Project Report

University Industry Partnership in China:
Present Scenario and Future Strategy

UNESCO Chair on Cooperation between
Higher Engineering Education and Industries
Preface

As two basic parts of society, higher education and industries respectively take up different missions for social development. Being organic parts of society, they should be closely connected to and cooperate with each other rather than separate from each other, for the common goal of pursuing social development. This is very important for both China’s engineering education and industrial development. Only by making higher education and industries work in close cooperation, can we make quality talents with practical experiences who can integrate theory with practice effectively and are welcome by industrial sectors. And only in this way, can rich intellectual resources of colleges and universities be used to better serve the society and improve the innovation system in both China’s basic research and industrial practice and then, greatly promote the development of China’s productive forces. University-Industry Cooperation will be one of the strategic directions for China’s higher engineering education reform.

University-Industry Cooperation is of strategic significance in terms of the cultivation of engineers and technicians at different levels, scientific research and knowledge innovation, industrial upgrade and the development of national economy. Especially in recent years, along with the vigorous growth of China’s industries and the promotion of China’s standing in global economy, China’s higher engineering education has improved greatly in its scale, level and quality. However, due to the transition of social-economic system and the reform of educational system, higher education is still divorced from industries in varying degrees—-sometimes rather severely, which has been reflected in such aspects as curricula design, qualification of teaching staffs, content and method of teaching courses, scientific research, management and organization of colleges and universities, educational appropriation, and the enrollment and job assignment of students. This phenomenon has severely hindered the improvement of the quality and level of engineering education. As a result, it has been very difficult for universities to provide quality professionals for China’s industrial sectors, to transfer technology achieved in basic researches and key researches tackling technological difficulties into productivity, to develop a complete system for knowledge innovation and industrial upgrade. Therefore, in order to meet challenges caused by internationalization of economy and globalization of education, to vigorously enhance China’s higher engineering education for the purpose of satisfying the needs of national economy and global economy, in
particular, the needs for talents of industrial development, we must strengthen fundamentally University-Industry Cooperation and conduct systemic researches on its system, mechanism, rules, regulations, modes, methods, operational approaches and procedure, from both macroscopic view and microcosmic view.

This research project is the first research work conducted by UNESCO Chair on Cooperation between Higher Engineering Education and Industries since it was set up in February 2005. At the request of UNESCO Office Beijing, we have convened many universities of engineering and enterprises both at home and abroad to participate in related investigations, symposiums and discussions, with the hope to bring forward countermeasures on the basis of summing up historical experiences. Owing to the limitation of time and budget, we can only do some preliminary research work. We hope that our research results will draw more people’s attentions to University-Industry Cooperation and inspire more valuable opinions on it, so that research in this respect can be kept going thoroughly in a deep-going and scientific way.

Cha Jianzhong, Ph.D.
Chairholder of UNESCO Chair on Cooperation between Higher Engineering Education and Industries
Professor, Beijing Jiaotong University

Johan De Graeve, Ph.D.
Co-Chairholder of UNESCO Chair on Cooperation between Higher Engineering Education and Industries
President and Professor
Group T Leuven Engineering School

December 2005, Beijing
## Contents

1. Introduction ...................................................................................................... 5

2. Cooperation between higher engineering educations and industries in China in the era of planned economy ......................................................... 12

3. Cooperation between higher engineering education and industry in China in the era of market-driven economy ......................................................... 16

4. Incentives of cooperation between higher engineering educations and industries ............................................................................................................. 22

5. Obstruction of cooperation between higher engineering educations and industries ..................................................................................................... 26

6. Policy suggestion on cooperation between higher engineering educations and industries ............................................................................................... 28

Reference............................................................................................................... 30

Acknowledgement .............................................................................................. 31
1. Introduction

1.1. Status of education globalization and cooperation between higher engineering educations and industries in the world

1.1.1. Economy globalization drives education globalization

The trend of global economic integration has set new demands for communication and cooperation between higher engineering education and industries, as well as the internationalization of education. Safe investment environment, low-paid and good quality labor resources and huge markets are important inducements attracting many multinational companies to invest in such developing countries as China. The localization of multinational companies will certainly lead to a growing need for local talents who are familiar with company culture and can communicate in foreign languages fluently, with top comprehensive qualities and practical abilities. This need has significantly promoted the internationalization of education. On one hand, universities in developed countries have attracted a great many students from developing countries to study there. And many of these students have become the backbone of multinational companies after they graduated and return from abroad. On the other hand, many universities in developed countries have started branch campuses in developing countries or worked together with local governments to jointly running schools, using good local students sources and educational resources to train professional personnel for multinational companies. The transference of multinational companies to developing countries also urges universities in developed countries to consider sending their teachers and students to go abroad in order to obtain international work and teaching experience.

