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The Evolving Role of Academic Institutions in Innovation Systems and Development

## The Evolving Role of Universities in the Chinese National Innovation System

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# The Evolving Role of Universities in the Chinese National Innovation System

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## 1. Introduction

A look back at the 20th century reveals that education provided the momentum for economic growth and social development in both developing and developed countries. The 21st century is likely to be dominated by the knowledge-based economy, and the most important sources of economic growth will turn out to be the production, processing, dissemination, and application of knowledge as well as information. Therefore, education will play a prominent and basic role both in knowledge innovation and human resource development.

China has the largest population in the world. With the deepening of the education system reform in China, universities have become an important actor in the Chinese National Innovation System (NIS), and play a necessary role in talent training, scientific research and technology transfer.

This paper mainly examines the roles that universities play in the Chinese NIS. The first section describes the history of the Chinese NIS and university system, the second and third section describe the characteristics of the current Chinese NIS and university system respectively. The paper concludes with a discussion of some current debates upon the roles of Chinese university.

Since the People's Republic of China was founded in 1949, the evolution of China's NIS and its university system has experienced four phases.

### ● Phase I 1950s—Soviet pattern

After World War II and the four-year civil war, the Chinese Communist established the People's Republic of China in 1949. Following the Soviet pattern, China adopted the planned economy and centralized command system, and the economy began to recover. However, the Chinese NIS was isolated from the Western world.

At this phase, research institutions were the core of the NIS. Influenced by the Soviet Union, the Communist government established a complex research institution system, the most important one being the Chinese Academy of Sciences (CAS). The government directly organized and implemented numerous S&T plans and programs, and directly managed research institutions. Most research focused on military-related research, and few research results were applied to industrial production. The research institutes, universities and enterprises were segregated from each other, and researchers had few linkages or interactions with industry.

In this phase, the characteristics of the NIS were (chart 1):

- a) The government was the only supporter and controller of research.

- b) Research institutions, universities and enterprises were separated from each other.

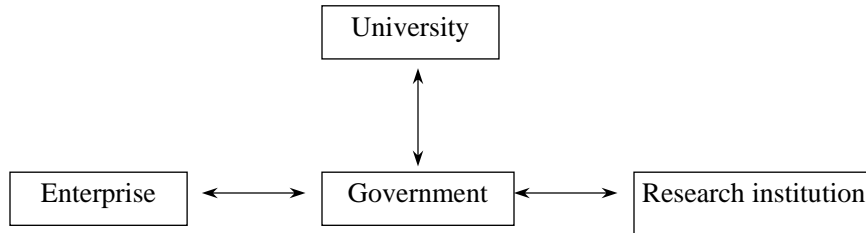


Chart 1 Chinese NIS in 1950s

In 1949-1952, the Communist government took over the public universities, which were established by the previous government, and gradually transferred the private universities to public universities. In 1952, the Ministry of Education made an adjustment to the university system, and adopted the Soviet model. After the adjustment, Chinese universities were mainly divided into two kinds – comprehensive universities and specialized universities. The task of comprehensive universities was to provide human resources for research institutions or to train teachers for high schools and universities. The task of specialized universities was to provide high-level S&T personnel for enterprises. Consequently, the number of students in engineering and pedagogy was largely increased, while the number of students in humanities and social science dropped sharply.

Corresponding to the planned economy, Chinese higher education system was also centralized, and directly under the administration of the central or local governments. The disadvantages of this system were that, because of government control, universities lacked the flexibility and autonomy to provide education according to the needs of the society.

Due to the establishment of a large number of research institutes, the research function of the universities was weakened. The only mission of Chinese universities in this phase was education.

In this phase, the characteristics of the university system were:

- a) University system was paralleled to research system.
- b) Universities provided skilled human resource for research institutions and enterprises.
- c) Education was the single aim and mission of universities.

### ● **Phase II 1966~1978—the Cultural Revolution**

The Cultural Revolution began in 1966 and lasted for ten years. In this phase, the whole nation was in the grip of political movements, and the development of the economy and S&T system almost came to a halt, which led to even greater isolation from the outside world. The NIS and university system were in a state of chaos and vacuum.

In this phase, the centralized university system established in the 1950s was completely

destroyed. Universities became the tool of the despotism of the proletariat. They were controlled by soldiers, workers and students, while many teachers were put into prison or surveilled. Academics didn't teach or do research any more, and students didn't study but joined political movements. The only mission of universities was to foster people with political ability.

● **Phase III 1978~1990**

In 1978, Deng Xiaoping, the new leader of China, advocated economic reforms that aimed at creating a market-oriented economy. From that time, China began to implement the “reform and opening up” policy. In 1985, the central government further reformed the science and technology system, decentralized fiscal and managerial control, redefined public and private ownership, and encouraged new linkages between research and industry.

In this phase, the Chinese NIS began to change from “government ruling” to “government guiding”. State-owned enterprises increasingly joined the competition in the marketplace, and private enterprises gradually became more significant. The government reformed the finance system, and ceased to finance research institutions and universities, forcing them to funding elsewhere. Some research institutions began to foster graduate education, and universities began to undertake research projects, but there was still a lack of interaction between universities and research institutions, and the enterprises were still relatively separated from research system.

In this phase, the characteristics of NIS were (chart 2):

- a) Changing from “government ruling” to “government guiding”.
- b) Enterprises were relatively separated from universities and research institutions.

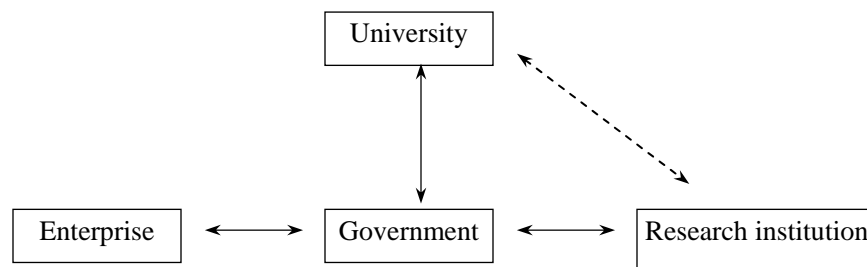


Chart 2 Chinese NIS in 1978-1990

In December 1977, the Chinese government resumed the entrance examination for higher education, and ended the recommendation systems for entrance of higher education. With the reform of the S&T system from 1985, the transformation of the higher education system was intensified with the aim of extending the rights of self-determination of universities and strengthening their interaction with other actors. The emphasis of education policy turned from political function to economic function.

