]

The Key Technology R&D Programme was created in 1982 to support the five-year objectives for economic and social development. This programme receives more than one quarter of China's total budget allocation for national programmes.

The programme's focus is on:

- Coordinating resources for technological development and addressing the diverse challenges facing economic and social development. This includes problems concerning long-term development.
- Accelerating the process of integrating S&T innovation into the economy.
- Strengthening the development of key technologies for engineering and industrial uses.
- Attaining breakthroughs in key technologies to produce multiple high-technology products with high market competitiveness.
- Developing vital key technologies in the field of social development to promote the establishment of industries related to this area.

The Key Technologies R&D Programme of the ninth five-year plan requires roughly RMB 9 billion (EUR 1,2 billion) in funding, which is traditionally raised through multiple channels. These include government appropriation, locally raised funds, bank loans, etc. However,

between 1996 and 2000 the vast majority of funding came from the central government[23]. In the near term the central government intends to contribute an additional RMB 2,2 billion (EUR 300 million) to this programme, of which agricultural projects will receive RMB 630 million (EUR 86 million), or 28,7 percent of this funding, high technologies will receive RMB 870 million (EUR 120 million), or 39,5 percent, and social development RMB 700 million (EUR 96 million), or 31,8 percent. Between 1996 and 2000 more than 60% of this programme's expenditures were directed toward industry, as opposed to agriculture (15%) and social development (24%). The programme also anticipates acquiring about RMB 6 billion (EUR 824 million) in loans to support S&T development.

The administrative measures of the programme include

- Joining expertise with the programme's administrative department. This involves forming an "expert committee" to oversee the implementation of projects, while project approval and organisation remain in the hands of the administrative department.
- Establishing an adjustment practice in which projects are initiated only when the conditions required for their operation and maximum contribution are in place.
- Creating post-funding management practices for projects involving long-term benefits. This includes fields where support is required over a long duration, but where clear short-term objectives are difficult to define and there are multiple technical approaches available. This definition applies to such projects as those addressing disease control and crop breeding.
- Utilizing competitive mechanism to meet the needs of a market economy, and encouraging the selection of projects through a bidding process.
- Improving evaluation practices and strengthening the evaluation of project implementation through third parties, in order to monitor and guarantee the realization of project objectives.
- Standardizing the management of S&T funds, to ensure adequate, effective and timely use of governmental appropriation.

5. The State Key Basic Research and Development Programme ("973")[24]

Another important initiative is the State Key Basic Research and Development Programme, which seeks to build up the nation's capacity for innovation and to maximize the utilization of Chinese experts. This programme was initiated in 1997, and has accounted for 2,5 billion RMB (EUR 343 million) over a five-year period. The programme is administrated by MOST, which oversees approximately 50 projects with funding on average of about 50 million RMB (EUR 7 million) per project.

The specific tasks of the 973 Programme[25] are:

- To carry out key basic research on important scientific issues related to agriculture, energy resources, information, resources & environment, and population & health, to provide a theoretical basis and scientific foundation for innovation,
- To train and bring up talented people, and
- To establish a number of high level scientific research bases.

In conjunction with the Key Technologies R&D Programme and the 863 Programme (described below), the 973 Programme is considered on of the principal S&T programmes currently being promoted in China.

6. High Technology R&D Programme ("863")[26]

The 863 Programme is concentrated on mid to long-term development in both civilian and military areas. This programme is also administrated by MOST and by the Commission on Science, Technology, and Industry for National Defence. Its creation was the result of concerns on the part of researchers in maintaining a high-quality fundamental research programme at a time when policy was heavily oriented toward the application of S&T for economic growth.

The main objectives of 863 are to monitor international developments in several important areas, and work to improve China's relative position. This involves equipping the next generation with the tools needed for S&T innovation, promoting the application of S&T in various fields, and coordinating achievements with the advances made through other programmes so as to realize the maximum economic benefits

Guilin, China

The 863 Programme also emphasizes the development of state-of-the-art technologies in seven areas: biotechnology, space technology, information technology, laser technology, automation, new energy sources, and new materials (these are similar to the areas identified in the 1978 National Conference on Science and Technology). There are now more than 13.000 scientists and engineers involved in the programme, as well as several newly established research centres. These include the Computer Integrated Manufacturing Systems Engineering Research Centre, the Intelligent Robot Research Centre, the Photo-electron Research Centre, the Genetic Engineering Drug Research Centre, the Artificial Crystal Research Centre, the Genetic Engineering Biological Products Research Centre, and the Genetic Engineering Vaccine Research Centre.

7. National New Products Programme[27]

The National New Products Programme was put forward by MOST for the purpose of guiding and encouraging enterprises and research institutes to accelerate technical progress, promote the capacity for technical innovation, optimise the industrial structure, and facilitate the industrialization of new high-technology products. The programme's mission is to establish the innovative abilities of enterprises, to promote the renovation of research institutes, to promote enterprises becoming the main source of technological developments, and to accelerate the process by which innovations are introduced to the market.

The programme defines new products as those that are developed and produced based on new technical principles and new ideas of design, or improved products that are significantly

upgraded in at least one aspect of structure, material, quality or technology, thereby enhancing product performance or increasing product functions.

8. National Science and Technology Achievement Spreading Programme[28]

The National Science and Technology Achievements Spreading Programme, approved by the State Council, is intended to mobilize technological workers in applying appropriate S&T achievements in their fields. This includes utilizing technical innovations in industrial and mining enterprises, and aiding in the development of the country's expansive rural areas. The overall objective is to foster economic and social development within a socialist market economy.

During the ninth five-year plan, 1.500 projects will be newly added to the project list of the programme on a screening basis. This number will eventually be increased to 2.000.

9. Climbing Programme (National Basic Research Priorities Programme)[29]

The Climbing Programme was developed to promote key projects in basic research. This programme supports science-oriented projects with valuable, applicable results. It favours the use of capable research teams for conducting basic research, and provides them with relatively high funding and stable support. In this way resources are concentrated so as to achieve "break-through" progress in specific fields.

The Climbing Programme was first implemented in 1991, and has since included 45 projects in succession. Of these, 30 have been basic research projects (Climbing A) and 15 have been application research projects (Climbing B). The Climbing Programme is funded by state appropriations (each project under the eighth five-year plan received RMB 1 million annually).

10. Examples of other programmes:

National Programme of Key Industries Experiment - for the promotion of technical enterprises in basic industries.

National Innovation Fund of Mid-Sized and Small Enterprises – to support technology innovation in S&T enterprises, and promote the transfer of S&T achievements to market and industry.

The Intellectual Property Rights Cooperation Programme – to promote trade, encourage innovation efforts, protect producers and consumers, and ensure fair practices in international business.

China Torch Programme Software Industry Base – an extension of the Torch Programme, this programme is directed at the development of the software industry specifically and provides support to designated software parks, or "bases".

Innofund

Innovation Fund for Small Technology-based Firms

This is a public sector fund to support the development of innovations by small, tech-based firms. The fund was started on June 25, 1999 with an initial budget of 1 billion RMB. By 2001 it was 8 times larger. In its first two years Innofund sponsored nearly 2.000 projects, primarily in information technology, automation and materials. These projects were mostly conducted by private, limited liability companies with fewer than 100 employees.

Source: Jiachang, Chen; *The Science and Technology Programs for Innovation in China*; Dept. of High Tech Development and Industrialization; MOST; April 9, 2002.

The abundance of programmes reflects the will to improve China's economy by means of S&T innovation. It is clear that there should be more interaction and cooperation between these programmes, but also that China's policy-makers have set S&T innovation at the centre of their attention as a means of developing socially and economically, and of putting China in a relatively stronger position in terms of global developments.

The Great Wall of China

3.3.2 Incentives and Rules

As the primary influence on S&T innovation in the PRC has been, and continues to be, the government's broad objective of elevating the economy, the administration considers domestic S&T innovations to be a key area. The country hopes to become a source of innovations, rather than an imitator of them. The consensus is that China can become more competitive, more open to market forces and more interactive in global matters. Efforts to achieve innovations in S&T are clearly a necessary component in making the prospect of international collaboration enticing. The existing incentives and rules promoting this in China are the second part of measures addressed in this study.

China's goals in this area have been achieved to some degree, but developments are ongoing. China has actually decreased recently in terms of scientific competitiveness, according to a 2000 study by the Research Institute of International Management Development. This is likely a reflection of China's need to improve the country's performance in developing, as opposed to transferring, technologies, and in promoting business cooperation.

The country's administrators have put a great deal of energy into finding incentives for both foreign and domestic firms developing S&T innovations, including incentives for importing technology and research activities from abroad.

Throughout its years of development China has relied heavily on imported technologies to keep up with scientific developments. This is a concern, as the country wishes to produce innovations rather than replicas – to lead rather than try to keep up. In 1997, China's import of high tech products reached USD 29,47 billion, an 11 percent increase over the previous year[30]. The growth in imports of such products has steadily increased since the beginning of the reform period, and China suffers from a deficit in this trade, importing far more than it exports. The vast majority of such products have consistently been in the field of computer technologies, followed by electronics and aerospace equipment. Though it is noteworthy that the export of high tech products has been led by SOEs, the situation has nonetheless increased the urgency of advancing the country's technological performance and production.

The opening of markets is a new phenomenon in China, one that has developed over the previous two decades. The resulting interaction with the outside world has made the need for S&T innovation apparent in China. Events like the country's recent ascension to the WTO only elevate this concern. For China to tap its potential and become the competitive world leader it could be, attaining and sustaining the leading edge in S&T at home is vital. This agenda has been pursued through incentives for Chinese students abroad to return, bringing their education and foreign "know-how" with them, and through promoting international cooperation with foreign organisations and enterprises.

Foreign capital continues to play a crucial role in China's development. Roughly four-fifths of all FDI in Southeast and East Asia, apart from Japan, is flowing into China[31]. The primary foreign source of investment in China (Hong Kong excluded) in 2001 was the EU as a whole, followed closely by Japan and the US. Naturally China promotes such investment, and encourages investors to consider areas pertaining to S&T innovation. They further promote the establishment of research and development centres - like IBM's Innovation Institute, a valuable part of Peking University – and promote the industrialization of Chinese and foreign research in China. In terms of technological innovation, China now offers more incentives - such as preferential treatment for joint ventures, contractual enterprises and wholly owned foreign companies - than it did in the past. These incentives have also included tax exemptions or reductions, import duty exemptions and rent reductions.

The incentives to attract FDI have also increased in recent years. Despite some progress, significant considerations remain for parties contemplating investment in China. It has been noted: "China's restriction on the flow of foreign exchange greatly diminishes the ease and efficiency of international transactions for both domestic and foreign industry."[32] Many

interested foreign entities have adopted a “wait and see” approach, believing that the conditions are not yet adequate to enter this market. In the meantime China has continued in its reforms to improve the attractiveness of the country for foreign investors.

The main sectors in China that are encouraged as targets for foreign investment, are the following:

- Software design,
- Information technology,
- Medicine,
- Environmental protection,
- Export industries,
- Business and management,
- Industries in China’s Western region.

China’s WTO accession will result in important changes in this regard, as an increase in the number of those interested in China can be anticipated. This will likely include sectors that have been traditionally government controlled, such as banking, and those that have faced unmanageable barriers to trade. As China adheres to its WTO commitments its markets will be increasingly accessible, resulting in an elevated level of competition. This will bring with it the heightened need for innovation in all areas. Thus, an increase in the level of S&T activity is expected.

Maple Bridge, Suzhou

Competition Rules

An understanding of the scope of allowable activities in China is a pre-requisite for international collaborations, as is having a firm grasp on the environment in which organisations operate there. In both instances European partners are likely to find that conditions are not as they might expect at home. In the past many foreign firms have been frustrated in doing business with China due to a lack of clarity in the rules of business, and inconsistency in their enforcement. It was often found difficult to find mutually acceptable contractual terms, and even when terms were accepted they were sometimes ignored. Additionally, western companies could not expect to enjoy the enforcement of legislation concerning intellectual property rights. This has historically hampered China's development, despite the radical shift in policy of the late 1970's. Since that time China has made great strides in removing or reducing such hindrances, and continues to do so. The State still retains control over certain sectors (such as telecommunications and banking), but is gradually relinquishing this control.

In assessing the rules of competition that exist in China it is important to understand that the country strives for improvement in this area. As recently noted:

> "Opening to the outside world and establishing contact with other countries is a basic, long-term policy for China's scientific and technological development. Within this field, the utmost will be done to integrate foreign trade with technology and industrial production, and greater importance will be attached to importing patented technology, technical know-ho, and software. More channels will be opened to expand various forms of international cooperation in development, design, and manufacture... A policy of active support will also be adopted for technology development projects with promising international prospects…"[33]

In order the gain the benefits of interacting with the outside world, and develop a socialist market economy, China has taken many steps to create and enforce the appropriate legal structures. Intellectual property rights protection (IPR), patent laws and antitrust legislation are relatively new concepts. For example, China's antitrust laws specify only 12 activities that fall under the category of unfair competition. In developed countries, antitrust laws normally contain more than 1.000 articles and provide comprehensive protection. In China, the law specifies just 12 prohibited activities that fall into the category of unfair competition[34]. Examples include:

- Deceiving consumers by selling items falsely bearing the registered trade marks of others;
- Abusing administrative powers to hinder competition;
- Enforcing the purchase of goods designated by public utility enterprises or enterprises having monopoly status;
- Selling products with prizes attached by fraudulent methods or bribery;
- Damaging a competitor's reputation through falsehood;
- Squeezing out competition through selling goods at prices below cost.

It is important to understand that the evolution of China's legal environment in regard to competition has been both recent and rapid. Over the past four decades China has instituted comprehensive reforms, including the Trademark Control Act (1963), US-China agreement

on intellectual property protection (1979), Trademark Law of The People's Republic of China (1982), Patent Law of The People's Republic of China (1984), Computer Software Protection Regulation (1991), Unfair Competition Law (1993), and Regulations on Anti-dumping and Anti-subsidization (1997). In 1993 China also passed The Law of the People's Republic of China for Protecting Consumer's Rights and Interests[35].

These laws are subject to enforcement through the Administration for Industry and Commerce of China (AIC), which has now handled more than ten thousand cases. Additionally, nearly 20 cities or provinces have set up intellectual property rights courts. This has facilitated the advent of numerous legal precedents and the ongoing improvement of China's competition legislation. As the cases are widely publicized, the issue of social perception and adherence to these laws is also being addressed.

Additionally, the amount of pirated works confiscated in 2000 by copyright administrations at various levels continued to increase, compared with previous years. The major products confiscated by the anti-counterfeit campaign in 2000 were: Toshiba TV sets (946 units), ONEHAN SHOW perfume (17.160 bottles), Nike and CAT sneakers (7.210 pairs), Adidas caps (13.440 units), Honda motorcycle spare parts (2.600 units), Citizen calculators (100.000), and BOSS trousers (4.200).