The strengthening of University-Industry Cooperation and the implementation of internationalization of education—for the purpose of improving students’ practical ability and comprehensive qualities as well as widening their horizons—have become very critical to the enhancement of China’s higher engineering education and the training for talents who can adapt themselves easily to the integration of global economy.
1.1.2. Important role of cooperation between higher engineering education and industry in education for talented engineers, research and industry development

Being two major basic parts in modern society, education and industries bear different functions and missions in their respective and definite positions. As a pillar of national economy, the major mission of industries is to develop production, to create material wealth and to provide society with material and spiritual products, so as to fulfill the needs of the county and the people. As to education, its basic function is to cultivate talents for society, and higher education shoulders particularly the tasks of doing basic researches, tackling key technological difficulties and developing knowledge innovation. In the process of high-speed development of China’s economy, there has not been a clear-cut division between the responsibilities of education and that of industries. In many cases, the two of them often run business of each other’s. Fortunately, the government and society have attached importance to this problem in recent years and taken forceful measures to put schools run by industries under the administration of educational administrative departments; and meanwhile, separate industries run by schools at different levels from school management and make them become independent social industries. By doing so, this problem has been corrected fundamentally.

While on the other hand, being basic components of society, higher education and industries also share a common mission of developing material civilization, spiritual civilization and economy, so as to maintain the sufficient and sustainable development of society. Meanwhile, the two large sectors also have a thousand and one links with each other in terms of their basic components. Industries need higher education to offer them quality talents at different levels in order to meet current and future needs for industrial upgrade; they also need new achievements in basic research and knowledge innovation so as to achieve continuous innovation in products and services. On the other hand, higher education needs to be supported materially by industries and also, influenced by industries in terms of setting goals and process for talents training. Cooperation between higher education and industries is therefore very necessary for the development of industries and higher education and even the whole society. It is an essential condition for forming talents training system and system of scientific and technological innovation. It is also extremely important in building up a
harmonious society.

1.2. Experiences of cooperation between higher engineering education and industry overseas

Developed countries in the world have got over 100 years of history in University-Industry Cooperation, which has developed many sorts of models and mechanisms in this area, with varied kinds of operational ways and practical experience. It’s very meaningful to summarize these useful experiences. This will enable different universities in different countries to put feasible modes of University-Industry Cooperation into practice according to local concrete conditions.

1.2.1. Co-operative (Co-op) Education

Among varied modes of University-Industries Cooperation, Co-op education is the most rigorous and systemic one. It is designed for engineering student to alternate academic study on campus and practical work in cooperative enterprises. Co-operative student receives remuneration for the work performed, and the time he/she spent in the periods of practical work must be at least thirty percent of the time spent in academic study.

In 1903, co-op education was first initiated in Sunderland College of Technology in Britain. Then, in 1906, Mr. Herman `Schneider introduced it to the Faculty of Engineering of University of Cincinnati for the first time. It was University of Waterloo that took the leadership in exercising co-op education program in Canada. After 50 years of development, co-op education program has become a distinguished feature and advantage of University of Waterloo. The university offers 5-year courses for undergraduate students who can alternate academic terms and work terms every four months. The university has over 3000 enterprises and organizations as partners, where each semester, 3500-4500 students can work there. The co-operative education program has made University of Waterloo—a university with less than 50 years of history—the biggest base of co-op education worldwide. In 2005, for the 14th year in a row, the University ranked most innovative and best overall among all universities across Canada.