The mission of universities was extended to education and research. In early 1979, the Chinese government decided that key universities should become research centers,

which marked that research formally became a mission of Chinese universities. In the 1980s, the number of research institutions established by universities increased rapidly, and achievements in the R&D field became an important indicator for evaluating a university.

In addition, the universities could cooperate with enterprises without the permission of government from 1980s. Finally, as government ceased to lend financial support, many universities established self-run enterprises to generate profit.

In this phase, the characteristics of university system were:

- a) Both education and research were the primary missions of universities.
- b) Universities were a component of the research system.
- c) University-run enterprises emerged.

#### ● Phase IV 1990s

In 1992, the Chinese government formally clarified that the aim of economic reform was to develop a market-oriented economy, and the main task was to promote economic development. Many state-owned enterprises gradually changed into joint-stock enterprises, and a large number of private enterprises developed rapidly. In the same year, the Chinese government initiated the project of “enterprise-university-institution cooperation” to encourage the cooperation among the enterprises, universities and research institutions. Enterprises played a more active role in technological innovation and were becoming the focus of the NIS.

Corresponding to the economic reform, the S&T system reform was also developing faster. In 1995, the government decided to implement the “VNSE (Vitalizing the Nation through Science and Education) Strategy” in the National Science and Technology Conference. In 1998, the State Council accomplished internal reform, which accelerated the reform of the research institution and university system. Some research institutions transformed into enterprises and some entered enterprises to become internal research institutions of enterprises.

In this phase, the characteristics of NIS were (chart 3):

- a) Science and Technology System Reform required that research must aim at economic development.
- b) Interaction among enterprises, universities and research institutions was more frequent than before.
- c) The NIS was more open.

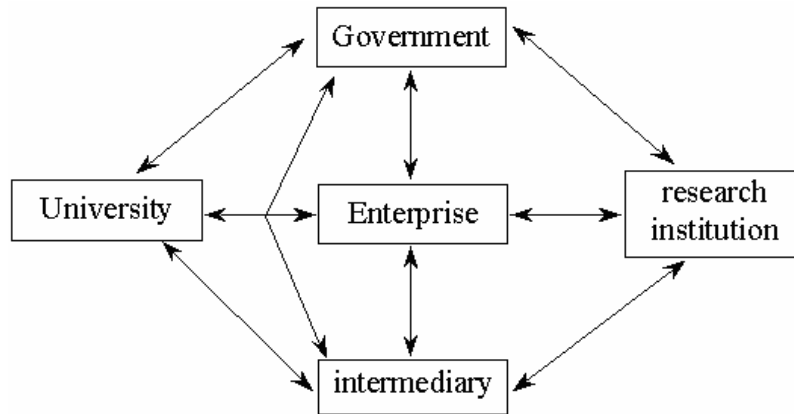


Chart 3 Chinese NIS in 1990s

In the 1990s, the university system began “the second adjustment” after the first one in the 1950s. Following the U.S. and European model that emphasize comprehensive universities, many Chinese universities or colleges that had been separated in 1950s began to merge. For example, Hangzhou University, Zhejiang Agriculture University and Zhejiang Medical University merged to become Zhejiang University, and formed the most comprehensive university in China. In 1998, as a result of the reforms of the State Council, many Chinese universities that were formerly managed by the central government began to be managed by the local government. After the adjustment, the number of universities decreased, but the scale of merged universities enlarged.

Through the second adjustment, China instituted a framework under which the majority of universities are administered by provincial governments and operated jointly by local and central governments. The provincial governments enjoy greater responsibility, authority and benefits in bringing local higher education under their unified planning. This new system has overcome problems of segmentation and isolation, redundancy and resource waste, smoothed various relations, activated willingness of the local government and various circles to support higher education development; tightened links between universities and regional economic and social development, thus having profound and strategic significance for the development of higher education in China. (Zhouji, 2002)

In addition to the system reform, from 1993, the government also carried out a series of steps to further extend the right of universities: universities have the right to enroll self-financing students; to design their own curricula and material; to undertake joint research with enterprises; to appoint and dismiss the vice-president of the university; to relocate the educational funds from government etc. Through the reform, universities could orient themselves towards the market more actively, and the relationship between the universities and the society has been strengthened.

The mission of universities changed to serve economic development and promote the advancement of science and technology. More and more Chinese universities began to set up their own enterprises. On the one hand, these university-run enterprises provide

necessary financing for universities; and on the other hand, they directly contribute to economic development. More and more people gradually recognize that universities could be the growth engine for the knowledge-based society.

In this phase, the characteristics of the university system were:

- a) VNSE Strategy required that universities must serve economic development.
- b) The cooperation and linkage between universities and research institutions, universities and enterprises were closer than ever before.
- c) More and more universities set up their own enterprises.

## **2. The Characteristics of Current Chinese NIS**

In a knowledge-based society, the generation, diffusion and appropriation of knowledge are more active than ever before. NIS, as a core conceptual framework for analyzing technological change within a country, is becoming very important. There are many kinds of definitions on NIS, and this paper follows Lundvall's definition: "National Innovation System is constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge."(Lundvall, 1992)

Nowadays the Chinese NIS is changing from the former government-dominated pattern to a new market-dominated one. Through a series of reform, the research system in China has experienced significant changes: the function and position of the former research institutions have been changed; the research capability and the status of the enterprises have been promoted; and the universities have become an important part of the Chinese research system. There are various kinds of interaction among the enterprises, research institutions and universities. Therefore, a new kind of research system consisting of multitude of actors has formed in China.

The government is still a strong supporter of research. In order to meet the global challenge of new technology revolution and competition, the central government initiated several S&T programs on technologies that small enterprises were not able to undertake, such as the 863 Program, which aims to boost innovation capacity in the high-tech sectors, particularly in IT, bio-technology, advanced materials technology, energy technology, etc; the Key Technologies R&D Program, which aims to address major S&T issues in national economic construction and social development; the 973 program, which aims to strengthen basic research in line with national strategic targets. (<http://www.most.gov.cn>)

The government also encourages the development of S&T through restructuring the environment for S&T industries. Many S&T programs have shifted their orientation from project implementation to environment construction, which aims to enhance technical services and exchanges, stimulate development of small and medium-sized S&T enterprises, vigorously develop S&T intermediaries, and create a sound environment for the commercialization and industrialization of S&T findings. Meanwhile, efforts are also being made to promote trade through S&T, provide innovation funding for small technology-based firms, and establish productivity

promotion centers, university S&T parks, and agricultural S&T parks.