Despite this progress in enforcement, foreign participants to activities in China should be aware of the challenges they can expect to face. As noted by the World Bank as late as September of 2000:

> "The regulatory framework in China is extraordinarily complex, often unclear, and sometimes contradictory. This seems to result principally from the many uncoordinated legal initiatives taken by the different levels of power – central, provincial, and local – and by different ministries, each with specific responsibilities and administrative territories… The conditions of economic competition in China are far from good at present, as they are still strongly affected by established monopolies, reserved markets, opaque procurement policies, activities closed to foreigners, barriers to trade such as discriminatory standards between provinces, and so on…"[36]

The Meridian Gate, The Forbidden City, Beijing

IPR Protection

As with other aspects of the NIS, Chinese policy makers view IPR legislation as critical to economic growth. This is because entrepreneurs, inventors, and "innovators" in general can easily lose the fruits of their efforts if laws to protect them are not respected, complied with and enforced. Additionally, protection of innovations makes it possible for future improvements and follow-up innovations to occur. Patent laws require the disclosure of specific information pertaining to an innovation, thus making further advances by their inventor, or others, feasible. Also, for these subsequent innovations patents are frequently obtainable[37].

Thus, in recognition of the importance of IPR, the government of China has adopted intellectual property laws consistent with international standards. Furthermore, they have established training programmes for judicial officials and otherwise established IPR as a major focus of reform. Existing legislation has been reviewed and refined, and at the administrative level the country is willing to see that the right steps are taken to offer legitimate IPR protection as a component of its NIS.

Beginning in the 1970's China began formulating legislation concerning IPR protection. By 1980 the country was accepted as a member of the World Intellectual Property Organisation (WIPO), which was followed by ratification of trademark, patent, industrial property and IPR protection legislation. According to current law, all research entities – both state-owned and private – should be treated equally in the patent application process.

However, social acceptance and adherence to these laws is not addressed so expediently. With a history of IPR violations, a change in the public's attitude may take years to develop. Though currently some laws are in place for the protection of intellectual property, the application and enforcement of them is another issue.

It is encouraging that patent applications have continued to climb in China, roughly doubling from 1991 to 1999. In the year 2000, more than 170.000 patent applications were submitted to the State Intellectual Property Office of China (SIPO), indicating an increase of over 27 percent from the previous year. It seems that even if regulations are yet inadequate, they have improved and are not an insurmountable barrier to innovative activity. It should be noted that the majority of these patent applications were domestic – made by Chinese firms – but thousands were also filed by foreign enterprises.

Restrictions for the Creation of Foreign Companies in China

Foreign investment enterprises (FIEs) can take the form of 1) an equity joint venture in which the company takes the form of a limited liability corporation, 2) a co-operative or contractual joint venture in which the company again becomes a limited liability corporation but does not need to distribute profits proportionate to the amount of capital invested by the parties (also the foreign company can receive a return if all assets are transferred freely to the Chinese counterpart at the conclusion of the venture's term), or 3) a wholly foreign-owned enterprise, but only if the enterprise will benefit China technologically or economically.[38]

The issue of foreign taxation is dependent upon the company's status – whether it is a FIE or simply a foreign enterprise (FE). FIEs are taxed on total worldwide income, but receive a tax credit for foreign taxes paid on foreign-sources income. On the other hand, FEs are taxed solely on the China income.

Tax Incentives

In August of 1999 the Foreign Economic and Trade Administration, the State Planning Commission, the State Economic and Trade Commission, the National Ministry of Finance,

the People's Bank of China, the Custom Bureau, the General State Tax Bureau, the State Exchange Authority and the State Entry and Exit Test Bureau formulated the following policies to further encourage foreign investment.

A. Income Tax

The government will collect business income tax from investing foreign enterprises at the rate of 33 percent, but only 15 percent from enterprises in the special economic zones, the national hi-tech industrial zones and the national economic and technical development zones. The income tax rate will be 24 percent for enterprises in open coastal regions and the capital cities of local provinces. A foreign enterprise can enjoy tax exemption for a period of time, depending on the type of legal entity, technologies used, R&D expenditures, level of exports from China and the location of its operations within China.

B. Import Tax

The Chinese government has reduced import tariff rates eight times since 1991. The current rate is down to 16 percent, covering over 4.800 tariff categories. These account for 73 percent of all tariff categories.

For foreign projects that fall under the Encouraged or Restricted categories, imported equipment is exempt from tariff and import taxes. Domestic projects under the category of Products and Industries Encouraged by the State incur neither tariff nor import taxes, so long as their imported equipment falls within the amount invested.

Foreign investment enterprise projects, belonging to the Encouraged or Restricted classifications, that wish to purchase domestic equipment within the amount invested can also receive tax benefits in specific instances. Generally, the equipment purchased must fall under the category of tax-exempted items. In cases where foreign enterprises transfer technical innovations into the market, the resulting business income may be exempted, according to regulations.


7-up advertisements

In cases where foreign research and development centres import equipment that cannot be domestically manufactured, import tariffs and taxes may be exempted according to the Information for Adjusting Import Device Tariff of the State Council.

C. Tax-Free Businesses

Tax exemptions are allowable for income acquired by corporations or individuals through transferring technology into the market, development of new technologies and technical consulting and services. These regulations are applicable to domestic and foreign enterprises. Foreign enterprises can enjoy tax exemption for income in cases where they transfer advanced technologies into the Chinese market, subject to approval by the State Council Taxation Authority.

Foreign investment research and development centres, and foreign enterprises that are transferring advanced technology to the market that are intended for export, can import

technologies (not available domestically) without incurring import or tariff charges. This is in accordance with the Information for Adjusting Import Device Tariff by the State Council.

D. Domestic Enterprises

If domestic enterprises, non-profit making establishments, social organizations, or small private business proprietors sponsor research institutes and higher educational institutes for the research and development of new products, technologies, or technical processes, they can receive an income tax reduction equivalent to their payout funding. This policy excludes foreign enterprises.

Research institutes directly under government control receive preferential treatment in the form of an exemption from income taxes, as well as exemption from a tax for the use of urban land for the purpose of R&D. This benefit is collectable only after these institutes are transformed into independent enterprises.

A summary of some basic tax issues is illustrated in Table 4. This is intended for reference only. Any need for current, detailed and specific information should be sought outside the scope of this project.

Moulinex advertisement

Table 4: General Tax Reference

General Tax Reference		
Form of Tax	**Domestic Enterprise**	**Foreign-invested Enterprise**
Enterprise Income Tax	30 percent	15 percent
Local Income Tax	3 percent	1.5 percent
Tax-cutting policy	2 years: tax free, 3 years: half tax	All enterprises with investment in the zone, high-tech or other enterprises with registered capital exceeding 1 million USD and investment in other locations in Pinghu City enjoy tax exemption in the first five profit-making years and 50 percent tax reduction for the next five profit-making years.
Value-Added Tax	17 percent	For enterprises with registered capital exceeding $500,000, 20 percent of the value-added tax actually paid in two years by the enterprise will be refunded by the local finance department; for those with registered capital exceeding 1 million USD, 20 percent of the value-added tax actually paid in five years will be refunded.
Income tax of enterprises which export up to 70 percent of annual productive value		10 percent
Note: Those who successfully introduced and participated in the business negotiation can charge a 1-3 percent commission of the amount of actually invested foreign capital.		

Source: Tax incentives for foreign investment, State Administration of Taxation, PRC.

Investment Procedures

There are many steps in the process for foreign entities wishing to invest in China. Information concerning what is required is often difficult to obtain. For a step-by-step general description of investment in China, refer to Table 5.

Table 5: Overview of steps for investment in China

Foreign Investment in China	
1. >	Investor provides complete document and materials.
2. >	The Jointed Examination and Approval Department give approvals. *
3. >	Municipal government issues the approval certificate.
4. >	Administration Bureau of Industry and Commerce issues the business license.
5. >	Registers in Administrative bureau of foreign currency.
6. >	Registers in Taxation Department.
7. >	Registers in Financial Department.
8. >	Registers in Financial Department.
9. >	Pays for land in the Branch Administrative Bureau of National Land.
10. >	Registers in Customs and applies for Customs Declaration.

* Jointed examination and approval is finished in Municipal Foreign Investment Administration and Service Centre.

Source: The Investment Policies and Regulations, Administrative Committee of Lushun Economic Development Zone; PRC; June 1998.

The establishment of foreign enterprises in China can also be quite complicated. For an account of the necessary procedures, refer to Table 6. The information presented here is intended as a reference only. Any need for current, detailed and specific information should be sought outside the scope of this project.

TABLE 6: Investing Procedures

→ Investors should go to the *Economic Development Bureau* to ask for the approval for establishing foreign-invested enterprises. The main procedures are as follows:

1. Obtain and arrange all the documents needed for establishing joint ventures, to include:
   (1) The project proposal (or the feasible research report);
   (2) Approval from the departments of environment protection;
   (3) The business license, bank testimonial, and authorization proxy of the legal person on behalf of China;
   (4) The business license, bank testimonial, legal person certificate and authorization proxy of the legal person on behalf of the foreign country;
   (5) The contract and regulations;
   (6) List of names of the directorate members, delegation letters and identity certificate of each member;
   (7) The utilization certificate of the business site or land;
   (8) Approval notice of the name registration;
   (9) Other necessary materials for the approval.

2. Obtain and arrange all the documents needed for establishing foreign-invested corporations, to include:
   (1) The feasible research report;
   (2) A copy of the regulations;
   (3) A trust testimonial from the bank;
   (4) The registration chart of the legal representative;
   (5) Approval of the departments of environment protection;
   (6) A utilization certificate of the business site or land;
   (7) The proxy of the directorate members.

   Note: If the above documents - for joint ventures or foreign-invested corporations - are in complete accordance with the regulations of state enterprises policies, as well as examination requirements, the investor will obtain the approvals of establishment, feasible research report, contract and regulations in five workdays, and Approval Certificate of Foreign-Invested Corporations in the People's Republic of China as well. The investor can then go to the Industry and Business Bureau to transact the Enterprise Legal Person Business License of the People's Republic of China.

3. Establish the seal of the corporation.
   After obtaining the business license and registering at the public security bureau, the investor can go to the nominated department of seal service to make the seal of the corporation.

4. Complete the formalities of registration.
   Before starting business activities, the investor should go through the necessary formalities as follows: open a bank account in China, verify and confirm assets, taxes, finance, customs, foreign currency management, and statistics, and develop awareness of economic and trade issues.

Source: The Investment Policies and Regulations, Administrative Committee of Lushun Economic Development Zone; PRC; June 1998.

WTO

Entry into the WTO will usher in broader changes in the rules of competition in China. The country will be obligated by the participants of world trade to open its markets and relinquish a great deal of State control. This is clear, and is perhaps the most advantageous development in the last two decades for foreign parties hoping to collaborate with, or conduct operations in, China.

China's long-awaited acceptance into the WTO has come about only following the resolution of a broad range of reform issues. The issues that must be addressed in order for the country to meet its WTO commitments are extensive. These include: the fair and equal administration of justice, transparency of information, non-preferential treatment of entities in "special economic areas", non-discrimination, special trade arrangements being brought into conformity with WTO standards, liberalization of the right to trade, price controls, trade licensing, conformity in non-tariff measures, subsidies, technical barriers to trade, etc.[39] Clearly, ascension to the WTO will bring about a series of reforms deeper than those that have already taken place.

The expected changes pertaining to S&T innovation are far reaching. As summarized by CAS[40], these include:

- Adjustment of the government's role in the NIS,
- Reduction of governmental intervention in competitive areas,
- An increase in the support available for research in strategic high technologies, and
- Strengthening of the system of patent application and protection.

It is expected that the pursuit of S&T innovations will subsequently depend more upon private enterprises as the primary actors in the NIS. This will be marked by the expansion of in-house technology development centres, local technology development centres for the support of SMEs, and trade-based technology development centres, as well as the improvement of the venture capital system and intensification of funds available for the support of small S&T oriented firms (e.g. Innofund).

From the standpoint of foreign entities, the most apparent difference will be found in trade barriers. While China has made use of high tariffs and import restrictions to protect domestic competitors, entry into the WTO should bring the tariff average down from around 17 percent to something closer to 10 percent. Additionally, any existing import quotas will be gradually phased out. China will be obliged to grant trading rights to foreign enterprises, and services industries will be opened. This includes foreign firms providing information and services on Chinese law, which should help address some of the transparency problems the country has been challenged with. Ascension will also help standardize product quality between Chinese manufacturers and the outside world.

3.4 Structural Support of S&T Innovation

The organisation and components of China's R&D system make up support structures. The influential participants in this system are R&D centres, the Chinese Academy of Science, the Engineering Research Centre, the Ministry of Science and Technology, national research centres, independent research institutes, national and regional R&D institutes and universities. Naturally, the presence of foreign enterprises also influences administrative decision-making in China, but this cannot be considered a part of the country's infrastructure.

The main common support structures are business incubators (also referred to as innovation centres) and high-technology parks or zones. At the national level alone nearly 200 business incubators and 53 high-technology parks/zones have been developed through governmental support[41]. Additionally there are 57 High & New Technology Industry Development Zones at the provincial level, and by 2001 there were a total of 465 business incubators including those at provincial and local levels[42]. This makes China second only to the United States in the quantity of incubators present in the country. In some cases, the output from technology parks comprises roughly a third of their province's total output.

The majority of these structures are concentrated in high-technology development zones. With the recent shift in the focus of policies toward development of China's western regions, the administration has taken an interest in drawing foreign investment there, and in establishing S&T parks and incubators, to support development. The establishment of such structures has proven effective in the more densely populated coastal regions, and is now being broadened to support more rural areas.

3.4.1 Special Economic Zones

There are a variety of types of development zones in China. These include: Special Economic Zones, Economic and Technology Development Zones, New High-Technology Development Zones and science parks.

Special Economic Zones

The purpose of the special zones is to present an appropriate platform for FDI and export operations. These zones enjoy special tax incentives and operate more autonomously than do other regions.

There are 6 economic Special Zones that have been established in China. These are: Shenzhen (excluding Hong Kong), Zhuhai (excluding Macao), Xiamen, Shantou, Hainan and more recently the Pudong Zone (Shanghai).

Economic and Technology Development Zones

The Economic and Technology Development Zones have normally been constructed in the vicinity of cities. As the Economic Special Zone policy proved to be successful, the central government issued a second open policy. This paved the way for the creation of Economic and Technology Development Zones such as are found in Tianjing, Shanghai and Dalian. There are currently a total of 32 such zones. These zones lie mostly along the heavily populated coastal regions, and enjoy similar benefits as the Economic Special Zone, described above. Their purpose is to attract FDI and promote industrial development.

New High-Technology Development Zones and Science Parks

The New High-Technology Development Zones and science parks were created to attain advances in specific industries. Most incubators are located inside these zones. The science parks themselves can also be divided into zones for specific industries. The leading High-Technology Development Zones in China are those located in Beijing, Shanghai, Shenzheng, Xian, and Suzhou. International collaborative projects in S&T are likely to find viable partners in these locations.