Presently, more than 1000 universities around the world have launched co-op education programs. Shanghai is the first city where co-op education appeared in China. In 1985, the School of Textile under Shanghai University of Engineering Science cooperated with University of Waterloo to develop a co-op education pilot
program, adopting the model of “three terms a year, alternating between academic term and work term.” Following over 20 years’ advancement, the program has taken a certain shape, with the number of co-op students going up from 36 in 1985 to over 2100 in 2003. In early 1990s, nearly 50 universities began to operate co-op education programs to varied degrees in different ways. Currently, many other universities in China have also started co-op education pilot programs.

1.2.2. All-aspect cooperation between higher engineering education and industry

University-Industry Cooperation involves many aspects. First, regarding talents training — no matter higher vocational education, undergraduate education or graduate education, as employer, industrial sector should make demands and suggestions in terms of the quality, standard, process, method and content of education, and provide students with opportunity for fusing their academic knowledge with practical experience. Universities shall cooperate closely with industrial sector in such areas as teacher training, curricula design and academic program settings, teaching management, teaching content and teaching method, fully respecting and considering their opinions for the purpose of attracting their supports materially and spiritually. Universities also bear the responsibility of offering continuing education for industrial people in order to update their knowledge and make them keep pace with the development of the time. Regarding scientific research, universities should conduct basic research and key technological research according to the demands of the development of the country and industries, and transfer the research results to industrial sector.

1.3. Opportunities and challenges confronted by higher engineering education in China

It is true that higher engineering education in China has advanced in large scale in last 20 years and transferred from elite education to popular education. However, there still exists many problems, especially the great opportunities and severe challenges facing us under the situation of integration of global economy and internationalization of education.

1.3.1. Potential engineer cradle in the world

(1) Great demand on engineers from domestic and global manufacturing

The rapid development of domestic and international industries has brought
about greats needs for advanced talents who can be engaged in global economy. This has created good developing opportunities and great challenges for China’s higher engineering education. In future 10-15 years, multinational companies in China need about 75000 senior managers who are capable of working in global markets. So far, however, we can only supply 3000-5000 such kind of management talents. In the future 5 years, multinational companies in China need to employ 750000 Chinese university graduates accounting for 60% of all graduates in corresponding period. In other words, only 40% graduates can get access to the opportunities of working for a huge number of domestic or foreign enterprises located in China. On the other hand, international industries also need a large number of engineers, but the sources of engineering graduates from developed countries are far from enough. For example, in world-famous Silicon Valley in America, engineers of Chinese, Indian and other foreign descent almost account for 60% of all engineers working there, whereas most of them have received graduate or undergraduate education in American universities rather than just have been educated by Chinese universities.

(2) Enormous and excellence student resource for engineering education in China

Compared to the current situation that developed countries are short of engineering students, China possesses huge source of excellent student and rich engineering education resources. In China, 33% college students major in engineering while the proportion of that is 20% in Germany and 5% in India. It has long been a tradition in China that excellent students tend to specialize in science and engineering. Even in nowadays when medical science, management science and social science have fully developed, there are still a large number of students choose to major in science and engineering. It is predictable that this situation will continue for a rather long period. Thus, the large source of excellent engineering graduates has laid a solid foundation for the enhancement of engineering education in China.

(3) Great scope of Chinese engineering education

In recent years, engineering education in China has continuously improved in both scale and quality. Colleges of engineering have achieved outstanding results in terms of teaching, academic research, teacher quality, teaching facility and campus construction. Each year, over one million students are enrolled in colleges of engineering. Compared with other countries, the number is rather huge. For example, in the year of 2004, American universities graduated 75000 engineering graduates while Chinese universities graduated 450000. Along with the further
development of the integration of global economy, world industries constantly transfer from developed countries to developing countries. The great needs demanded by world industries will offer large quantity of opportunities for China’s higher engineering education. The large scale of engineering education and excellent student source will make it possible for China to become a cradle of engineers in the world.

1.3.2. Challenges faced by Chinese engineering education

Of course, while economic development brings opportunities for China’s engineering education, great challenges co-exist with the opportunities as shown below:

(1) Education model and mechanisms for creative talented R&D engineers

Currently, the teaching model and mechanism of China’s engineering education is not adaptable to the goal of making creative engineers for research and development. There is still a wide gap between China and developed countries in this respect. Most teachers engaged in engineering education in China lack practical work experiences in industry, while professors in colleges of engineering in developed countries usually have industrial background. For example, in Germany, a teacher engaged in engineering education must have practical work experiences in industry, and a professor is required to have at least 10 years’ of work experience in industrial sector. On the contrary, few engineering teachers in China are technical experts and used to be senior managerial personnel in enterprises. Although universal specialty settings, teaching materials and teaching program is useful to maintain a universal teaching standard, they prevent teachers from giving full scope to their creative power, thus confining the fosterage of student’s creative ability. The gap between higher engineering education and industries is a universal phenomenon in China, and sometimes, rather serious.