With the support of the government, the S&T enterprises are playing a more active role in the current Chinese NIS. The R&D input and output of enterprises are increasing significantly. Many enterprises established their own R&D Center, and began to cooperate with universities for the development of new products or technologies. The government encouraged greater linkages between universities and enterprises by encouraging university-run enterprises, establishing fiscal and legal services for professorial and student start-ups, strengthening patent laws and supporting the establishment of university science parks.

The characteristics of current Chinese NIS are as follows:

- a) The government is trying to build up a more effective NIS.
- b) Enterprises are becoming the most important actor, but not yet.
- c) The linkages between actors in NIS are closer than before.

The following part introduces the Chinese NIS by describing the distribution of the R&D expenditure.

R&D activity is an important part of NIS. With the implement of “VNSE Strategy” and the development of economy, the scale of the gross R&D expenditure (GERD) in China has increased rapidly (table 1). From 1998 to 2004, the average increase speed of the GERD in China was 21.3%, and in 2004, it reached 196.63 billion Yuan. The percentage of GERD/GDP was also increased from 0.70% in 1998 to 1.44% in 2004.

**Table 1 GERD/GDP in China (2000-2004)**

	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>GERD (100 million)</b>	895.7	1042.5	1287.6	1539.6	1966.3
<b>GDP (100 million)</b>	89442.2	97314.8	105172.3	117390.2	136875.9
<b>GERD/GDP (%)</b>	1.00	1.07	1.23	1.31	1.44

Source: *China Statistical Yearbook (2005)*.

Table 2 shows the intramural expenditure for R&D by type of research from 2000 to 2004. In 2004, R&D expenditure in fundamental research, applied research and experimental development were 11.72, 40.05 and 144.87 billion Yuan, having increased by 33.6%, 28.6% and 27.0% compared to the previous year respectively. The percentages of the R&D expenditure in fundamental research, applied research and experimental development were 5.96%, 20.37% and 73.67% respectively. Though the expenditure of the fundamental research kept increasing year by year, from 4.67 billion Yuan in 2000 to 11.72 billion Yuan in 2004, the percentage of it in the total R&D expenditure was still low, hovering between 5% and 6%. This was partly because of the pursuit of short-term research in R&D activities and the large share of experimental development expenditure in government R&D expenditure, which will exert a negative impact for the development of the long-term research.

**Table 2 Intramural Expenditure for R&D by Type of Research (2000-2004)****Unit: 100 million yuan**

	2000		2001		2002		2003		2004	
<b>Total</b>	895.7	%	1042.5	%	1287.6	%	1539.6	%	1966.3	%
<b>Fundamental Research</b>	46.7	5.22	55.6	5.33	73.8	5.73	87.7	5.69	117.2	5.96
<b>Applied Research</b>	151.9	16.96	184.9	17.73	246.7	19.16	311.5	20.23	400.5	20.37
<b>Experimental Development</b>	697.0	77.82	802.0	76.93	967.2	75.12	1140.5	74.08	1448.7	73.67

Source: *China Statistical Yearbook on Science and Technology (2005)*.

In 2004, R&D expenditure performed by universities was 20.09 billion Yuan, and increased by 23.8% over the previous year; R&D expenditure performed by independent research institutions was 43.17 billion Yuan, and increased by 8.2%; the R&D expenditure performed by enterprises was 131.4 billion Yuan, and increased by 36.8%. The share of the R&D expenditure performed by universities, research institutions and enterprises in the gross R&D expenditure were 10.2%, 22.0% and 66.8% respectively. According to the data in table 3, the R&D expenditure performed by enterprises is growing stably, and the enterprises are becoming the core actors of the R&D activities. However, the share of university R&D activities is still much lower.

**Table 3 Intramural Expenditure for R&D by Performer (2000-2004)****Unit: 100 million yuan**

	2000		2001		2002		2003		2004	
<b>Total</b>	895.7	%	1042.5	%	1287.6	%	1539.6	%	1966.3	%
<b>Independent Research Institution</b>	258.0	28.8	288.5	27.7	351.3	27.3	399.0	25.9	431.7	22.0
<b>Enterprises (including SOE)</b>	537.0	59.9	630.0	60.4	787.8	61.2	960.2	62.4	1314.0	66.8
<b>Large and Medium-sized</b>	353.4		442.3		562.0		720.8		954.4	
<b>Higher Education Institutions</b>	76.7	8.6	442.3	9.8	130.5	10.1	162.3	10.5	200.9	10.2
<b>Others</b>	24.0	2.7	21.6	2.1	18.0	1.4	18.1	1.2	19.7	1.0

Source: *China Statistical Yearbook on Science and Technology (2005)*.

### ● Public R&D

The sources of R&D funds in China include the government funds, enterprise funds, foreign funds and other funds. Table 4 shows the sources of R&D funds in 2003 and 2004. Enterprises have become the major R&D investor in China, and accounted for more than a half of the total R&D funds.

**Table 4 Intramural Expenditure for R&D by Source (2003-2004)****Unit: 100 million yuan**

	2003		2004	
<b>Total</b>	<b>1539.6</b>	<b>%</b>	<b>1966.3</b>	<b>%</b>
<b>Government Funds</b>	460.6	29.9	523.6	26.6
<b>Enterprises Funds (including SOE)</b>	925.4	60.1	1291.3	65.7
<b>Foreign Funds</b>	30	1.9	25.2	1.3
<b>Other Funds</b>	123.8	8.1	126.2	6.4

Source: *China Statistical Yearbook on Science and Technology (2005)*.

The government fund is also an important source of R&D funds in China, but its percentage is decreasing. In 2004, the R&D funds from government were 52.36 billion Yuan, or 26.6% of the total funds. However, due to its guidance and strategic function, the government funds still play a significant role in the development of science and technology.

**Table 5 Intramural Expenditure for R&D from Government (2003-2004)**

**Unit: 100 million yuan**

	2003		2004	
		%		%
<b>Total</b>	460.6		523.6	
<b>Independent Research Institution</b>	320.3	69.5	344.3	65.8
<b>Enterprises (including SOE)</b>	47.3	10.3	62.6	11.9
<b>Large and Medium-sized</b>	27.6		35.3	
<b>Higher Education Institutions</b>	87.7	19.1	108.8	20.8
<b>Others</b>	5.2	1.1	7.8	1.5

Source: *China Statistical Yearbook on Science and Technology (2005)*.