These zones and parks offer support through facilities and services, but also through tax incentives. Enterprises located in such zones are entitled to a "tax holiday" for 3 years, followed by two years of half-tax.

One of the most famous of these parks is the Zhongguancun Park, described in Box 4.

Box 4: Zhongguancun Science Park

The Zhongguancun Science Park:

China puts particular emphasis on Zhongguancun Science Park. The Park will be built into a national innovation base, an incubating base for the commercialisation of scientific achievements and technology industry, and a world-class science park. In short, China wants to make it China's "Silicon Valley". Various incubators in Zhongguancun Science Park have become cradles for the commercialisation of scientific achievement and development of hi-tech enterprises. There are Fengtai Innovation Centre, Haidian Innovation Centre for Overseas Chinese Scholars and Qinghua Innovation Centre inside the Park. These incubators have business strategies similar to those of Suzhou Incubator. In addition, the Park attaches great importance to the international technological and economic co-operation, participates actively in the international economy and trade, and takes full advantage of various sources of international capital to develop its hi-tech industry. Inside of the park there are five Zones. Inside of the Zones you have parks (Tsinghua, Peking parks). Normally the incubators are inside of the parks or in the zones.

http://www.zgc.gov.cn/english/pages/approaching.htm

3.4.2 S&T Parks

Since the early 1990's China's efforts to accelerate the development of high-tech industries have included the creation of National Science and Technology Industrial Parks (STIPs). These are critical in supporting the efforts of researchers, transforming research results into products and services and otherwise leading technological development. Their significance is quickly acknowledged in China, as reflected in President Jiang Zemin's 1996 comments before the 4th Asia Pacific Economic Cooperation (APEC) Summit:

> "The most important pioneering undertaking of the 20th Century in science and technology development is the initiation of science and technology industrial parks. The integration of industrial development with scientific and technological activities [solved] the problem of separation of science and technology from the economy, and made the discoveries and inventions of mankind convert smoothly into economic and social effectiveness." [43]

Municipal governments typically manage China's S&T parks, and most decision-making authority exists at this level. It is usually city councils that establish the guidelines pertaining to the development of high-technology zones, and during their construction municipal administration normally makes efforts to ensure that the conditions are in place that are needed for a park to be successful.

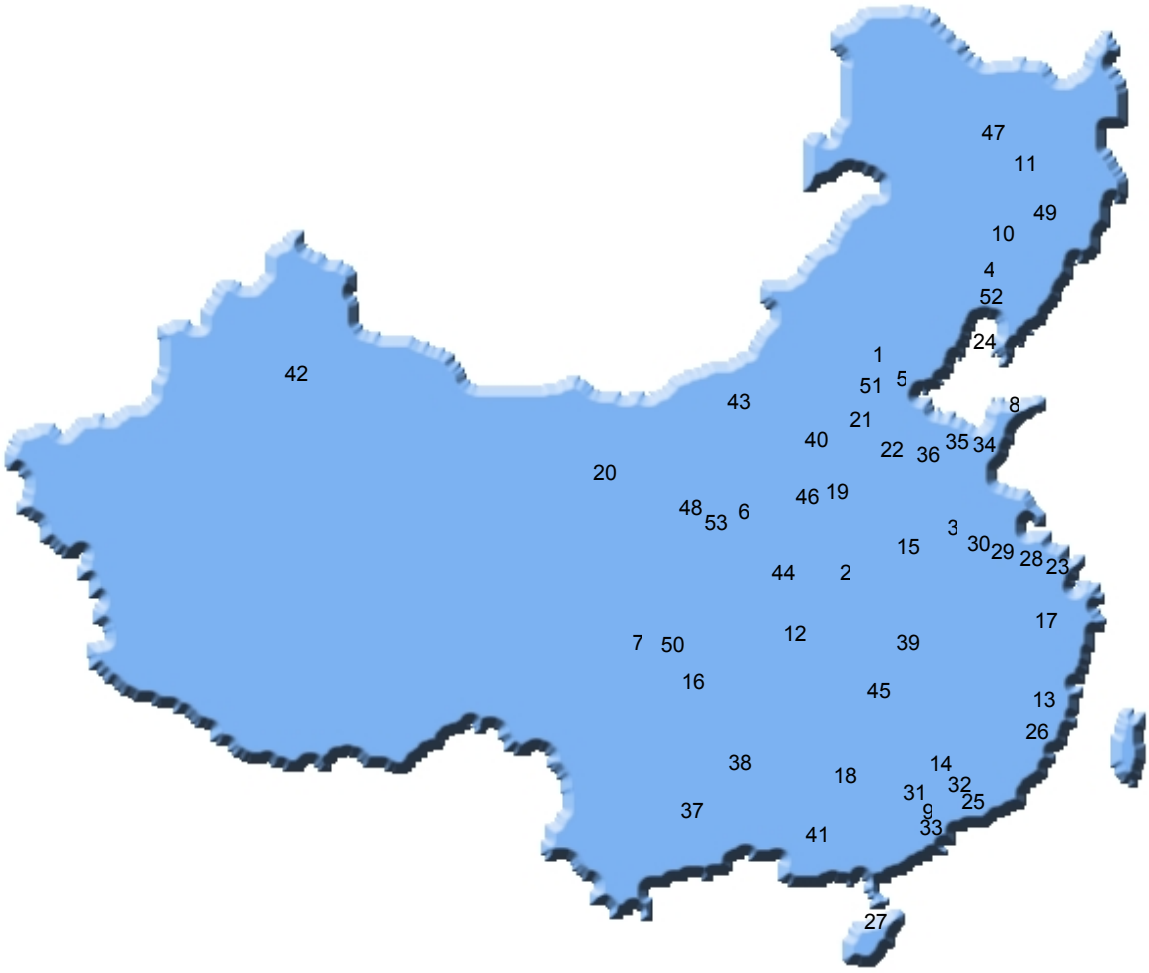
Science parks usually incorporate different zones or classifications (technology zone, electronics zone) if they cover an area of more than 250 square kilometres.

The parks generally provide the following services, and often many more:

- Consulting services during the formation of construction plans,
- Information support concerning economic issues,
- Consulting regarding the protection of intellectual property rights,
- Coordination of relations between project sponsors and contractors,
- Facilitation of relations between occupant firms and the government,
- Law and technical information management services,
- Loans for the necessary construction projects of occupants,
- Facilities for public utilities.

China's technology development strategy has consisted of rapid growth of the manufacturing sector. This growth is taking place mainly in high technology mass production that is located in the high-technology parks and free-trade zones. Following the new incentives promoted by the Chinese innovation system's policies and measures, many technology-based spin offs have emerged. In 1999, the 53 high and new technology zones (see Diagram 2) contained some 20.000 enterprises and more than 2 million employees.

Diagram 2: Distribution of China's S&T Parks/Zones



1. Zhongguancun Science & Technology Park
2. Wuhan Donghu New Technology Development Zone
3. Nanjing High and New Technology Industry Development Zone
4. Shenyang High and New Technology Industry Development Zone
5. Tianjin New Technology Industry Park
6. Xi'an High and New Technology Industry Development Zone
7. Chengdu High and New Technology Industry Development Zone
8. Weihai Torch High Technology Industry Development Zone
9. Zhongshan Torch High Technolo9gy Industry Development Zone
10. Changchun High and New Technology Industry Development Zone
11. Haerbin High and New Technology Industry Development Zone
12. Changsha High and New Technology Industry Development Zone
13. Fuzhou High and New Technology Industry Development Zone
14. Guangzhou High and New Technology Industry Development Zone
15. Hefei High and New Technology Industry Development Zone
16. Chongqing High and New Technology Industry Development Zone
17. Hangzhou High and New Technology Industry Development Zone
18. Guilin High and New Technology Industry Development Zone
19. Zhengzhou High and New Technology Industry Development Zone
20. Lanzhou High and New Technology Industry Development Zone
21. Shijiazhuang High and New Technology Industry Development Zone
22. Jinan High and New Technology Industry Development Zone
23. Shanghai High and New Technology Industry Development Zone

24. Dalian High and New Technology Industrial Park
25. Shenzhen High and New Technology Industry Development Zone
26. Xiamen Torch High Technology Industry Development Zone
27. Haikou High and New Technology Industry Development Zone
28. Suzhou High and New Technology Industry Development Zone
29. Wuxi High and New Technology Industry Development Zone
30. Changzhou High and New Technology Industry Development Zone
31. Foshan High and new Technology Industry Development Zone
32. Huizhou High and New Technology Industry Development Zone
33. Zhuhai High and New Technology Industry Development Zone
34. Qingdao High and New Technology Industry Development Zone
35. Weifang High and New Technology Industry Development Zone
36. Zibo High and New Technology Industry Development Zone
37. Kunming High and New Technology Industry Development Zone
38. Guiyang High and New Technology Industry Development Zone
39. Nanchang High and New Technology Industry Development Zone
40. Taiyuan High and New Technology Industry Development Zone
41. Nanning High and New Technology Industry Development Zone
42. Urumqi High and New Technology Industry Development Zone
43. Baotou Rare Earth High Technology Industry Development Zone
44. Xiangfan High and New Technology Industry Development Zone
45. Zhuzhou High and New Technology Industry Development Zone
46. Luoyang High and New Technology Industry Development Zone
47. Daqing High and New Technology Industry Development zone
48. Baoji High and New Technology Industry Development Zone
49. Jilin High and New Technology Industry Development Zone
50. Mianyang High and New Technology Industry Development zone
51. Baoding High and New Technology Industry Development Zone
52. Anshan High and New Technology Industry Development Zone
53. Yangling Agri-tech Demonstration Zone

Source: National Science & Technology Industrial Parks of China, Torch High Technology Industry Development Centre, 2000, p. 10.

In the future, reforms within the new and high tech industrial development zones will be intensified to enhance services and to help enterprises of all kinds to develop technological innovations. High-technology industrial development zones will also be given support to create a favourable climate for attracting qualified technical and management personnel.

Link Between R&D and the Market

Some of China's high-technology parks are the offshoots of universities and research institutes, and are located near them. These sponsors are able to contribute valuable personnel, research achievements and spin-off companies to parks, thus constructively influencing growth and development in their regions.

There are many ways in which S&T parks interact with the rest of the research community and the market. Common forms of this include:

1. Forums on innovation for introducing technical projects, held by the government. These meetings gather researchers, personnel from incubators and investors to exchange information and promote partnerships among them.

2. Developing agreements with universities and research institutes making parks available sites for their research facilities.

3. Acting as an agent for potential partners within the park to assist in the commercialisation of their research achievements. This can also take the form of a park buying research results of tenants and commercialising them independently.

4. Developing networks to promote interaction in the research community. Important examples of this include: the Network of Information Centre of the Chinese Academy of Science, Education and Research Network and the Economic Information and Communication Network.

Despite these efforts, a means of more constructive interaction has yet to be discovered. Most S&T parks and incubator managers still hold to the belief that research institutes and universities should take the initiative in contacting them to develop interactions. Also, the interactions that do occur usually require the intervention of government administrative powers. This issue needs to be further addressed if Chinese infrastructure in the form of S&T parks and incubators are to become more effective in shaping the country's developments.

An additional deterrent is the minimal incentives offered to researchers for their results. Programmes have been implemented to provide awards, but in general they are considered underpaid and possess neither the capital nor resources needed to finance the commercialisation of their own results. Also, they are commonly unaware or non-responsive to the needs of the market and are not qualified as managers able to navigate in it.

It is only since 1991 that China has established the 53 national parks. The annual gross industrial output from these STIPs increased ten-fold over the following decade.

Ming Dynasty wheelbarrow

Description of S&T parks in China

There are many important S&T parks in China. Following are description of several significant examples.

1. Zhongguancun Science Park

The Zhongguancun Science Park (see Table 7) is well known in China. The country has high hopes for the park's future, and thus extends to it the most favourable policies to support it. In the first state-level high-technology development zone, Zhongguancun Science Park is now the largest and most successful hi-tech park in the national zones. More than any key laboratory, Zhongguancun Science Park is nationally the largest area of concentration for intellectual resources, human resources and information resources. Zhongguancun maintains the nation's largest reserves of IT capacities in China.
http://www.sinocbw.com.cn/busbj/issue32/p10.html
http://www.zgc.gov.cn/english/pages/approaching.htm

2. Shanghai Zhangjiang High-Technology Park

Zhangjiang Hi-tech Park is one of the most important high-tech innovation bases in China. It now covers an area of 4 square kilometres. Currently the National Bio- pharmaceutical Base, the National Micro-electronic Information Base, and Shanghai Software Park make joint efforts in promoting the development of this park. By May 1st, 2000, 130 foreign had established high-technology enterprises registered in Zhangjiang Park. Among the park's occupants are Roche Pharmaceutical Limited, Kirin Kun Peng (China) Bio-pharmaceutical Corp. and NYCOMED ASA. Since its inception, more than 70 knowledge-intensive enterprises and 15 research and development institutes have settled in Zhangjiang.

3. Shenzhen Science & Technology Industrial Park

The Shenzhen Municipal Government and the Chinese Academy of Sciences founded the Shenzhen S&T Industrial Park jointly in July of 1985. In 1987 the Guangdong International Trust and Investment Corporation became an additional investor. The park is now one of the country's 27 S&T industrial parks. The park now aims to become a facilitator of technological exchanges between China and the world. This objective is aided by the park's proximity to Hong Kong. Since its beginning, the park has been involved in the introduction many innovations in technology, and has imported scores of technological items from abroad.
http://www.wtdb.com/investment/park/Guangdong/gdp6.htm

4. Tsinghua S&T Park

The most famous of China's 15 university-sponsored S&T Parks is Tsinghua. This park was specially designed to provide the conditions needed for R&D to create sophisticated technological innovations and products, launch visionary enterprises, train technical personnel and be an accessible source of technical information. The park was initially established in 1998 with the completion of some of its facilities, including: Ziguang Plaza, Huaye Centre, Tongfang Tower and Xueyan Complex. Additional construction is planned, including an international S&T exchange centre. At present more than 100 enterprises and research institutes have joined the park.
http://www.tsinghua.edu.cn/docsn/kjy/ahead.htm

PIP Science Building (left) in the Dalian Free Trade Zone

3.4.3 Business Incubators

> "A business incubator is a dynamic process of business enterprise development. Incubators nurture young firms, helping them to survive and grow during the start-up period when they are most vulnerable. Incubators provide hands-on management assistance, access to financing and orchestrated exposure to critical business or technical support services. They also offer entrepreneurial firms shared office services, access to equipment, flexible leases and expandable space – all under one roof." [44]

China has made extensive use of business incubators as part of their development strategy. The Chinese incubators, or "innovation centres", are modelled after successful foreign examples. After 10 years of development, such innovation centres have become a primary vehicle of the new high technology innovation system in China. They are used as bases to facilitate the transition of research results from the laboratory to the market, and to cultivate new high-technology enterprises and entrepreneurs. The 5-year survival rate for enterprises that have graduated from incubators is more than 80%. For non-incubated enterprises it is only 20%[45].