(2) Education environment for international engineers, who can work in international enterprises anywhere in the world

There is a wide gap between the level of China’s higher engineering education and that of developed countries’, especially in the respect of University-Industry Cooperation and internationalization of education. Only 10% Chinese graduates in engineering are capable of working in multi-national companies, whereas the proportion of that in Indian can reach 25%. Internationalization of education involves not only foreign language environment, but also such links as international University-Industry Cooperation, academic program settings, teaching material and method as well as quality assurance system. There is still a
long way to go for China’s engineering education to realize the goal of training a
great number of talents for industries at international level. Investigation shows
that among the 200 million engineers in China, only about 160000 are suitable for
the work requirements of multinational companies——a number that is equivalent
to the total number of engineers in the UK.

(3) Graduates with industrial experiences from higher engineering education

The lack of close association between higher engineering education and
industries is an important factor that constrains the quality of engineering talents
training. As students have got no access to academic knowledge-related practical
work, enterprises often complain that graduates in engineering are rigid in thought
and weak in operational skills, which makes it difficult for them to get talents they
are seeking. On the other hand, graduates in engineering are under great pressure
of employment and complain that there are few jobs suitable for them. It is the fact
that practical work is not available to them on campus that leads to their poor
practical experience. This situation is popular especially when foreign companies
recruit engineering graduates. Only 10% graduates searching jobs in foreign
companies can be hired at last. Even they need to receive a great deal of pre-job
professional training. It is therefore extremely urgent to strengthen the cooperation
between China’s engineering education and industries.

1.4. Goal and importance of this research project

1.4.1. Statement of the mission

The objective of this research is to learn, analyze and summarize the history
and current situation of University-Industry Cooperation in China on the basis of
research and investigation of typical cases, so as to further advance
University-Industry Cooperation in China and provide the government department
concerned with suggestions for policy-making.

1.4.2. Methodology used in this research project

(1) To analyze collected documents and conduct research on theory and
experience related to University-Industry Cooperation.

(2) To investigate and study typical cases of University-Industry Cooperation
programs worldwide including those operated in University of Waterloo,
University of Royerson, State University of New York at Buffalo, Group T Leuven
Engineering School, and such enterprises as Schneider Electric, International
Microelectronics Center (IMEC), LMS of Belgium, Telinous Co. of Belgium,
Philips Shanghai Center of Applied Technology, NOKIA (Suzhou), UMICORE (Suzhou).

(3) To take Tsinghua University, Shanghia Jiao Tong Univeristy, Beijing Jiaotong University, Central South Univeristy, Suzhou Industrial Park Institute of Vocational Technology (SIPIVT), National Taiwan University of Science and Technology and Group T Leuven Engineering School as typical cases, collecting data and materials concerning University-Industry Cooperation through interview, investigation and other methods.

(4) To interview and investigate currently enrolled college students, graduates, professors, university administrators, enterprises staffs and entrepreneurs on special topics and then, analyze collected information.

(5) To hold symposiums on University-Industry Cooperation in Suzou and organize representatives from industrial sector and universities of science and engineering both at home and abroad to discuss the current situation and future development trend of University-Industry Cooperation.

2. Cooperation between higher engineering educations and industries in China in the era of planned economy

2.1. Goal of higher engineering education in this era

Chinese mainland was carrying out a system of planned economy between the 1950s and the 1980s. During this period of time, the guiding principle for higher educational was to cultivate well-educated labors with socialist consciousness and to provide professional talents for national economy and industries.