Table 5 shows the distribution of the government R&D funds in 2003 and 2004. More than 80% of the total government R&D funds were distributed to public R&D sector, including research institutions and universities. The share of research institutions was above 60%, while the share of universities was only about 20%. This was mainly because of the traditional Soviet scientific system, which does not attach importance to R&D activities in universities.

It should be mentioned that SOEs' share of public R&D is not available due to the complicated classification of Chinese enterprises. However, they are the main body of the large and medium-sized enterprises in China, which account for more than half of the total enterprises' R&D expenditure.

### ● Industry R&D

With the implementation of the "reform and opening up" policy, the industry structure of China has been adjusted continuously. The share of agriculture decreased from 28.1% in 1978 to 15.2% in 2004, while the share of the service industry increased from 23.7% to 31.9%. However, the development of service industry is relatively slower.

**Table 6 Industrial Structure of GDP in China □%□**

	1978	1989	1997	2004
Primary Industry	28.1	25.0	19.1	15.2
Secondary Industry	48.2	43.0	50.0	52.9
Tertiary Industry	23.7	32.0	30.9	31.9

Source: *China Statistical Yearbook (2005)*.

In 2003, the average R&D intensity of Chinese manufacturing industries was 2%, much lower than the average level of developed countries. Therefore, the classification

standard of high-tech industries in China is also lower than the one in developed countries. The high-tech industries in China include manufacture of aircraft and spacecraft, manufacture of electronic and telecommunications equipments, manufacture of medical equipments and meter, manufacture of medical and pharmaceutical products, and manufacture of computers and office equipments. Table 7 shows the R&D intensity of these high-tech industries in 2003.

**Table 7 The R&D Intensity of High-tech Industries in China □2003 □**

Industries	R&D Intensity
Manufacture of Aircraft and Spacecraft	15.8%
Manufacture of Electronic and Telecommunications Equipments	5.4%
Manufacture of Medical Equipments and Meter	3%
Manufacture of Medical and Pharmaceutical Products	2.7%
Manufacture of Computers and Office Equipments	2.5%

Source: *China Statistics Yearbook on High Technology Industry (2005)*.

In the past two decades, China has become the sixth largest trading country in the world. Though the share of high-tech products in export is increasing, the main parts are still labor-intensive and low-value-added products, such as textiles, toys, clothing, etc.

**Table 8 Percentage of Exports of High-tech Products, Manufactured Goods and Primary Goods □2000-2004 □**

	2000	2001	2002	2003	2004
<b>Manufactured Goods</b>	89.8	90.1	91.3	92.1	93.2
<b>Of which: High-tech Products</b>	14.9	17.5	20.8	25.2	27.9
<b>Primary Goods</b>	10.2	9.9	8.7	7.9	6.8
<b>Total</b>	100	100	100	100	100

Source: *China Statistical Yearbook on Science and Technology (2005)*.

Table 9 shows the share of exports and imports of high-tech products in 2004. The data indicates that Chinese exports and imports of high-tech products are mainly concentrated in three industries: computers, telecommunications and electronics. The three industries accounted for 93.5% of the total export value and 79.2% of the total import value.

**Table 9 Percentage of Export and Imports of High-tech Products □2004 □**

	Export (%)	Import (%)
Computers	50.7	17.7
Telecommunications	31.7	13.7
Life Science	2.0	2.4
Electronics	11.1	47.8
Computer Integrated Manufacturing	0.9	10.8
Aerospace and Aeronautics	0.6	3.9
Optic-electronics	2.3	2.0
Biotechnology	0.1	0.1

Material	0.4	1.4
Others	0.2	0.2
Total	100	100

Source: *China Statistical Yearbook on Science and Technology (2005)*.

### ● Universities' R&D

The sources of the R&D funds in Chinese universities are multiplex. External funds, especially from enterprises, are increasing. In 2004, enterprises' funds were 7.45 billion RMB, accounting for 37.1% of total R&D funds in universities, an increase by 1.2 percentage over the previous year (table 10). Compared with research institutions, which depend primarily on government funds, universities are closer to the market, and the relationship between universities and enterprises is much closer.

**Table 10 Intramural Expenditure for R&D in HEIs by Source □ 2003-2004 □**

	2003		2004	
	(100 million yuan)	%	(100 million yuan)	%
<b>Total</b>	<b>162.3</b>	<b>100</b>	<b>200.9</b>	<b>100</b>
<b>Government Funds</b>	87.7	54.0	108.8	54.2
<b>Enterprises Funds</b>	58.3	35.9	74.5	37.1
<b>Foreign Funds</b>	3.0	1.8	2.6	1.3
<b>Other Funds</b>	13.4	8.3	14.9	7.4

Source: *China Statistical Yearbook on Science and Technology (2005)*.

Comparing R&D expenditure between research institutes and universities, we can see that universities emphasize basic research and applied research, while the research institutions emphasize experimental development (table 11).

**Table 11 Comparison of R&D Expenditure between Research Institutions and HEIs**

Unit: 100 million yuan

	Research Institutions		HEIs	
Basic Research	51.7	12.0%	47.9	23.8%
Applied Research	159.1	36.8%	108.8	54.2%
Experimental Development	221.0	51.2%	44.2	22.0%

Source: *China Statistical Yearbook on Science and Technology (2005)*.

### 3. The Characteristics of Current Chinese University System

The experience of educational development in China indicates that a high-quality educational system is one of the most important infrastructures and has a particularly strategic role in narrowing the gap between China and developed countries. The Chinese government is vigorously carrying out its educational strategy — Vitalizing the Nation through Science and Education (VESE Strategy). Higher education has developed steadily.

In light of the changes in socio-economic development, the Chinese government made

an important policy decision to expand enrollment in higher education in 1999. According to official statistics, in 2004 there were 3423 higher education institutions in China: 1731 were Regular Higher Education Institutions (Regular HEIs), of which 684 offered degree courses and 1047 offered higher vocational courses; 505 Higher Education Institutions for Adult; and 1187 Non-government HEIs (table 12).