China's leading business incubators are found in Xian, Shanghai, Beijing, Chengdu, and Hangzhou. There are now incubators located in every province and major city, with the exceptions of Tibet and Qinghai. Of these, 38 are administrated at the state level. There are an additional 64 organizations (such as "software parks") that function much like incubators. By the end of 1998, 77 incubators were included in the Torch Programme, which helps to facilitate the commercialisation of research results. Within the next five years China intends to develop 500 more incubators.

The main types of incubators (innovation centres)

The China Torch Programme recognizes seven specific types of incubators in China. These are identified as follows:

1. Comprehensive Technology Incubator,
2. Specialized Technology Incubator,
3. University-based Incubator,
4. Overseas Scholar Innovation Park,
5. State-owed Enterprises Incubator,
6. International Business Incubator, and
7. Business Incubator Networks.

According to Torch data, by the year 2000 there were 131 incubators, or "innovation centres", in China operating under one of the capacities listed above. This number had nearly doubled over the previous five years, represented in Table 7.

Table 7: Development of Innovation Centre Development

1995 – 2000 Development of Innovation Centres						
Year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Number of Innovation Centres	73	80	100	100	110	131
Floor space (10,000 sq. m.)	10,2	56,6	77,5	88,4	188,8	272,1
Number of tenants	1,854	2,476	2,670	4,138	5,293	7,693

Source: China Torch Programme brochure, National Science & Technology Industrial Parks of China, 2000, p. 12

Descriptions of some of the various types of incubators will help develop an understanding of how these facilities function, their direction and contribution to China's objectives in science innovation:

Comprehensive Technology Incubators

These are the most common type of incubators developed in China. According to the Torch programme, the focus and technological priorities for these incubators include: new materials, environment technologies, biotechnology, aerospace, and information technology.

Most of the companies in the facilities of general technology incubators are spin-off companies created to commercialise the results of research achieved by research institutes, universities and enterprises. Typically, the ownership of these companies is retained by the organisations that developed the product for which the companies were created.

It is noteworthy that in China, 87 percent of the incubators are technology focused, whereas this type of incubator represents only 25 percent of incubators in the United States. Prominent among China's technology incubators are Suzhou New & Hi-tech Innovation Service Centre and Tianjin Technology Innovation Centre.

University-based Incubators

College and University Incubators are the most promising and fastest growing type of incubator in China. These first began operating in 1998. Most of these incubators are the subsidiaries of science parks. A good example of the success such incubators have achieved in bridging the gap between universities and enterprises is Tsinghua Pioneer Park, founded jointly by Tsinghua Science Park Development Centre and the High & New Technology Incubator of Zhongguancun Haidian Science Park, which was founded by university students and teachers.

There are many other incubators that were created by leading universities, and their science parks, like Beijing University Science Park, Dongda software Park and Shanghai University Science and Technology Park.

International Business Incubators

The designation of an International Business Incubators is to support entry into China's market by foreign enterprises and R&D institutes, promote economic and technological exchange with foreign entities and accelerate the internationalisation of China's new and high-technology industries.

In reality these incubators have not yet experienced much success. According to Prof. Chen Jiachang, currently the International Business Incubators at the national level house only a single foreign enterprise – a Korean firm – and no others. Those at the provincial levels have not exceeded this achievement. In the future, reforms may make these incubators more interesting for foreign collaborators, but at present they are greatly ineffectual.

The most sizeable of the incubators with this designation are located in Beijing, and include: the Pioneering Service Centre for Science and Technology – Beijing International Business Incubator, Tianjin, Shanghai, Suzhou, Wuhna, Xian, Chengdu and Chongqing

Incubators in China

As discussed, there is a broad range in the scope of policy objectives in which incubators are created. Consequently, the location and functions of incubators also varies greatly. Following is a description of some of China's main incubators.

1. Suzhou International Business Incubator (SIBI)

Suzhou International Business Incubator

The Suzhou International Business Incubator is located within the Suzhou New District (SND) – established by the State Council as one of China's four APEC science parks. The Incubator has 30 tenant units ranging from 30 to 110 square meters. This is a facility where attempts are made to commercialise research results and develop technology-based enterprises. The success of this type of incubator in attracting foreign enterprises has been quite insignificant, as previously discussed.

The target clients of this facility include international-market-oriented domestic enterprises and enterprises interested in obtaining foreign investment. SIBI has a total area of 8,300 square meters. The building was open in September 1997. Rent charges range from RMB 350 and RMB 500/m^2/year (building management and service charges included).

2. China Suzhou Pioneering Park for Overseas Chinese Scholars

Also located within SND, this incubator was created to attract knowledge-based enterprises operated by repatriated, or soon to be repatriated, Chinese scholars. The park was jointly set up in February 1998 by the Chinese Service Centre for Scholarly Exchange, the Torch Programme Office of MOST, the Science and Technology Commission of Jiangsu Province, the Exchange Service Centre of Jiangsu Province, the Suzhou Science and Technology

Commission and the SND Administrative Committee. It enjoys special support from the Ministry of Education and MOST.

The park's facilities include a building of 7.600 square meters, which was put into use in September 1998 and contains 80 units between 30 and 200 square meters. Within every ten square meters there is an Internet connection. Tenant enterprises of the park can also share common facilities in the SIBI building and enjoy the services provided by intermediary organizations located in SIBI. Living accommodations are available for short-stay overseas Chinese scholars, as well as the management staff of the tenants.

Suzhou New District
http://www.cs-snd.org/ss1.htm

3. Wuhan Donghu Technology Innovation Service Centre (Wuhan International Business Incubator)

The centre has successfully incubated over 205 businesses since it was founded in 1987. This was the first Chinese business incubator. It is a mixed-use incubator operating as a business park and an incubator. Currently, it provides services to 40 resident businesses. Facilities include office space for resident businesses, a cafeteria and a business services centre. The incubator's young staff includes administrative and clerical personnel, computer systems technicians, and financial advisors. The services offered include business counselling, administrative services, office space, and access to copy and fax machines, etc. In addition to basic services, resident businesses can also apply for funding through the incubator, which assists residents design business plans in preparation for bank and venture capital funding requests.
http://www.ibi.org.cn

4. Tianjin Incubation Centre (TIC)

The Tianjin Municipal Science &Technology Commission set up Tianjin Incubation Centre in 1989. A technology business incubator, the incubation building has 11.000 sq. meters for workspace and 9.000 sq. meters for leasing. TIC offers a favourable environment for new firms, and provides well equipped facilities to help technology based newborn enterprises to

grow quickly. The primary objective of the incubator is to provide non-profit and value-added services to start-ups, help them learn how to manage a company, respond to the market, and to be successful. There are more than 60 services offered. TIC is now an international business Incubator as well. This is to say that TIC provides services for enterprises both domestic and abroad. Also, as Tianjin Overseas Students Science Park, it helps those students studying abroad to set up their own enterprises in China.
http://www.incubation.com.cn/eng/eindex.htm

Management and Organization of Incubators

The organizational structures of Chinese incubators vary, but they are typically administrated by a board made up of a managing committee (from facility staff), a party committee and S&T committee. The latter two are both connected to government sources.

The main departments of the incubators are:

- Incubator Director
- General Office
- Enterprise Department
- Real Estate Financing Department

As non-profit organizations, most of incubator administrators are more concerned with providing services to tenants than exercising their authority over them. As they are normally large, incubators to not themselves retain a high number of administrative personnel – usually only around 15 employees.

Typically services offered include:

- Providing information on human resources, labour issues, and salaries,
- Organizing advertising and exhibitions for enterprises,
- Assisting in marketing needs,
- Communicating between enterprises and the government,
- Consulting on legal matters, especially copyright protection, and
- Facilitating inter-tenant relations and promoting reciprocal development.

Most incubators are established as non-profit organizations that serve the needs of technology-based SME's. Nonetheless, some incubators have begun to charge their tenants service fees as a means of generating their own revenue.

It is now possible to find some incubators in China that have been financed by private enterprises, SOEs, or partnerships between these two. This form of incubator operates on a for-profit basis.

Financial Support of Incubators and S&T Parks

There are typically four potential revenue sources for procuring financial support for the activation and operation of incubators and parks. These are: fiscal government expenditures, subsidies from universities, subsidies from SOEs and independent financing. The operational funding of such facilities is often supplemented by service fees and rent collected from tenants.

The terms of these three forms of sponsorship are here described in general terms:

1. Government-sponsored, fully subsidized or financed: Fully government sponsored and financed. Minimal or no fees collected from tenants. In this form the government usually provides the entire initial investment but requires the facilities to become self-sustaining within a stated period – normally 2 to 3 years.

2. University-sponsored and financed: University-sponsored facilities usually operate on revenues partially generated by tenant fees. The remainder of their funding comes through university subsidies.

3. State-Owned Enterprise sponsored: Incubators and parks in this category usually receive an economic development mandate with their sponsorship. They are expected to perform a social function, but also to be practical economically. The SOEs supporting them are often interested in the potential returns they can generate through innovative start-ups and the commercialisation of new technologies.

4. Independently sponsored: This type of facility is typically sponsored and funded by both government and private organisations. Some privately sponsored incubators are run solely as for-profit businesses.

The most common of these is sponsorship through SOEs, though direct government sponsorship is generally available in a park or incubator's initial phase. While many facilities have developed to the point of becoming self-sustainable, many, particularly those in underdeveloped areas, can subsist only on governmental support.

3.5 Innovation Training Programmes

> *"Confronted with the changes and the trend of the times resulting from the rapid development of information technology, network technology and biological techniques, human capital is the most important resource of all the productive forces in the 21st century, because it represents the development tendency in the world economy."* [46]

Naturally, individuals hoping to become successful scientists, researchers or entrepreneurs will have a greatly reduced risk of failure if there are training programmes and structures in place to support their education and development. Many lingering issues can be addressed in this manner. For example, Chinese education is currently mostly technical rather than comprehensive – foreign companies often have to do their own "in house" training of foreign staff in broader issues and concepts. Also staff must be hired through a labour service company (e.g. Fresco), which limits their flexibility in human resource management. Addressing these concerns through education can increase China's capabilities and competitive advantages. This move appears to be beginning, often with foreign assistance. One such example is the increase in foreign MBA training, such as that offered through the China Europe International Business School in Shanghai.

China practices a theory-based educational approach with a high level of student specialization. Though recent years have witnessed an elevation in enrolments, a shortage remains in China of individuals with high levels of education. This increase in enrolments is illustrated in Table 8, below. However, students generally are not active participants in the classroom, and few courses are offered which support student's needs in the industrial S&T environment. There is little international contact or experience gained through the educational system, and the emphasis on theory leaves students with little practical experience in applying their learning.

Table 8: Education Statistics

	1985	1990	1995	1998
Number of Schools				
Regular Institutions of Higher Education	1016	1075	1054	1022
Secondary Schools	104848	100777	95216	92071
Specialized Secondary Schools	3557	3985	4049	4109
New Student Enrolment (10.000 persons)				
Regular Institutions of Higher Education	61,9	60,9	92,6	108,4
Secondary Schools	1789,8	1815,8	2354,1	2705,4
Specialized Secondary Schools	66,8	73,0	138,1	166,8
Graduates (10.000 persons)				
Regular Institutions of Higher Education	31,6	61,4	80,5	83,0
Secondary Schools	1279,1	1497,5	1636,9	2124,1
Specialized Secondary Schools	42,9	66,1	83,9	129,3

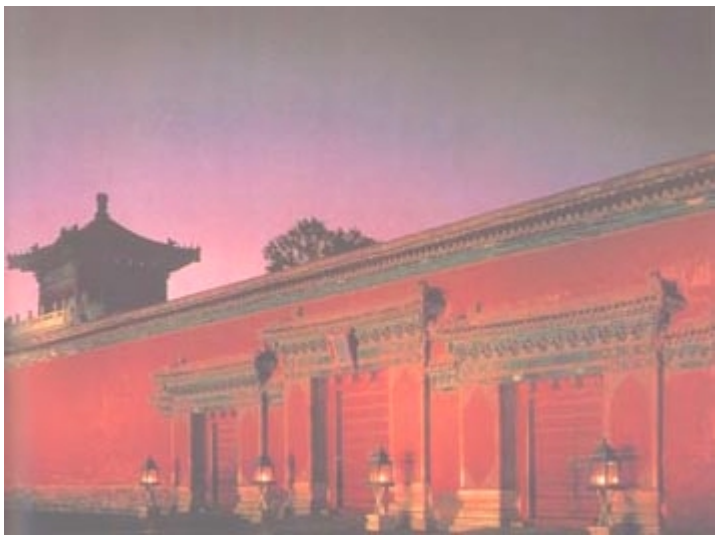
Source: China Statistical Yearbook, National Bureau of Statistics of China, 1999.

Although general education in China has made great strides in eliminating illiteracy, rural education remains a challenge and the country is still confronted with the problem of dealing with 100 million illiterates. The best universities are concentrated in the most urban areas,

and particularly in Shanghai and Beijing. The number of students in these institutions has increased dramatically since 1978, from 1,7 million graduates (from institutes of higher education) to 8,3 in 1998. This is roughly a five-fold increase in 20 years, to a level 26 times higher than the 320.000 graduates of 1952[47]. However, the urban concentration of universities partially contributes to the low level of education in rural areas. Estimates are that about 2 percent of the general population have completed a degree programme at the college level, and only 8 percent have completed high school. In 1999 the province of Beijing had more than 400 times the number of people working in S&T than did the poorer western province of Tibet. The system is considered under-funded, teachers underpaid, and differences of opinion over content hamper reform of the cultural mindset. Universities in general lack a high degree of autonomy, as the government as yet retains much central control of the educational system. These obstacles hinder the ability of the educational system to provide the country with the qualified individuals needed to attain its economic and social development goals.

This was revealed in one study which explained that the share of education was responsible for 8,84 percent of the annual GDP growth of 9,58 percent between 1982 and 1990. Of the 8,84 percent, only 0,48 percent was found to be due to higher education.[48] This indicates that education in China could be reformed in system, support, structure and concept. This is because education in China is not yet oriented to a competitive environment, despite the ongoing advances in the scenario of global competition and a knowledge economy.

In addition to its other reform efforts, China has initiated changes in the area of education. One such innovation has been the formation of a body to help develop ties between educational institutions and the S&T research community. This policy-directing body is made up of public sector leaders in areas relevant to the subject at hand. This group includes leadership from Zhu Rongji as chairman, Li Lanqing as vice-chairman, and the ministers of the leading science, education, and economic agencies: MOST, SETC, State Development and Planning Commission, COSTIND, the Ministries of Education, Finance, and Agriculture, the Presidents of Chinese Academy of Sciences (CAS) and Engineering (CAE) and a deputy secretary-general from the State Council. Together they direct the S&T components for ongoing 5-year plans, and establish long-term goals for the country's S&T development. They have been instrumental in formulating the knowledge innovation programme (through CAS), the State Key Basic R&D Programme (discussed below), a new education revitalization programme, and setting the direction of several major innovative science projects



Gate of Divine Prowess, The Forbidden City, Beijing

China has also undertaken several initiatives to specifically address inadequacies in the preparation of students as innovative performers in the S&T sector. These efforts to elevate S&T capabilities in China aim to increase the availability of qualified personnel, and therefore are of special interest to foreign parties interested in developing collaborations with China pertaining to innovation in S&T. In middles schools in Shanghai, students in research-oriented courses are now presented with identifying problems, selecting research projects, determining the direction of research, collecting materials, conducting all research and drawing their own conclusions[49]. More and more Chinese students are participating in

international exchange programmes, and concurrently the number of technical personnel involved in S&T in industry is rising. From 1987 to 1997 the level of personnel in this area nearly doubled.[50] Also advantageous is the prospect that by 2004 five to ten percent of courses at colleges and universities will be conducted in English, including courses in information technology, biotechnology, finance and law.

A notable example is the Chinese Education and Research Network (CERNET), which serves as a clear reflection of the educational policy objectives in China. This was the first nationwide education and research computer network in the country. (called "Xinhuanet") The CERNET project is financially supported through government funding, and is managed by the Chinese Ministry of Education. Tsinghua and other leading universities direct its operations. The network exists on four levels, which are: a national network, regional networks, provincial networks and campus networks. The national centre is located at Tsinghua University, which is responsible for operational and managerial concerns at the national level. The ten regional network centres are distributed throughout Tsinghua University, Beijing University, Beijing University of Telecommunications, Shanghai Jiaotong University, Xi'an Jiaotong University, Central China University of Science and Technology, South China Institute of Technology, China University of Electronic Science, Southeast University and Northeast University. These work in an administrative capacity over the network at the regional level. In effect, the network serves well in connecting academians and researchers.

The emphasis on, and level of, innovative training programmes in China have increased. Table 9 displays some examples of important training programmes in China focused on supporting innovation activity:

Table 9: Sample Training Programmes

Name of Institution	Programme	Content and Methodology
Management Committee of Incubators and Science and Technology Parks	Training of Innovation Personnel from Enterprise to Enter Incubator	Management rules and service issues for incubators and science and technology parks, short-term training.
Local Government and the Science and Technology Committee	Training of the Spark Programme Item	Knowledge and methodology of the Spark Programme.
China Development Fund for Teenagers and China Association of International Personnel Exchange	The Prospect Programme C - West Personnel Engineering	Innovative thinking and synthesizing management abilities, topical training for young leaders of local government and enterprises.
APEC Training Centre of Enterprise Incubator	Training of middle and small enterprises based Science and technology	Innovation management, Xian High-Tech Development Zone and APEC cooperate to train high-ranking managers of Chinese enterprises.

There are various ways of classifying the training programmes offered in China. Following is a brief description of three classifications of such programmes:

1. Programmes to instruct how to manage newly established enterprises.

2. Programmes for fostering creative thought.
3. Programmes to improve the professional techniques.

1. Programmes to instruct how to manage newly established enterprises

Content:

ISO 9000 Series.
Business administration.
Legal Terms.
Sales and marketing.
Finance.
Computer and Internet skills.

Methodology:

In-class lectures, workshop.

2. Programmes for fostering creative thought

Content:

Principles of Creative Thought.
Removal of the old passive thought shackling your creativeness.
How to ignite the potential of creative thought and develop it in full play.
Application of the creative thought techniques.
Drills for creative thought.
Practice of creative thought.

Methodology:

a) Carried out by government or incubators by the means of forum, lecture, and seminars.

b) Implemented by professional organization. Creating a free, relaxed and interesting air, professional trainers give lessons and develop a series of discussion and other activities, all of which the trainees take part in.

3. Programmes to improve the professional techniques

Content:

a) Developing innovation activity during the research & development phases of new products.

b) Core and essence of product innovation.
Key factors during product innovation/differentiation.
Various techniques for developing diverse new products.
Three kinds of innovation know-how for middle level managers.

c) Professional techniques in various industries.

Methodology:

a) Interactive instruction by professionals: school teaching, discussion, inquiry and answer.

b) In-class lectures.

These examples reflect the priority China has placed in professional training for innovation, and thus developing able and skilled personnel to compliment their counterparts in international collaborative activities.

Finance Support of Training Programmes

The Chinese government will consider issuing treasury bonds and inviting investment from international financial institutions, foreign government and individual investors to foster the country's education three to five years after its WTO entry, according to the Ministry of Education (MOE).

The sources of financial support of various types of training programmes are indicated in Table 10.

Table 10: Financial Support of Training Programmes

Training Programme	Financial source		
	Government	Enterprises	Free
Programme for improving professional techniques.		√	√
Programme for improving management techniques of incubators.	√		
Programme to improve business administration of enterprises under incubation.		√	√
Programme for fostering creative thought.	√	√	

The impact of training programmes on innovation activity

The consensus among S&T researchers in China seems to be that the existing training programmes may not be currently able to prepare students to perform as innovative thinkers in S&T. In other words, these programmes have greater potential in assisting China to reach its economic and social goals as they relate to innovation in S&T. The attention of observers is generally drawn to similar or specific areas:

- Existing programmes provide training on innovative ideas, but neglect the operational aspects of innovation. Students who are able to generate ideas are not prepared to apply them nor develop them for market utilization.
- Programmes generally provide short-term training, and thus limiting their long-term impact.
- The scope of current programmes is limited.
- Programmes lack social support.

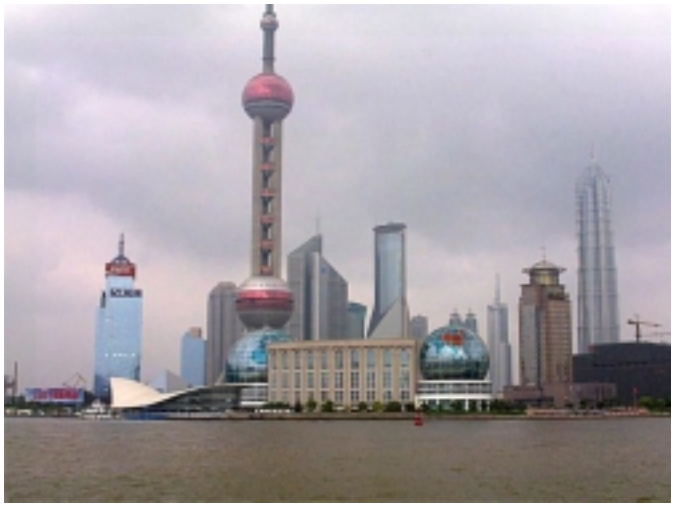
Education is one of the most challenging points facing China's development in the new century. The central government control in the universities and programmes (programmes have limited autonomy from the government), the limitations on the mobility of the people, the passive attitude of the students not participating and thus contributing to the development of their education, and the traditional social mentality all exacerbate educational system reforms. These problems and others are being addressed as China acts to improve the level of innovation activity, and the knowledge base of its people, through education.

Although professional techniques training is conducive to improving the level of innovation activity, it has not been as effective as expected. Perhaps this is because programmes are generally not geared toward providing for the needs of enterprises. Furthermore, due to the lack of such programmes in China, this sort of programme's contribution to fostering an innovation culture is limited.

3.6 Impact of Initiatives on Innovation

It is evident that China's support structures (incubators, S&T parks and economic zones) have attracted foreign enterprises, international capital, human capital and technical skills. Consequently it is safe to conclude that these structures have contributed to the country's economic growth and improved technical competence. Without them it is unlikely that China would have achieved the quadrupling of its GDP since the reformation of its policy objectives in 1978.

Chinese spending on R&D has not increased beyond the level of GDP growth. As a result, the ratio Gross Expenditures on Research and Development to Gross Domestic Product (GERD/GDP) has remained largely unchanged since 1991. When China's GERD/GDP ratio is considered in comparison with those of other countries, it appears rather meagre in contrast with highly industrialized countries, and even with some of its Asian neighbours. It is clear that the central government does not want China to attain the 1,5 percent objective only through increases in central government S&T expenditures. Instead, it looks to enterprises and to local governments to pick up much more of the load. While expenditures from these sources have increased, the share form enterprises has not changed significantly over the 1990s.



Shanghai skyline

A common repercussion of public policies promoting technology is the development of a reliance on the State, as opposed to private initiative, to make gains in this area. This may also reflect a particular cultural mentality somewhat attributable to a country's political history. In China, the intensification of foreign competition, more likely to escalate now as a result of WTO acceptance, should bring with it a more competitive atmosphere. This will challenge economic reliance on the government. Foreign competition can serve an exemplary role in China, as they model operational and marketing aspects of research. In this sense, China is fortunate to have such a large and appealing market – one whose potential is not likely to be overlooked globally – to attract its own benefactors. In any case, heavy government support of R&D has been the primary impetus of development, but may now become a hindrance to it in an environment of open competition. This realization is bringing about changes to reduce the government's funding and sponsorship of research, and placing more reliance upon the private sector.

Also, many incubators have largely overlooked social and economic concerns due to their particular emphasis on developing technology-based enterprises. China has clearly stated its priority in all levels of technological progression, but has emphasized the need to target broader economic and social advances as well.

Incubators and parks have created a secure foundation for R&D operations, one from which the practical application of research results can be promoted. These facilities have given researchers opportunities they would not have otherwise had. They have opened the doors for the pursuit of innovation in S&T, and provide imperative services and funding. Their contribution to the economy is evident in that there are now some regions in China that depend on high-technology development from incubators and parks for a full third of their total production.

The Impact of Policies and Measures on Innovation

In general the impact of the policies on innovation activity in China have been improvements the R&D system. The target of the government in 1995 was to increase gross expenditures on R&D (GERD) to a GERD/GDP ratio of 1,5 percent by the year 2000[51]. This was not accomplished (GERD/GDP was just 0,83 percent). Though expenditures on R&D have increased, so has GDP, thus keeping the GERD/GDP ratio low. It is reasonable to anticipate that by 2010 the ratio will reach 1,7 percent, because the R&D growth rate (now 15 percent per year) is climbing to a level roughly twice that of the GDP growth rate, which at the moment is in slight decline.

Some organizations have used the new direction of public policies to further develop emerging industries. One such example is found in Northeast University Science Park, which was started in 1985. This was the first University, with East Software Cooperation Limited, to develop information industries. This effort subsequently sprouted a few famous software enterprises, such as Shenyang Dongdapai Software cooperation and East Software Cooperation.

Additional results of Chinese policy reforms related to innovation are the:

- Escalation of technology-based spin-offs,
- Growing importance of high-technology zones in developing some areas. (In some regions, they account for more than 30 percent of total output.),
- Changing university functions to include contribution to industry, in addition to educational and research objectives,
- New market orientation of research institutes,
- Increase in the R&D activity of SOEs,
- Elevated efficiency in S&T innovation efforts,
- Improvements in transferring technical innovations onto the market,
- Increases in the acquisition of foreign machinery and equipment,
- Increased number of innovative companies,
- Increased number of R&D entities, concurrent with a decrease in the number of R&D personnel,
- Increased competition between research institutes,
- Increased number of information technology (IT) oriented companies,
- Increased ratio of R&D to GDP,
- Decreases in the number of innovations produced by government R&D institutes and universities, concurrent with increases in the number coming from private enterprises,
- Increased number of Chinese returning from overseas.

This progress stems from government policy modernizations, but the primary obstruction for SOEs in developing new technologies remains political. The Chinese administrative system includes provincial governments modelled after the structure of the central government. At this level, provincial governors carry out ministerial functions. Control of SOEs falls under provincial jurisdiction, but they must also answer to the ministries of central government. This causes some tension, as provincial governments would like to see development take place inside their boundaries, and the central government has an overall developmental agenda that does not always coincide with the interests of provinces. Thus SOEs sometimes do not receive the funding they would like, and the potential for advancements is not always realized.

The policies to encourage scientists and engineers to develop innovations focus on various areas, and are effective to varying degrees. Among the most effective policies have been those aimed at luring Chinese scientist and scholars back from overseas. However, some policies cannot actually be implemented at all in many enterprises. For example, because of the idea of the equal distribution of wealth and the complexity of SOEs, the notion of stock ownership is only used in some well-run enterprises in developed regions of China. Also, in most SOEs, the financial awards for innovative technical personnel, if there are any, are only small sums in comparison with the incomes of sales staff. Furthermore, there is no significant difference between the average income of technical personnel and that of common workers. Finally, there are no training systems in most enterprises. As a result, the initiatives and creativity of technical personnel has no outlet.

4. Ability of Initiatives to Promote Innovation

The elements previously outlined are each important contributors toward establishing a complete and a healthy NIS and creating the environment needed for successful innovation activities in S&T. Naturally, the degree of effectiveness of each element varies, and each is used to respond to a different issue confronting economic and social development. However, it is their aggregate influence over the system that results in an NIS being effective or ineffective. Each element must adequately meet its objective in addressing particular concerns, or the system as a whole is weakened.

The influence of an NIS as a whole should be evident in the results that have been achieved through it. In China, the short period following the policy shift of 1978 has witnessed a rapid increase in economic growth and international trade. This, combined with the market potential of a population that makes up roughly a fifth of the world's inhabitants, has easily grabbed the attention of international businesses. It should be remembered that the economic growth that has taken place has been made possible in part because conditions prior to 1978 were so poor. China's GDP growth has out-paced that of other countries because the country had so far to go to catch up.

It is evident that the first step in the development of China's current NIS was the redirection of public policy. The priorities set by the administration have been the foundation upon which all elements of the NIS have been built; and have led to the development of the programmes, measures, regulations, structural supports and training programmes as discussed. The economic outcome of the NIS is apparent, though there is yet room for further improvements. As China's policy agendas have been consistently reviewed and updated, it can be anticipated that the NIS will continually evolve to meet new challenges.

It should be noted that some have argued that business parks and incubators provide their inhabitant enterprises with an unfair advantage. Through providing services, facilities and funding these businesses are sheltered from the sometimes-ruthless environment of free-market competition. In essence, they are not required to "stand on their own two feet". While this may be accurate, it is generally understood that businesses that enjoy this protection enjoy it only during the initiation, or "incubation", phase of the enterprise. Businesses are allowed to mature and stabilize in this manner, prior to facing established competitors on equal ground. Defensible or not, this practice has provided the conditions needed for many new enterprises to gain their footing in China. From 1991 to 2000 the number of enterprises in STIPs increased from 2.587 to 20.796, and total income from STIPs went from RMB 8,7 billion to more than 920 billion[52]. At the same time, the number of enterprises "graduating" from incubators has increased, with more than 1.300 such companies leaving incubators in 1998 alone[53]. With these results it appears that China is making good use of S&T facilities to meet its goals.