**Table 12 The Number of HEIs in China (2004)**  
Unit: institutions

	Total	HEIs under Central Ministries & Agencies	HEIs under local Auth.	Non-state/Private
Institutions Providing Graduate Programs	769	369	400	
● Regular HEIs	454	97	357	
● Research Institutes	315	272	43	
Regular HEIs	1731	111	1394	226
● HEIs Providing Degree-level Programs	684	104	571	9
● Short-cycle HEIs	1047	7	823	217
Of which: Tertiary Vocational	872	2	662	208
HEIs for Adults	505	19	484	2
Non-government HEIs	1187			1187

Note: Data in “( )” don’t count number of school.

Source: *Educational Statistical Yearbook of China (2004)*.

According to the International Standard Classification of Education (ISCED), Chinese universities should refer to the Regular HEIs which provide the 6 level and 5A level education. However, in China, many Regular HEIs also provide 5B level education, and the official statistical data classifies the tertiary vocational school into Regular HEIs. Consequently, the data on Chinese universities used in this paper is a little larger than the one according to ISCED’s criteria.

### ● The Number of Students

From 1985 to 2004, the number of the Regular HEIs grew from 1016 to 1731, and the number of enrollment students increased from 1.7 million to 13.3 million. The total number of students enrolled in the Chinese higher education system in 2005 reached 23 million. This makes the Chinese higher education system the largest higher education system in the world. (Wang Libing, 2006)

As can be seen in table 13, the number of Regular HEIs fluctuated between 1000 and 1100 during the 1990s but has increased dramatically since 2000. The total number of students has increased continuously.

**Table 13 The Number of Regular HEIs & Students Enrollment (1985-2004)**

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
<b>Schools(institutions)</b>	1016	1054	1063	1075	1075	1075	1075	1053	1065	1080
<b>Students(10000persons)</b>	170.3	188.0	195.9	206.6	208.2	206.3	204.4	218.4	253.6	279.9
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<b>Schools(institutions)</b>	1054	1032	1020	1022	1071	1041	1225	1396	1552	1731
<b>Students(10000persons)</b>	290.6	302.1	317.4	340.9	413.4	556.1	719.1	903.4	1108.6	1333.5

Source: *China Statistical Yearbook (2005)*.

Table 14 shows the number of graduates, entrants and enrolments of Regular HEIs in 2004. In this year, 4.5 million new students enrolled in the Regular HEIs for undergraduate education, resulting in total enrollment of 13.3 million. The number of postgraduates increased to 779,000.

**Table 14 Data on Students in Regular HEIs in China (2004)**

Unit: persons

	Graduates	Entrants	Enrolments
<b>Postgraduates</b>	<b>143813</b>	<b>310672</b>	<b>779408</b>
Doctor's Degree	20607	47502	148561
Master's Degree	123206	263170	630847
<b>Undergraduates in Regular HEIs</b>	<b>2391152</b>	<b>4473422</b>	<b>13334969</b>
Normal Courses	1196290	2099151	7378436
Short-cycle Courses	1194862	2374271	5956533

Source: *Educational Statistical Yearbook of China (2004)*.

In 2004, the average number of students in Regular HEIs per 100 inhabitants was 1.09, and the average number of graduates was 0.2.

**Table 15 The Average Number of Students in Regular HEIs per 100 inhabitants (2004)**

	2004
Total Population (10000 persons)	129988
Number of Students Enrollment (10000 persons)	1411.4
Percentage (%)	1.09
Number of Graduates (10000 persons)	253.5
Percentage (%)	0.2

Source: *China Statistical Yearbook (2005)*, *Educational Statistical Yearbook of China (2004)*.

Table 16 shows the number of students in Regular HEIs by academic field. Compared with developed countries, China has a relatively low proportion of students in social science and humanities. However, with many specialized universities changing to comprehensive universities, the number of students in social science and humanities has been growing in recent years, and their respective share in undergraduate, master and doctor level were 49.1%, 38.3% and 28.2% in 2004. Administration is an emerging

academic field in China, including Management Science and Engineering, Business Administration, Public Administration, Agricultural Economics & Management and Library & Archive Science. Though administration as a field was introduced to China only a little more than one decade ago, it has been developing fast and become the largest academic field in social science & humanities. From 1999 to 2003, the number of students granted master and doctor's degree in administration accounted for 9.18% and 4.64% respectively. The number of students in literature is also large, accounting for 7.42% and 4.07% in master and doctor level from 1999 to 2003. (Wu Shulian, 2006). According to the academic classification of Chinese universities, literature not only refers to Chinese Literature, but also covers Foreign Language & Literatures, Journalism & Communication, and Art. Large numbers of students learning foreign languages contribute to the large share of literature.

**Table 16 The Number of Students in Regular HEIs by Academic Field (2004)**

**Unit: persons**

		<b>Doctor's Degree</b>	<b>Master's Degree</b>	<b>Undergraduate</b>
	<b>Total</b>	<b>148561</b>	<b>630847</b>	<b>13334969</b>
Social Science & Humanities	Philosophy	2036	7291	9980
	Economics	7922	33061	731263
	Law	6166	48133	629549
	Education	2433	20231	724416
	Literature	6279	50826	2118209
	History	2714	8407	60071
	Military Science	109	312	/
	Administration	14294	73551	2272728
Natural Science	Science	19921	65722	1156113
	Engineering	63768	238528	4376167
	Agriculture	5617	22155	280212
	Medicine	17302	62630	976261

Source: *China Statistical Yearbook on Science and Technology (2005)*.

### ● Non-government Regular HEIs

The 1982 Constitution provided a legal foundation for the emergence of private higher education institutions in China, and in 1984, the first non-government university – Haidian Day University – was founded in Beijing. However, the development of non-government universities was slow in 1980s due to the immature social environment. After the open-minded address of Deng Xiaoping in 1992, the number of non-government higher education institutions increased rapidly, from 450 in 1991 to 1219 in 1995, and the government had to control the scale of non-government higher education in 1997 and 1998. ([www.cuaa.net](http://www.cuaa.net))

In 1999, the government formally permitted the foundation of Non-government Regular HEIs, and the related supportive law was approved in 2002. During the recent five years, the scale of Non-government Regular HEIs in China is expanding. By 2004, there were

226 Non-government Regular HEIs and the total number of students was about 710,000.

**Table 17 The Number of Students in Non-government Regular HEIs(2004)**

**Unit: persons**

	<b>Graduates</b>	<b>Entrants</b>	<b>Enrollments</b>
Normal Courses	3266	21635	76420
Short-cycle Courses	84697	297272	633216
Total	87963	318907	709636

Source: *Educational Statistical Yearbook of China (2004)*.