In examination of the effectiveness of China's NIS, a review of specific case studies can offer insights which statistical data and figures do not. In Box 5 and Box 6 examples of important success cases are illustrated, as they have resulted from the NIS in China.

Box 5: Huawei Technologies Co., Ltd.

Huawei Technologies Co., Ltd.

Huawei Technologies Company was established in 1988 in Shenzhen, under the auspices of the National Torch Programme, through the programmes created under the national administration's Ninth Five-year plan. The company's focus is on the research, development, manufacturing and marketing of telecommunication products. It also provides its clients with customized networks (in fixed, mobile and data communication networks) to address their specific needs.

From its inception in the Science-Based Industrial Park at Shenzhen, in the Nanshan District, the company has grown dramatically. Today it has operations in 40 countries and is considered one of China's premier technology enterprises. It has consistently been included in the annual list of China's "The Hundred Powers" in electrons enterprises. The company reports its revenues have grown at close to 100 percent annually, with 2000 revenues reaching USD 2,66 billion. The company enjoys a AAA credit rating by the Industrial and Commercial Bank of China.

The contributors to the company's success include the services provided through the industrial park and highly qualified personnel. Its staff is highly educated, and primarily active in research. In contrast to China's numerous SOEs, Huawei is a private enterprise and fully owned by its employees.

http://www.huawei.com.cn/english/index.htm

Box 6: Legend Holdings, Ltd.

Legend Holdings, Ltd.

Legend began in 1984 when 11 technicians from the Chinese Academy of Science came together to develop information technology (IT) products. It has since grown tremendously, enjoying significant annual increases in sales and revenue figures. Today the company is focused on designing, manufacturing and distributing computers and providing Internet services and content. The company is now a major competitor in computer manufacturing in the Asia-Pacific region, and commands 30 percent of the market in China. In 2000 Legend was ranked 8th in Business Week's Information Technology 100, and in June of 2001 it announced a merger with the US firm AOL.

Legend operates under a policy of sound human resource management. The management maintains that by providing its staff with a good living and working environment, they are helping them to become innovative thinkers and performers. Legend clearly values its people.

Legend is located in the Zhongguancun Science Park, China's largest scientific R&D and technological development base. This support is naturally a prime contributor to the company's remarkable rise. The company recognizes this, stating that Legend was:

> " …born amidst the digital wave symbolizing china's reform and open door policy…", and "Leveraging on the excellent environment created under china's reform and open door policy, together with the encouragement and support of government leaders and people from various sectors of the community, Legend Group has been able to develop rapidly. Today, many people in China and the Asia-Pacific Region agree that Legend is the typical model of an high-tech enterprise of the Chinese people, which is becoming more mature and getting stronger everyday." (Chairman's Message, Legend Holdings, Ltd.)

Legend Holdings, Ltd.

http://www.legend-holdings.com/index.html

4.1 S&T Innovation In Europe

China and Europe are at different levels of development and different stages of technological adaptation, and thus confront different geographical and cultural issues. As such, it is natural that their respective innovation systems vary in many ways.

From a public policy stance, Europe's objectives in innovation relate fundamentally to competitiveness and social and economic development. In principle, Europe makes up a part of the West and already has access to state-of-the-art technologies. One of the stated intentions of Europe's Innovation Programme is to "keep abreast of innovation policy developments" through: "1) fostering an innovation culture, 2) establishing a framework conducive to innovation, and 3) gearing research more closely to innovation at both the national and Community level."[54] Acquisition of existing technological tools is less critical than developing new improved versions. China's reliance on imported technologies shows a marked departure from this approach.

China's aim is also to expand social and economic development, but starting from a lower base and broader population. Technologically, China seeks to obtain technologies that are more readily available in Europe. The innovation system a the national level is subjected to more central authority than is found in Europe, though regional and local innovation systems function more autonomously. In this way the innovation systems between Europe and China have much in common, and both seek to maximize strengths at the regional level.

Components of the innovation system in Europe are normally managed at the country level, though the EU helps in their direction through programmes and funding. One example of differences at the national level is observable in the link between science parks and universities. In Germany such networking is considered unnecessary, while in France the link is much closer and university members are frequently involved in the management of nearby science or research infrastructures.[55]

Technology Park,
Sophia Antipolis, France

A primary application of Europe's NIS is in addressing its social agenda pertaining to the integration of the Community's diverse membership – integration across cultures, languages and regions. The use of technology to facilitate this assimilation is regarded as an invaluable tool. Many programmes have been directed at this agenda, such as multi-lingual and cross-cultural e-Learning systems. In this way cross-national citizens can share a common standard in education and social development.

Networking knowledge and efficiently using the strengths of its members is a top priority, and has led to such innovative efforts as the programme in North Rhine-Westphalia, described in Box 7, below.

Box 7: North Rhine-Westphalia's Research Programme[56]

Offensive for Future-Oriented Top Research Programme

North Rhine-Wesphalia's central programme to promote research is the so-called 'Offensive for Future-Oriented Top Research' programme. Its objective is to expand the strengths of research facilities at universities and colleges of North Rhine-Westphalia in selected strategic fields of research. The programme aims to promote the networking of research both within these institutes as well as between institutes, external research establishments and industry, and to support the international exchange of scientists. The key areas of research selected for this 'offensive' are based on the demands of industry and society, and are as follows:

- Biotechnology, life sciences;
- Information and communications technology for the knowledge society;
- Material and production techniques;
- Sustainable environmental and energy research;
- Transport and mobility;
- Intensification of research in the arts and social sciences.

A total of EUR 20 million per year have been made available for this purpose. The universities and colleges, research establishments and companies must contribute up to 25 percent of their own funds to these projects. The Ministry of Economic Affairs and the Ministry of Labor of the state of North Rhine-Westphalia offer corresponding programme aimed at small and medium-sized industrial companies, the so-called 'Technology and Innovation Programme NRW' (TIP). This programme sets out to provide public funding to support small and medium-sized companies competing in the field of innovation in order to enable them to assert themselves in the long term in the particularly dynamic and expanding fields of innovation and technology. These sectors are also promoted in the field of scientific assistance. Such measures also strengthen cooperation between industry and science.

Every institution of higher education in North Rhine-Westphalia has a transfer agency that cooperates with industry. There is a close network of technology centers and advisory agencies which also includes industry in North Rhine Westphalia…."

Source: The Fraunhofer-CAE Symposium "Science for Innovation", 1996.

Europe's First Action Plan for Innovation[57] was initiated in 1997, and established 3 policy priorities - areas in which the Community hoped to improve:

1. to foster an innovation culture,
2. to establish a framework conducive to innovation, and
3. to better articulate research and innovation.

Europe has also sought to assist in the maturation of developing markets, realizing the potential and importance of developing ties to such markets and driven by the rapid changes brought on through globalisation. In this endeavour Europe's programmes have also been directed toward networking and bringing technology tools to various industrial sectors in many developing communities around the world. This includes China, and projects and programmes supported through the establishment of the European Commission Delegation in China (of which the current project is one). The financial investment is weighed against

the potential future benefit of global competitive positioning, and is deemed a valuable investment opportunity. This benefit was also of no small significance in the transition to a single currency beginning in 2002.

On the other hand, European assistance to China is balanced against the prospect of China becoming dominant in economic affairs. While Europe hopes to leverage its competitive advantages, it is ultimately strengthening an international competitor through its aide to China and could suffer the consequences in the long run. There is not yet any anticipation that cooperation between the two will lessen, but as China's economic strength grows this could become a significant political issue, and thus a hindrance to collaborative work in science innovation.

Europe's Innovation Programme, or "the Specific Programme for the Dissemination and Optimisation of the Results of Activities in the Field of Research and Technological Development Including Demonstration", established following the Treaty of the European Union, is the third activity of the Framework Programme. The Fourth Framework Programme ran until 1998[58], and in accordance with the Treaty established four activities:

1. Research, technological development and demonstration programmes,
2. Cooperation with third countries and international organizations,
3. Dissemination and optimisation of results,
4. Human capital and mobility.

This was replaced by the current Fifth Framework Programme[59], which will continue through 2002. In this programme the 4th activity was changed to read "4. Stimulation of the training and mobility of researchers in the Community", and a 5th action for direct research was added: "Joint Research Centre" (for institutional support of research activities). It is evident that all of these activities apply to current efforts to establish cooperation in S&T with China, particularly the second.

The activities are intentionally broad, so as to incorporate a vast array of projects related to a variety of scientific research-related areas. More narrow specifications of such projects are included in the Programme, and include:

1. Financing innovation,
2. European Innovation Monitoring System,
3. Patent and Intellectual Property Rights,
4. European Network and Services,
5. Innovation Management Techniques,
6. Regional Innovation and Technology Transfer Infrastructures and Strategies,
7. Technology Transfer and Technology Validation Projects, and
8. Increasing Awareness.

It is noteworthy that there is some consistency between these areas and those that are of concern to China. With the perspective of Europe in mind, it is clear that collaborations with China fit well within the scope of public policy. In terms of working together in S&T innovation projects, or any other area, it is important that the objectives and results are complimentary to the respective policy agendas, as noted:

> "With regard to science, national governments have different motivations for promoting collaboration. It is important to recognize these different objectives and to develop strategies to maximize the national benefits of collaboration and minimize the disadvantages." [60]

There must be balance between the parties in collaborative efforts.

4.2 S&T Innovation In China

China has implemented extensive initiatives in order to establish a viable NIS and develop into a global competitor in S&T. As reflected in the discussion of the NIS in Section 3, it is evident that "the Chinese government has tried hard to introduce science into decision-making by using up-to-date S&T and by adopting democratic and scientific methods, in order to adapt the process so that it draws upon collective knowledge and absorbs all useful ideas on a scientific basis and with institutional guarantees,"[61] as noted by Fang Xin. However, the initiatives for reforming the economy are still in the process of achieving their aims. Further reforms are expected, particularly now as China moves to adhere to its WTO commitments.

In contrast with Europe, China's initiatives have been aimed at economic renovation, rather than at advancing what is already in place. This means the country has had to face a comprehensive overhaul of the economy, while at the same time balancing reforms against an historically incongruous political ideology. Winning support from the CCP-leaning administration has allowed for the changes achieved thus far.

Li River

With respect to science and research initiatives alone, the country has established objectives on a broad range of related issues. Among these are the adequacy of available personnel, the development of the western regions, the direction and internationalisation of research efforts, the improvement of innovation networking and research funding.

In addressing personnel issues, the country's objective is to "create a situation favourable to the emergence of a large number of talented people who can put their specialized knowledge to good use."[62] The problems to be addressed include the aging of research institute leadership with insufficient numbers of potential replacements, a lack of mobility that has led to the concentration of researchers – and development - in only certain areas, poor living and working conditions, an inadequate rewards and recognition system, and the "brain drain" tendency of intellectuals to go abroad to find conditions that are not available domestically.

Development in the western regions of China has become a concern of policy-makers and has been the target of rural development programmes, such as the Spark Programme. Foreign investment into these regions remains low, and this will likely be a continuing concern for the administration.

China has used its sequential Five Year Plans as a means of guiding the direction of research. This is considered a critical component of development: "the principal objective for [China's] R&D policy is that the country's economic development must be based on research

and development, and that R&D activities must be structured to meet the needs of economic development."[63] This commitment - enhancing competitiveness through promoting research and innovation in particular areas – is only half achieved through directing research. The application of results is equally important, and so China must find the appropriate means to maximize the benefit of innovations. An agenda of China's initiatives is to address both the research efforts and their means of application in part through international partnerships: "The science and technology sector of China will work in partnership with the international community of science and technology, and the global economic and business community, to construct a platform for innovation in the new century."[64]

The ability to effectively disseminate information and make use of innovations has been an ongoing objective of government initiatives, and was identified as a priority for future initiatives by a joint study between the United Kingdom and China:

> "…our evidence suggests that there is a lack of synergy and coherence among the actors and networks, in particular among the three networks we have studies, i.e. the S&T network, the geographical network and the industrial network. These networks are at present somewhat 'misaligned'. A considerable restructuring of the system is therefore necessary which incorporates more interactions not only among actors (e.g. universities and industry), but more importantly among networks. This is also necessary to encourage regional integration and avoid fragmentation…the generation of knowledge is not a sufficient condition for economic progress. Equally essential is the capacity for technology and innovation to gain economic significance."[65]

Measuring the effectiveness of efforts to develop relevant S&T innovations is a continuing challenge in China and elsewhere. A uniform and internationally accepted criteria or standard for evaluations of this nature has not been established. It is in this interest that the European Commission initiated the *Innovation Scoreboard*, which assesses innovation via statistical data on 17 indicators. However, indicators that are helpful in gauging S&T innovations – such as the number of patents filed in a particular country or the number of science-oriented higher education graduates –do not necessary reveal the effectiveness of S&T innovations as a whole. It is therefore difficult to assess the actual impact of efforts to attain S&T innovations in China, beyond noting trends toward improvement found in statistical data.

PIP Science Building, Dalian Free Trade Zone

The level of funding being directed into research efforts has been used as a means of measuring the success of S&T innovation initiatives. This is the level of GERD, referred to earlier. Currently this level is equivalent to approximately 1 percent of GDP, and the government is the primary source funds. Over the previous decade the ratio of GERD to GDP has remained relatively unchanged, as both GERD and GDP increased considerably, but proportionately. Among the targets of the last five-year plan, China established a GERD goal of 1,5 percent of total GDP, intending that research investments should not come solely from the national government but from private enterprise and local governments as well. The current plan is for government funding to research institutions to decrease and potentially be phased out entirely, which will require research activities to be results oriented and market driven.

China's innovation initiatives have brought it far in developing its socialist market economy. Examples of successful and innovative companies are discussed in Boxes 8 and 9. These companies could not have achieved their success prior to the policy shift of 1978.

Box 8: Successful Innovation (A)

Example A: The Set Type System of Laser Chinese Characters

1. **Description of the initiative:**

In 1986, Peking University set up Fangzheng Croup of Companies on base of National Computer key Laboratory, National Research Centre of Computer Engineering, Authorizing Point of Doctor and Master Degree and enterprises. In 1988, the Fangzheng Croup of Companies researched and developed The Set Type System of Laser Chinese Characters C Huaguang No.1 that was invented by professor Wang Xuan of Peking University to go to the market. In 1991, Fangzheng Croup of Companies researched and developed the Part Area Network System of Chinese Electronic Set Type, the Indexing System of Light Dish and the Transmit System of Long C distance. In 1992, the Fangzheng Croup of Companies officially developed out the Fangzheng Colour Electronic Publish System. In 1993, Fangzheng Croup of Companies further developed the Products of 93 Series that accord with the International Standard PostScript level 2 and had haven treat ability of many type of characters, and the Large Synthesis System of News Work. Fangzheng Croup of Companies is occupying advance position in the electronic public field of all over the country.