The teaching content of Non-government Regular HEIs mainly focuses on the so-called hot specialization, such as foreign language, computer science, economics, management, etc. None of them teach philosophy, history or military science. Most of them conduct little research.

### ● **Tertiary Vocational School**

In China, tertiary vocational schools are the main institutions that provide 5B level education. Due to their diversity, there are not exact data to describe the general conditions of the Chinese tertiary vocational schools. According to an article published in Guang Ming Daily Newspaper, from 1998 to 2003, the number of entrants in tertiary vocational schools increased from 0.54 million to 2 million, and the number of enrollments from 1.17 million to 4.8 million, or 52.24% and 43.24% of the total numbers of entrants and enrollments in Regular HEIs respectively (Wu Qidi, 2004). However, as some tertiary vocational schools have not found their suitable orientation and lack adequate teaching competencies, their graduates are not widely recognized by society. The employment rate of the graduates in tertiary vocational schools was only 55% in 2003.

### ● **Source of Educational Funds**

A comprehensive educational reform changed the old system in which the funding of higher education depended on the governments, and a new system capable of pooling resources from diverse channels with the main responsibilities on government has been gradually established.

Today, there are various channels for Regular HEIs to get funds, including government appropriation for education, funds from social organizations and citizens, donations and fund-raising for running schools, tuition and miscellaneous fees and other educational funds. Table 18 shows different sources of educational funds in Regular HEIs in 2003. Government funds are the most important source for Regular HEIs, accounting for nearly half of the total. The percentage of tuition and miscellaneous fees is growing, and becoming another important fund source.

**Table 18 Educational Funds in Regular HEIs (2003)**

**Unit: 10000 yuan**

<b>Total</b>	17543468	%
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Government Appropriation for Education	8405779	47.9
Funds of Social Organizations and Citizens for Running Schools	603015	3.4
Donations and Fund-Raising for Running Schools	256375	1.5
Tuition and Miscellaneous Fee	5057307	28.8
Other Educational Funds	3220992	18.4

Source: *China Statistical Yearbook (2005)*.

From 1998, the central government decided that the proportion of education expenditure at the central government level should be increased by 1% each year over 5 years. Under the initiation and encouragement of the central government, local governments and various social sectors have actively increased their financial input to education. In 2001, the education expenditure from the national finance accounted for 3.19% of the total GDP, compared to merely 2.4% in 1997. This has provided a strong support to the nation's educational reform and development. (Zhou Ji, 2002)

#### 4. Some Current Debates on the Roles of Universities in the Chinese NIS

Nowadays, Chinese universities take an active part in the development of the society. Universities are not only education and research centers, but also enterprise incubators and the networker of NIS. This section describes some current debates on the roles of Chinese universities.

##### **Education—— expansion & quality assurance**

Education is the most basic role of universities, and universities are the base of talent training in China. Besides regular higher education, Chinese universities also provide continuous higher education through correspondence, sparetime schools, short-cycle courses etc (table 19).

**Table 19 The Number of Students in Correspondence Divisions, Sparetime Schools & Short-cycle Courses for Adults run by Regular HEIs □ 2004 □**

	Graduates	Entrants	Enrolment
Divisions of Correspondence and Sparetime Schools	1074327	1371001	2823639
Short-cycle courses for Adults	398483	411739	633247

Source: *Educational Statistical Yearbook of China (2004)*.

However, along with the fast expansion of Chinese universities, since 1999 the quality of higher education has deteriorated. A survey among the undergraduates in Guangdong Province shows that only 2.7% students are satisfied with the educational quality of their university, while 77% are not satisfied. Another survey among 12398 undergraduates indicates that, 79% students think they can't acquire useful knowledge in universities, 77% students think that what they learnt is not relative to the practice, and 80% students are not satisfied with the courses and content. (Lin Jian, 2001)

Recently, the quality of postgraduate education is becoming the focus of the society.

With the expansion of university, the enrollment number of postgraduates has been increasing rapidly, from 65,000 in 2000 to 324,940 in 2005. However, the number of tutors is increasing more slowly. Many tutors have to supervise about ten postgraduates or doctors, and some even have more than thirty students. Many students complain that they do not have the chance to consult their tutor frequently, and that they must do everything by themselves. Meanwhile, the tutors also complain about the poor quality of postgraduates. A survey conducted by a project team of Beijing University among more than 1000 tutors in 97 universities shows that 56.9% tutors of postgraduates and 47.8% tutors of doctors think the quality of students are dropping. (Yan Weifang, 2006)

Many articles about this issue indicate that the decline of educational quality is due to problems concerning the macro-level management system, the incomplete legal provisions, the inner management of universities and colleges, the capacity of teachers and the irregular model of evaluation of teaching and management (Cheng Fangping, 2006). Almost all the people admit that the increased concern for the quality of higher education in China might be a natural consequence of the expansion of higher education.

So how to improve the quality of higher education is still a challenge for Chinese universities. China is establishing a professional accrediting system. In 2002, the Ministry of Education introduced a new quality assurance policy, which would focus mainly on the assessment of undergraduate teaching at HEIs via a four-level gradation scheme for results: they would either be rated Excellent, Good, Fairly Good or Failing. According to official statistics, by the end of 2004, 116 HEIs across China had been assessed under the new regime. In August 2004, a semi-governmental national quality assurance agency called the National Higher Education Evaluation Center (NHEEC) was founded to monitor the implementation of higher education assessment in the country. (Wang Libing, 2006) However, further efforts to ensure the accrediting system are more relevant and effective.

The government's 11th five-year plan (2006-2010) on education lists "improving teaching quality" as a goal. In May 2006, the State Council restricted enrollment to control the rapid growth of students, in order to improve their teaching quality. However, college education will continue to expand in line with national development in a more rational, stable and sustainable way. The restriction is a mixed blessing to the public. Parents of would-be applicants still believe increased growth in enrollment could provide better chances for their children, while undergraduates are concerned that the expansion would exert more pressure on the employment market.

### **Research—*teaching & research; fundamental research & applied research***

Research is also a basic role of universities. Nowadays, the R&D income and outcome of Chinese universities indicate that they are playing a significant role in R&D activities. Taking full advantages of being a center of knowledge and talents, Chinese universities have improved their research strength, made more obvious contributions to the economic construction and social development of the country.

According to official statistics, during 1996-2000, Chinese universities undertook more

than 70% Natural Science Foundation Projects, more than 30% of the nation's "863 Project" and more than one third of the National Key Fundamental Research Projects. The National Natural Science Foundation is the most normative and equitable competitive research foundation in China. From table 20 we can see that the universities obtained more than 70% of the total funds in 2004.

**Table 20 Projects Funds Approved by the National Natural Science Foundation by Sector (2004)**

**Unit: 10000 yuan**

	Universities	Research Institution	Others	Total
General Programs	127982	37524	2010	167516
Leading Programs	21705	11625	/	33330
Major Programs	6300	7550	/	13850
Major Research Plan	8239	4997	250	13486
Projects of State Sciences Foundation for Distinguished Young Scientists	9690	5680	/	15370
Programs of Joint Funds	2080	1080	/	3160
Programs of Innovation Joint Research Funds	3960	3120	/	7080
President and Directors' Funds	4058	1232	209	5499
Special Funded Projects	1766	746	104	2616
International Cooperation and Exchange	4142	2903	1272	8317
Total	189922	76457	3845	270224

Source: *China Statistical Yearbook on Science and Technology (2005)*.

Table 21 shows statistics for the R&D projects and achievements in Regular HEIs in 2004. The Key HEIs undertook near half of the total R&D projects in universities, and they are becoming an important strength in the Chinese NIS.

**Table 21 Statistics of R&D Projects and Achievements in Regular HEIs(2004)**

	Projects	Awards	
		Total	National
Key HEIs	93520	1867	136
Ordinary Degree Level HEIs	95186	2193	51
Short-Cycle HEIs	3038	42	3
Total	191744	4102	190

Source: *Educational Statistical Yearbook of China (2004)*.

The debate on the relationship between teaching and research has lasted for more than two decades since research became one of the important missions of universities in 1980s. It has been agreed that teaching and research are interdependent as well as

inseparable in higher education, and that research is necessary for updating and verifying knowledge and ensuring the quality of teaching. In fact, however, research in some way exerts negative influence on teaching in some universities. Since the evaluation of a teacher's work highlights research achievements in many universities, more and more teachers devote themselves to research work, at the expense of their teaching and indirectly cause the deterioration of teaching quality. Moreover, many teachers just do research passively in order to meet the demand of universities, and the research quality and efficiency are not well satisfied. So how to balance teaching and research and how to make research more efficient are the problems in many Chinese universities.

Due to the cut of government funds, universities have to search for extra funds to support their research. Therefore, applied research, which is more likely to yield results quickly, and thus secure future funding, is more attractive than fundamental research which tends to take longer to produce returns. However, fundamental research makes a vital contribution to the development of S&T. Though government support for fundamental research is strengthening year by year, universities still face a difficult choice.

### **Technology transfer——*university & industry***

In most literature, activities related to technology transfer in universities are called “the third mission”. There are many forms of technology transfer in Chinese universities, such as publication, international meetings, co-research, licensing, university-run enterprises, etc. Particularly, Chinese universities have taken an active part in enterprises' initiatives to upgrade technology and in local economic construction, they've worked to transfer R&D results into practical productivity and acted as a vital force in technological innovation of the nation.

### **● Publications & International Meetings**

Publications and international meetings are common forms of technology transfer for all kinds of universities. However, as the participants are mainly academics, rather than potential technology users, they are not efficient fora for technology transfer, but good arenas for communication among academics in the same field.

**Table 22 The Number of Publications in Regular HEIs(2004)**

	Monographs	Papers
Key HEIs	2711	182316
Ordinary Degree Level HEIs	4996	232082
Short-Cycle HEIs	912	13831
Total	8619	428229

Source: *Educational Statistical Yearbook of China (2004)*.

**Table 23 International Communication of Key HEIs(2004)**

International Co-research	Send (persons)	Receive (persons)
	10329	9024

<b>International Academic Meeting</b>	Participants(persons)	Paper	Report
	20031	16251	2233

Source: *Statistical Data on Science and Technology of Higher Educational Institutions (2004)*.

### ● Co-research

Due to the traditional S&T system, Chinese enterprises do not have large R&D resources, and their R&D capability is very weak, so they have to seek help from universities for practical technology.

The direct co-research between universities and enterprises in China began in the 1980s. Universities not only provide professional training to employees in enterprises, but also cooperate with enterprises through research projects to resolve the practical problems.

With the implementation of the “enterprise-university-institution cooperation” project from 1992, the cooperation between enterprises and universities were strengthened. Enterprises’ funds given to universities for R&D increased from 3.6 billion Yuan in 1998 to 7.45 billion Yuan in 2004. Nowadays, the enterprise-oriented technology transfer is an important source of R&D funds for universities.

As can be seen in table 11, applied research in universities accounted for 54.2% in 2004.

### ● Licensing

Table 24 and 25 show the number of patents granted and technical contract deals of Chinese universities from 2000 to 2004. Though the number of patents granted in universities is increasing year by year, the number of contract deals in domestic technical markets with universities as sellers is not increasing as rapidly as the number of patents. This reflects the low commercialization rate of patents in Chinese universities.

**Table 24 The number of Patents Granted in Universities (2000-2004)**

	2000	2001	2002	2003	2004
Invention	652	579	697	1730	3484
Utility Model	868	943	973	1582	1910
Design	28	12	40	104	111
Total	1548	1534	1710	3416	5505

Source: *China Statistical Yearbook on Science and Technology (2005)*.

**Table 25 Contract Deals in Domestic Technical Markets with Universities as Sellers (2000-2004)**

	2000	2001	2002	2003	2004
Total	241008	229702	237093	267997	264638
Universities	31202	29553	31257	37974	39289
%	12.9	12.9	13.2	14.2	14.8

Source: *China Statistical Yearbook on Science and Technology (2005)*.

Table 26 shows the technology transfer data of the Key HEIs in China. The technology in Key HEIs mainly flows to state-owned enterprises.

**Table 26 The Data of Technology Transfer in Key HEIs (2004)**

	State-owned enterprises	Foreign enterprises	Private enterprises	Collectively-run enterprises	Others	Total
Contacts	1439	359	958	711	1044	4511
%	31.90	7.96	21.24	15.76	23.14	100
Value (thousand)	567337	51967	297769	169796	472467	1559336
%	36.38	3.33	19.10	10.89	30.30	100

Source: *Statistical Data on Science and Technology of Higher Educational Institutions (2004)*.