2. **Promoters of the initiative:**

The primary promoter was Peking University. According to the demands of National System Reforming of Economy and Science and Technology, Peking University promoted transformations of science and technology achievements, and provided investments to the Fangzheng Company, and gave many guides and supports to it.

3. **Actors that benefit from the initiative:**

The Fangzheng Company is most big benefit from the initiative, Scope of the Company extend rapidly, and the Company have 37 branch companies in domestic and abroad in 1994, and total sales volume of the Company in 1994 is RMB 1.800 million and was in lead to whole electronic public industry in China.

4. **Main contribution of the initiative:**

The main contribution of this innovation initiative was in the development of the technology, as well as the Peking University training programme.

Box 9: Successful Innovation (B)

Example B: Research and Development of Her Refrigerator

1. Description of the initiative:

In 1984, the Qingdao Total Factory of refrigeration was set up. The Factory operated in the categories of high technology, high functions, high incomes and creating international recognized commodities through technology innovation. It continuously sought to develop new products in producing generation, developing generation, researching generation and composition of generation. In 1988, the Factory gained the first gold award for new products. In 1992, it had products posted to quality confirmation and accreditation of ISO9001, and export products made up 20 percent of total production in the Factory. From 1984 to 1996, the Factory gained through 406 inventions.

2. Promoters of the initiative:

The promoter of the initiative was primarily the Factory. When the Factory was set up, it was equipped for the competition of 100 more units than other refrigerator factories. Thus the Factory established itself in innovation systems. The Her Science Park, were the Factory was located, launched many incentive measures for innovation, and established extensive cooperation with universities, institutes and domestic, international enterprises in innovation activities. The R&D invested was 3,5 percent of total sales.

3. Actors that benefit:

The actor that benefited from Her Refrigeration was mainly the company. From 1984 to 1996, sales income of Her Factory increased annually by an average of 86 percent, and the enterprise's profits increased annually by an average of 161 percent.

4. Main contribution of the initiative:

The main contribution was in modernizing the enterprise system of Her Factory. The open information policy contributed to improving social conditions of innovation activities because of Her's success. The Her Factory established an effective examination and award system within its personnel system, and strengthened management of the innovation process through its Overall Every Control policy. It also contributed to the enterprise structure in multilateral businesses, serving as an example of effective distribution and internationalisation of an enterprise.

5. Potential S&T Collaborations Between Europe and China

While the innovation objectives of Europe and China are not identical, there are clearly compatibilities in the areas they address, and thus opportunities exist for mutually advantageous collaborative projects. While China has a higher percentage of innovating companies than Europe, the level of actual research is lower.[66] Working in conjunction, each has the potential to benefit from the other's involvement.

International collaborations can take place for many reasons. From Europe's perspective, working with China in scientific innovation activities may be motivated by the desire to help the country address developmental challenges, to achieve political or economic goals, to gain access to a large foreign market, or to gain the financial benefit of cost-sharing on projects. Working with Europe, China can gain access to advanced technologies, input from highly skilled scientists and researchers, financial support on projects with shared costs, and strengthened political ties. In both instances there is great advantage in collaboration.

Similarly, working together can be challenging. For instance, the distances between the participating parties can increase the costs involved. Working with foreign counterparts can present complications in decision-making and communication, and result in bureaucratic inefficiency.

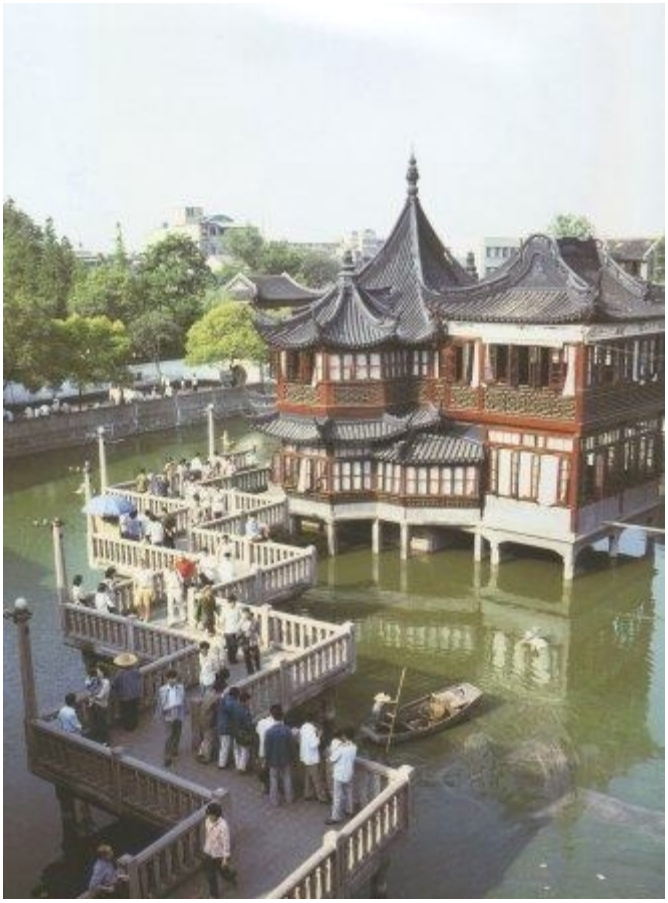
Xian Terracotta Army

European cooperation with China in S&T innovation efforts may take various forms. In some cases it may be deemed appropriate to invest in Chinese enterprises, or to form alliances with them. Common practices include cooperative research, exploitation of results, authorized research, personnel training, international conferences and importation of intellectual resources or technologies.[67]

Additionally, there are various means by which foreign direct investment (FDI) and partnerships are, or can be, promoted in China. Some of the most common of these include:

- Acceptance by Chinese banks of the guarantees of foreign shareholders,
- Allowance of foreign enterprise's application for stock issuance,
- Improving various insurance services for foreign industries,
- Reducing governmental authority over sectors open to FDI,
- Extending the limit of "Guide Content of Foreign Investment Industries",
- Abstaining from value evaluations of imported equipment for use in foreign firm's China operations,
- Tax incentives.

Certainly the opportunities and means of acting on them differ, but they can be employed to fit the needs of the parties involved. In consideration of collaborative efforts in S&T innovation, a full assessment of the benefits, weaknesses, opportunities and challenges is indispensable.



Nine Bends Bridge, Yu Gardens

5.1 Benefits

It was recently reported that "collaborative knowledge networks are gaining momentum because of two converging factors. First, new technologies have made collaboration relatively easy and inexpensive. And second, creative employees are finding ways to apply those technologies to the daily challenges they confront in the workplace."[68] There is growing awareness of the benefit collaborative work has over isolated efforts. These benefits include accelerated knowledge transfer, agility and productivity, creativity and optimisation of assets.

Both Europe and China have sought international collaborations in S&T innovation in order to assist with their individual development and international competitiveness. On both sides, collaborations offer an efficient and profitable means of enhancing their positions. There are many motivating factors for such efforts, as identified in the previous section. With access to the vast market and resources of China, Europe stands to greatly increase its economic strength in the world. As China produces comparatively less in terms of R&D innovations, collaborations can be used to gain access to such information.

Working in conjunction can be an effective way to address various issues:

> "Cooperation can generate value in several ways. By concentrating more and different minds on a given problem, it may increase the chance of solving that problem. By bringing a range of skills and resources to bear, it can foster an efficient division of labour and speed up the R&D process. By diversifying the contexts within which the participants in the R&D process are situated, cooperation may raise the likelihood that the results of R&D will be found to be useful and, along the way, generate interesting new problems and methods."[69]

Europe and China have a long history of cooperation, and the advent of globalisation has brought with it the opportunity for these two participants to mutually benefit one another. The levels of trade and cooperative activity have steadily increased, and will continue to do so, especially as a consequence of WTO entry. The European Community and China signed an S&T Agreement on 22 December 1998, paving the way for future cooperative activities. The countries have supported numerous programmes and activities to further strengthen their ties, and both have included international cooperation as a chief component of national policy and a fundamental part of economic and social development. The EU has stated its aim is "to support the country's [China's] sustainable economic growth and development, to integrate China further into the international community and to promote the rule of law. The overall approach is one of constructive engagement on the ground and cooperation with the Chinese authorities and with Chinese society."[70]

Chinese symbol signifying good fortune

When asked about the benefits of cooperating with China, managers of ongoing European-sponsored projects consistently sited market exposure and networking as the two most apparent advantages they experienced in China.

European parties hoping to embark on collaborative projects with China in S&T research and innovation activities can expect strong support from the public sector. In this area cooperation between the two has been actively promoted by the government for nearly two decades. The primary tool for collaboration has been the EU's Programme for Scientific and

Technological Cooperation with Developing Countries, known as the INCO programme. By 1998 this programme had already supported more than 100 collaborative projects between the EU and China. The European Commission has indicated that its budget for supporting EU programmes in China is EUR 250 million from 2002 through 2006.

As China continues to progress in its development, the benefit of having established connections with the country will increase. Working in collaboration now can serve to assist the country's improvements, and to build valuable relationships that can promote future alliances and elevate competitive positioning.

(Source: China International Chamber of Commerce)

Seacoast at Zhuhai

5.2 Weaknesses

Despite China's reform-driven progress, weaknesses remain which threaten the development and benefit of S&T alliances. One of the foremost of these is the issue of the enforcement of law in China. While the country has instituted, or will be instituting, the reforms needed to comply with international standards, piracy and copyright infringement remain viable threats to innovative activity. For European counterparts this is a problem much less frequently encountered at home, and which might be considered grounds for deciding not to become involved in China. In the same vein, the guidelines for testing, standards and product quality in China have all been called into question. These issues are gradually fading, but today remain hindrances to international S&T cooperation.

Additional barriers to innovation activity in China include a lack of capital among Chinese researchers, a lack of skilled personnel and a lack in the dissemination of information. In the context of working together on research and innovation, these can be insurmountable hindrances. China's government is aware of these issues, and initiatives to remedy these problems are expected.

Takli Makan Desert

Consideration among some international collaborators can also include language and cultural barriers. Partners on both sides should consider the cultural framework of the other's country. Some studies have indicated that the primary challenges confronting collaborative work include cultural differences pertaining to sharing information, lack of balance in the knowledge levels, awareness and abilities of associates, and lack of commitment from management[71]. Such cultural issues also topped the list in the IST manager's poll, previously mentioned, when identifying primary weaknesses in EU/China collaborative work. Their only other major concern was a lack of consistency in the two legal systems, particularly IPR legislation in China.

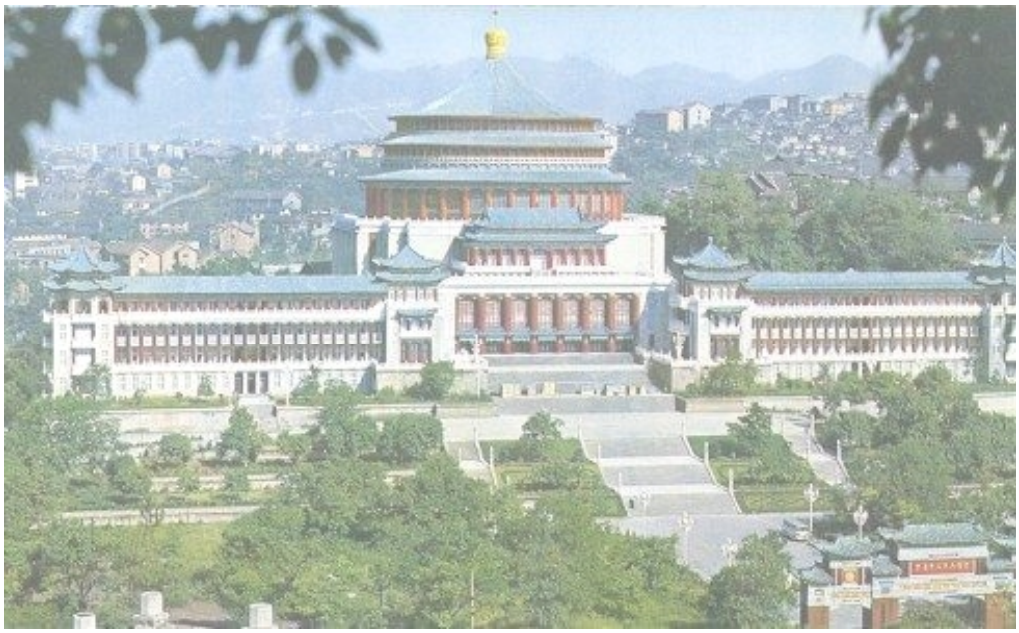
Working out understandings on issues of authority, leadership and decision-making, and then abiding by such agreements, may become of greater importance than the two sides would at first expect. As Europe comprises multiple countries, languages and cultures, it is difficult to arrive at a set formula for addressing this issue. The best approach is one of open-mindedness and understanding on the part of collaborators.

While an incentive for collaboration may be cost-sharing, the ongoing costs incurred in the operations of a project may become extremely high. The cost of international communications alone can put significant restrictions on a project's budget. The parties involved must have a clear and reasonable understanding of what their financial commitments will be, and this may be difficult to obtain in the absence of prior experience with international partnerships.

Due to unfamiliarity with the research activities of foreign firms, finding the right people to complement domestic strengths can be a challenge. There may be researchers in Europe and China that would benefit greatly from working together, but that are not aware of the other's work and thus do not meet, instead participating in less beneficial partnerships. The

availability of information in this regard can lessen the potential advantages to be gained through joint research or other international collaboration activities. It is generally conceded that this lack of available information exists in China, and perhaps in Europe as well, to some degree. Networking is becoming an important and ever-increasing part of an NIS, as globalisation makes joint international projects more feasible, and as countries work to use their strengths to the fullest.

While in principle the weaknesses associated with collaborations in S&T are fading at a pace equal to that of China's reforms and development, there are no guarantees as to the speed nor consistency of this pace. Therefore these considerations must be taken into account with a full understanding of both the probable and the possible changes.

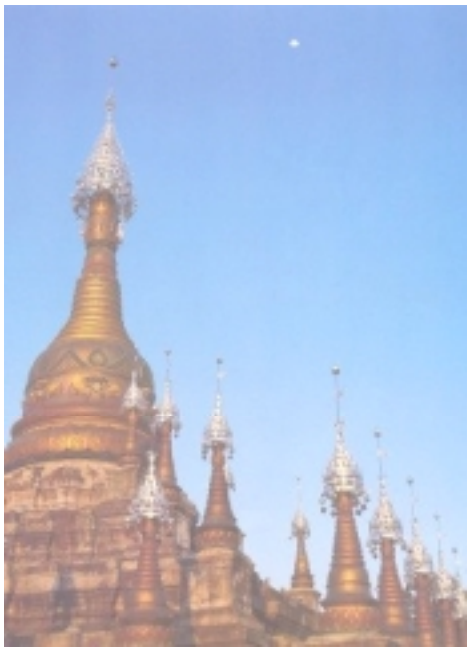


People's Hotel, Chongqing Municipality

5.3 Opportunities

There is a common belief, among businesses and governments, that the opportunities available in China are abundant. The country has become of interest to many international parties because of its vast population, but also because the reforms of the previous two decades have created valuable prospects in the country. It is anticipated that in the future China's open doors will create remarkable prospects in many areas, including science and research. Reforms have already made possible the entrance of foreign banks, and China's WTO commitments will expand this to include many additional sectors, particularly in services. The outlook for the future is positive.