### ● University-run Enterprises

Before the discussion on Chinese university-run enterprises, we should first understand that they are quite different from spin-off enterprises in the US. A spin-off enterprise by definition is an economic entity of academic origin that becomes an independent entity, while a university-run enterprise is an economic enterprise that remains part of the administrative structure of the university. (Zhou Chunyan, 2006)

The reform of the S&T system in 1985 drastically cut down government funding for universities. Therefore, many Chinese universities decided to run their own enterprises to search for financing support and improve teaching conditions. However, the Chinese university-run enterprises in 1980s were almost profit-oriented enterprises, such as printing houses, publishing companies, and some service businesses.

In the 1990s, more and more universities directly participated in getting profit from the market through establishing their own enterprises. A major change was that many Chinese universities began to set up S&T enterprises, and devoted themselves to S&T development and industrialization. The development of university-run enterprises, especially the university-run S&T enterprises, became an important criterion to judge a university. With the support of the government, university-run S&T enterprises are increasingly growing larger and stronger. Many university-run enterprises have taken a leading role in Chinese high-tech industry, such as Tongfang, Founder, and Dongruan.

On the one hand, the universities certainly obtain urgent finance support from these enterprises; on the other hand, these university-run S&T enterprises promote the technology transfer from university to society, and directly make great contributions to the economic development. However, the most important influence might be that more and more people are recognizing the important role of universities in the development of knowledge-based society.

Table 27 compares operating data of university-run enterprises in China from 2000 to 2004. In 2004, there were 4563 university-run enterprises nationwide, and total turnover was 96.9 billion Yuan, an increase of 17.25% over the previous year.

**Table 27 The Comparison of Operating Data of University-run Enterprises in China (2000-2004)**

Year	Number of enterprises	Turnover (100 million Yuan)	Total profit (100 million Yuan)	Net profit (100 million Yuan)
2000	5451	484.55	45.64	36.04
2001	5039	602.98	48.17	35.32
2002	5047	720.08	45.93	35.33
2003	4839	826.67	42.98	27.95
2004	4563	969.30	49.93	29.53

Source: Center for Science and Technology Development, Ministry of Education of the People's Republic of China, *Statistics and Analysis Report on China's University-run Enterprises (2004)*.

Table 28 shows the comparison of operating data of university-run High-tech enterprises in China from 2000 to 2004. In 2004, there were 2355 university-run high-tech enterprises nationwide which achieved a turnover of 80.7 billion Yuan, or 82.23% of the total turnover of the university-run enterprises. The total profit of them was nearly 4.1 billion Yuan and generated 2.4 billion Yuan in net profit.

**Table 28 The Comparison of Operating Data of University-run High-tech Enterprises in China (2000-2004)**

Year	Number of S&T enterprises	Turnover (100 million Yuan)	Total profit (100 million Yuan)	Net profit (100 million Yuan)
2000	2097	368.12	35.43	28.03
2001	1993	447.75	31.54	23.98
2002	2216	539.08	25.37	18.63
2003	2447	668.07	27.61	14.73
2004	2355	806.78	40.98	23.86

Source: Center for Science and Technology Development, Ministry of Education of the People's Republic of China, *Statistics and Analysis Report on China's University-run Enterprises (2004)*.

In 2001, the State Council issued the "Circular on the Experiment of Standardizing University-run Enterprises Management at Peking University and Tsinghua University". The government began to restrain university-run enterprises and call for separating them from universities. As a result, the total number of university-run enterprises has decreased since 2001. However, the number of university-run S&T enterprises was not reduced due to their great contribution to the universities and society.

In China, an important medium of technology transfer in some Key Universities is University S&T Park. In 1991, the first University S&T Park was set up in the Northeast University. Then, Peking University, Tsinghua Universities successively set up their

own University S&T Parks. Nowadays, there are 50 National University S&T Parks in China. According to an incomplete statistic of 42 National University S&T Parks, up to the end of 2004, they all together had 5037 enterprises in incubation, and 1256 graduated enterprises. The University S&T Parks have been an exchange platform for various innovative resources, and have become important incubators and disseminators of high-tech industry in China.

The fast development of university-run enterprises can in some way attributable to the weak innovation ability of Chinese industry. Most of Chinese industry operates at a low-tech level in a labor-intensive economy, and they have not become the core actor of Chinese NIS. In this case, Chinese universities take advantages of their S&T resources, and in some way take on innovation tasks to develop new industries.

Though universities promote technology transfer through establishing their own enterprises, the university-industry gap still cannot be eliminated, due to lacks of linkage between industry and the academia, cultural differences, different systems for cooperation, mission alignment and different social responsibilities.

Being part of the administrative structure of the university, university-run enterprises have brought confusion in ownership and management, and the debate on university's mission has risen after 2000. Many people complain that the university is becoming enterprise, and their competition with industry increases the tension between university and industry, which will eventually induce a difficult technology transfer from university to industry. Some people point out that the consultation activity should be enhanced. In the USA, consultation is an important interaction form between university and industry, while in China only a few Key Universities do consultation for industry. Lack of consultation led to the fact that teaching and research in universities are separated from industrial practice (Zhou Chunyan, 2006). How to find an effective way to strengthen the cooperation between university and industry is a problem for China to address urgently.

## **5. Conclusion**

The role of university in NIS is not static, and it will evolve all the time to adapt itself to the changes of economy, society and S&T system. The evolution of Chinese NIS and university system reflect that, the Chinese NIS is changing from the former government-dominated pattern to a new market-dominated one, and the Chinese universities are not only the education and research centers but also have the third mission, which is to make contributions to the development of the society.

A more reasonable NIS is developing in China, in which universities, research institutions and enterprises should play different roles. Currently, due to the weak innovation ability of Chinese industry, Chinese universities in some way replace the role of industry as the innovation actor in the NIS. However, with the increasing innovation ability of Chinese industry, the role of university-run enterprises will decline, and cooperation between the university and industry will be closer with the support of the government.

By strengthening cooperation between manufacturing, teaching and scientific research, Chinese universities are speeding up the turning of scientific and technological research results into products. However, the most important mission of university is education and research, followed by technology transfer. How to maintain the teaching quality with the expansion of university system, balance the fundamental research and applied research, and strengthen the linkage between universities and industrial system are the challenges for Chinese universities.

In the future, the role of Chinese universities will evolve continuously. Looking into the future and complying with new opportunities and challenges, Chinese universities bear a more glorious and arduous mission, which will need further effort by the whole society.

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