Science and technology ranks high among the current and anticipated budding opportunities in China. Some observers have concluded that science and technology-based industries are the top sectors offering foreigners opportunities in China. These include telecommunications, information technology and biotechnology. China's MOST reported that total revenue for biotech products in 2000 was ten times higher than it had been in 1986. In 2000 there were more than 500 biotech firms operating in China, with total revenues of RMB 20 billion.



Mangmengding Buddhist Temple

Many foreign companies have already begun to take advantage of the possibilities in China through establishing their own research centres in the country. These include IBM (see Box 10 on the following page), Hewlett-Packard, AT&T, Nokia, Ericsson, Siemens, and Mircrosoft, to name a few. There are now more than 50 such facilities in China. In this manner, these companies are able to reduce the complications of using complementary strengths jointly, but from afar - including language barriers, communication and travel costs, etc. They are also more easily able to access China's large market. With a growing number of entrepreneurs and expansion of the middle class, the lure of reaching the domestic market in China is increasingly enticing.

China's acceptance of foreign research centres is not without dissent. Similar to Europe's concern of strengthening a competitor, there is some discussion in China as to the benefit of allowing foreign firms to use their best scientists and researchers in developing products and markets. This also has a negative impact on domestic companies, who are naturally unwilling to train and develop their personnel if only to lose them to foreign firms paying higher salaries.

Nevertheless, foreign research centres have increased the total amount of research work going on in China, and assisted in shifting the source of such activity away from SOEs. By 2000, 60% of research activity was taking place in private companies. This is in contrast to the 1996 level of only 37%.

The opportunities for S&T collaborative work are generally centred in major urban areas, and particularly along the country's coastal region. It is along the coast that the majority of innovative research work is done and where collaborators can expect to find the most opportunity and the most support. The majority of Chinese scientists, research institutions and support structures are in these areas. The principal cities involved in research are Beijing, Shanghai, Guangdong, Shenzehn and Wuhan. It should be noted that with the current administrative concern over rural development, the structure of support and incentives available in various regions might change. In other words, collaborators may find

that incentives are offered in the future which may turn their attention to the more rural regions.

Box 10: Joint Innovation Institutes

IBM, Peking University and Tsinghua University

In July of 2000 IBM (China) signed agreements with both Peking University and Tsinghua to establish joint innovation institutes. These institutes are focused on research into progressive issues confronting high-tech industries, such as e-Learning, e-commerce and knowledge management.

IBM's contribution to these institutes is in expertise, hardware, software and payment of most operational costs. The partnering universities involved are responsible for providing the facilities, conducting research and experiments, and providing university resources needed for research.

The intention of this project is to elevate IBM to the forefront of innovation in their sector, and help establish their presence in the country. The Chinese universities stand to gain valuable access to computer technologies and expert advising, as well as a strong link to a major international firm.

Prior to this project, IBM had established an R&D center in Beijing in 1996. This facility is primarily staffed with highly educated Chinese, and concentrates on network and information technologies.

Sources:

Science and Technology Newsletter; Ministry of Science and Technology; No. 232, August 20, 2000.

"Foreign R&D Centres in China"; Asian Technology Information Programme; atip97.058; July 9, 1997.

The task of finding collaborative projects with partners in China is greatly eased by existing networks. In this regard there are many that may be of use to scientists seeking collaborative international projects. Networks have been established between the zones and incubators of the Torch Programme. Additional networks have been established through the programmes of MOST, the 863 Programme, Chinese productivity centres (of which there are more than 700 – these provide tech support and training for SMEs), and municipal and regional incubator networks. There is no incubator network at the national level in China. Additional networks can be located through the many levels of science-innovation support entities in China, as well as through scientific publications and journals.

In an opinion poll conducted for the purposes of the current study, managers of projects sponsored by the European Commission's IST Programme reported that they see a broad spectrum of opportunities in tech-based collaborative projects. In their experiences, the Chinese had shown interest in everything from virtual reality and digital TV to telecommunications and IT systems. The most probable opportunities for collaboration were equally broad, including e-Commerce, virtual reality, technology transfer, IT systems, environmental applications, and automated language processing. Because of China's vast market and potential, no consensus was found among these managers as to the leading opportunities.

China's history of NIS development is rather short, but in that time the NIS has come a long way. Much of this is due to international intervention - in the form of FDI, technology imports, collaborative projects and so on - that has been made possible through opening the economy and creating opportunities for foreign organizations. The forecast is for this trend to continue, and the potential to find mutually satisfactory, international, collaborative, S&T innovation projects is high.

5.4 Challenges

Uncertainty over the tendencies in China's administrative policy, as the long-term ramifications of globalisation unfold, presents an apparent challenge to the future of S&T collaborations. The previous 20 years indicate a consistency in reforming the country through economic rejuvenation. If this is to be taken as an indication of the next 20, then technological advancements and S&T innovations can continue unhindered.

It is clear that S&T collaborations between Europe and China today are made possible only through the development and reform that has taken place over recent decades. While WTO commitments and further changes appear likely, the continuation of reform is contingent upon lasting stability. Global problems such as political turmoil and poverty could threaten policies of openness and accessibility – for both Europe and China – and effectively close or reduce the opportunities that are available.

There are specific areas that continue to challenge and impede collaborative work in S&T. As developments reduce the obstruction posed by these issue, further collaborative opportunities should become apparent. These issues include IPR protection and enforcement, education, infrastructure, funding, taxes and incentives, social mentality, and establishing a framework of fair competition. There is reason for optimism in the momentum of developments, and in the potential for S&T innovation between Europe and China to be realized.

The Great Wall of China

Next Steps

Through the activities undertaken in the course of this project, several issues were brought to light as those that could foster innovative activities between China and the European Union. These issues should receive further attention and be addressed through government programmes sponsoring developmental projects. Because these items were identified through the detailed analysis of this project, it is evident that they are current and real opportunities to further the development of innovative activities between China and the European Union. Taking full advantage of these opportunities would thus be directly instrumental in China's development and in the fostering of innovative activities with the European Union in the field of science and technology.

The following four opportunities are summarized and described through four respective activities outlined by a project style structure. It is suggested that these four activities be supported and driven by the European Commission to ultimately develop stronger ties to China within areas of innovation in the field of science and technology.

- Cross-border science networks
- Common innovation indicators
- Cross-border experience in regional development
- WTO standards training

Cross-border science networks

The first of these opportunities relates to science networks. There are many such networks already in existence in China, though many are thought to be ineffectively managed. Science activities and technologies in Europe are generally more progressive, and networks better established. In the interest of facilitating collaborations and increasing cross-border innovation activities, through linking scientists from across Europe to those from across China, some experts indicated that developing linkages between existing networks is both needed and appropriate. This would require a detailed analysis of the networks that are in place, consideration of their areas and activities and identification of appropriate international linkages. In this manner scientists could gain the involvement and viewpoints of others working in similar areas, and the sharing of information and expertise would be greatly facilitated.

Cross-border Science Networks

OBJECTIVE

To develop a virtually based China – European Science Network focused on fostering cross-border innovation activities within the Science and Technology field.

METHODOLOGY

The following steps represent the general methodology to be applied in order to develop an effective virtual based China – European Science Network:

1) Identify the current relevant traditional networks established in China and the European Union.
2) Identify the Innovation Relay Centre counterparts in China that could play a relevant role in disseminating science and technology activities with a focus on the 6th Framework Programme.
3) Develop an Internet site designed to support communication between Chinese and European experts in the 6th Framework Programme priority research fields, through utilizing successful Internet applications such as search engines, chat rooms, and message boards. The site should take advantage of the currently available linguistics technology.
4) Develop a site management strategy that is proactive in promoting cross-border communication to foster innovation activities within the European Union priority areas. In doing so, the site will attract visitors and, thus, registered users, which will further develop the virtual network.
5) Disseminate the virtual network across the established networks and active institutions via Internet Links, email, relevant journal advertisements, and presentations at international conferences. The site should be marketed as a gateway to science and technology innovation abroad. This can become a powerful tool for researchers and developers seeking collaborations in China.

Result

A self-sustaining virtual gateway to Chinese experts and infrastructures active within the research priority areas of the European Union.

Ongoing long-term cross-border collaborations within the science and technology fields that are leveraged to support the European Union research priorities.

Common innovation indicators

A second opportunity that arose was the question of the measurement of innovation activity levels, and the transfer of applicable innovations from the laboratory to industrial application. This concern was brought to the forefront particularly by those involved in country and policy analysis. As they advised, there are some statistical indicators that relate to innovation activity in science and technology, but there is no standardization in the use of these measurements, nor is there general agreement on their ability to accurately reflect the level of science innovation activity on a national scale. Such indicators include the number of graduates in science-related fields, investment levels in research and development, the occupancy levels of incubators, and patent application figures. Naturally these all relate to the question at hand, but do not necessarily ensure the accuracy of conclusions drawn regarding the level of innovation activity, nor the practicality of such work.

Common Innovation Indicators

OBJECTIVE:

To identify and implement common innovation indicators within China and Europe, which will assist in policy development to foster cross-border innovation activities within the Science and Technology field.

METHODOLOGY

The following steps represent the general methodology to be applied to develop common innovation indicators in China and Europe:

1) Identify the current available indicators in China and the EU, pertaining to the area of innovation.
2) Review in detail the work carried out in Europe that led to the establishment of the European Innovation Scoreboard.
3) Assess the applicability in China of the methodology used in point 2.
4) Prepare appropriate suggestions for a common Europe / China approach regarding the establishment of common Innovation Indicators.
5) Propose the common Innovation Indicators to appropriate authorities within China as an additional means to assist in proper policy development towards cross-border innovation activities.

Result

A common approach allowing for an improved mutual understanding of the innovation frameworks of Europe and China.

Cross-border experience in regional development through science and technology

A growing concern in China is the increasing disparity in development between the rural and urban regions. While major urban centres have experienced tremendous growth over the previous two decades, advancements in rural areas have been remarkably slow or nonexistent. This is particularly true in the sparsely populated western regions. Access to updated technologies, levels of science-focused activities and expertise are all lacking in these regions. The developmental aims in the country are thus turning increasing attention to this situation. China is now searching for a means of escalating social and economic development in these provinces. It is recognized, however, that sciences and technologies promoted in these regions must be appropriate for their economic and social structures. Europe's experience with the development of Eastern Europe can be of great benefit to China, as well as China's recent experiences to Europe. Nevertheless, further attention needs to be paid to this opportunity in future developmental programme activities.

Cross-border Experience in Regional Development

OBJECTIVE:

To share recent regional development experiences in an effort to further develop innovative policies that will have the greatest positive impact in development regions of Europe and China.

METHODOLOGY:

The following steps represent the general methodology to be applied to allow Europe and China to benefit from their experiences in Regional Development

1) Review existing programmes available in Europe and China aimed at fostering Regional Development through Science & Technology supportive measures.
2) Develop a limited number of case studies that have proven to be both effective and efficient in assisting development regions in increasing and sustaining science and technology activities.
3) Identify best practices from Europe and China and identify the characteristics that caused success and are applicable across borders.
4) Develop a framework for collaboration among key players both in Europe and China.

Result

The opportunity for both Europe and China benefiting from each other's experience in promoting Regional Development through the fostering of science and technology.

WTO standards training

Finally, China's accession to the WTO and increasing involvement in global affairs brings with it the need for qualified individuals, able to adhere to international standards, improve the country's competitive performance and promote economic development. This requires training. There is need for management training among scientists, entrepreneurs, and public and private sector administrators. Additionally, the standards demanded by the WTO will change business operations in many sectors. Businesses must be educated on the standards expected of them, and how they can conform to these requirements. In Europe's effort to help China develop, the endorsement of training in various topics is strongly recommended. This would develop strong ties and the opportunity for further collaboration efforts.

WTO Standards Training

OBJECTIVE:

To provide WTO standards training to Chinese within relevant Science and Technology sectors to further develop necessary relationships to foster cross-border innovation activities.

METHODOLOGY:

The following steps represent the general methodology to be applied to allow stronger interactions between Europe and China in areas of interface between Science and Technology and Trade.

1) Review in China existing WTO standards training as it relates to the Science and Technology sectors.
2) Develop a training agenda that supports training in the opportunity areas identified by the previous step.
3) Obtain the support of leading European experts in the opportunity areas.
4) Develop a highly publicized training event in Beijing and Shanghai sponsored by the 6th Framework Programme that emphasizes the focus of WTO standards training with respect to relevant Science and Technology sectors.
5) Follow-up the training events with networking activities that allow the participants to receive European contacts with similar interests that have experience with WTO standards and their applicability to the Science and Technology sectors.

Result

The development of strong relationships to foster cross-border innovation activities while providing the opportunity for the 6th Framework Programme to continue to gain exposure as a leading programme in areas of concern to the Chinese Science and Technology sectors.

List of Acronyms

AIC	Administration for Industry and Commerce of China
APEC	Asia Pacific Economic Cooperation
CAE	Chinese Academy of Engineering
CAS	Chinese Academy of Science
CCP	Chinese Communist Party
CERNET	Chinese Education and Research Network
CPI	Corruption Perceptions Index
EC	European Community
EU	European Union
EUR	Euro
FDI	Foreign Direct Investment
FE	Foreign Enterprise
FIE	Foreign Investment Enterprise
GDP	Gross Domestic Product
GERD	Gross Expenditures on Research and Development
GNP	Gross National Product
IMF	International Monetary Fund
IPR	Intellectual Property Rights
IT	Information Technology
MBA	Master of Business Administration
MOE	Ministry of Education of China
MOST	Ministry of Science and Technology of China
NIS	National Innovation System
NNSF	National Natural Science Foundation of China
NPC	National People's Congress of China
PRC	People's Republic of China
R&D	Research & Development
RMB	China Yuan Renminbi
RTD	Research and Technology Development
SIBI	Suzhou International Business Incubator
SIPO	State Intellectual Property Office of China
SND	Suzhou New District
SOE	State Owned Enterprise
SME	Small and Medium sized Enterprises
S&T	Science & Technology
STF	Small Technology based Firm
STIP	Science and Technology Industrial Park
TIC	Tianjin Incubation Centre
TIEC	Technological Innovation Experimental City
UNDP	United Nations Development Programme
US	United States of America
USD	United States Dollar
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

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