2.2. System circumstance of higher engineering education

2.2.1. Roles of higher engineering education and industry in the society and their relationship

In the time of planned economy, higher engineering education must train engineers and technicians for industries and research institutes according to plans drawn up by the government. Colleges of engineering are divided into two types: one belonged to government departments in charge of education; the other belonged to industrial departments under the government. For example, over 10
colleges belonging to the Ministry of Railway were established, managed and regulated by the Ministry, whose graduates were all assigned to work in railway related departments and units. Colleges under the Ministry of Education also offered detailed engineering specialties, whose graduates were assigned to industrial departments and research institutes as planned by the government. Internship taken by students in industrial sector could only be arranged according to teaching schemes or under the government’s unified instruction. Colleges belonging to industrial departments were linked closely to corresponding industrial sector. All specialties were offered to meet the needs of related industries. Student training and scientific research also must be planned to embrace the needs of specified industries.

2.2.2. Function of the government in coordinating engineering educations and industries

Guided by the policy of combining education with productive labor, cooperation between higher engineering education and industries were undertaken under the instructions given by related government departments. The government was responsible for working out teaching programs, drawing up plans for student enrolment and job assignment on their graduation, designating enterprises to provide students with internship sites and learning situation. In a word, the government played a leading role in University-Industry Cooperation at that time. During the period of planned economy, the allocation of all social resources was finished under the instruction given by the government, and University-Industry Cooperation guided by the government had not direct connection with the achievements of enterprises. The enterprises admitted engineering students to do field work according to instructions given by the government rather than on their own initiatives. And internship program designed for students was actually continued classroom teaching and oriented at improving students’ attitudes to labor. As a result, the students had few opportunities to get access to practical work connected to their specialties. Naturally, it was impossible for them to prepare for their career development through University-Industry Cooperation.

In the 1950s and 1960s, on the initiative of chief leaders of the government, pilot program of work-study (part time work and part time study) was widely launched in educational institutions at different levels. Its main objective was: firstly, to combine education with labor, to eliminate differences between physical labor and metal work labor and to train students into new-style intellectuals possessing the fine qualities of worker class; secondly, to reduce the financial
burden of families and the government and make education universal and popular. Take the City of Tianjin for example. There were more than 100 factories ordered to set up part-work and part-study schools for students——most of them were unsuccessful for varied reasons except only 7 of them survived until the eve of the Great Cultural Revolutionary, with over 2000 graduates. Two other examples: there was a 5-year part-work and part-study university of engineering and industry at that time. It offered 24 class hours a week, occupying 16 working hours and 8 hours of spare time. In 1964, the university graduated more than 800 students. In 1965, Tsinghua University started a work-study pilot program in manufacturing, which as terminated due to the Great Cultural Revolutionary.

2.3. Main characters of cooperation between higher engineering education and industry

2.3.1. Education

Under the system of planned economy, universities could only enroll students and assign jobs on their graduation according to mandatory plan, and exercise a talents training model strongly geared to the needs of certain jobs. The universal training scheme, teaching program and learning requirements aiming at educating students into talents with same or generally same abilities and structure of knowledge had resulted in the lack of personal education that features competency-based instruction. As one link in overall teaching, practice teaching was arranged by the government’s mandatory plans, and enterprises had therefore got no initiatives and consciousness to cooperate with universities. Remodeling the students’ ideology by way of labor was the main objective of University-Industry Cooperation at that time.

2.3.2. Research

In the early days of the People’s Republic of China, its national economy was still in a recovery and starting stage. Under such a circumstance, universities had no special funds for taking up scientific research and. could only rely partly on specialized equipment fund and special fund for important disciplines or financial supports offered by coordinative units instead. In 1956, Science Planning Commission under the State of Council was established, which had helped improve the position of university in scientific research. Between 1962 and 1963, the Central Government decided to bring scientific research conducted by
universities into line with the state plan. In 1964, the State Scientific and Technological Commission determined the first 32 key scientific and technological research projects of the state, among which 21 sub-projects attached to 6 projects were conducted by 12 universities belonging to government departments. During this period of time, scientific researches in universities were in small scale at low level, mainly depended on the limited financial grants from the state. On the other hand, the industrial sector was also weak in the ability of conducting research and development, with few needs in this aspect. Cooperation between higher education and industries were therefore undeveloped then.

2.3.3. Funding

Under the planned economic system, outlay for teaching and scientific research was mainly granted by the Ministry of Education and industrial departments under the government. For example, Bejing Jiaotong University was once under the jurisdiction of the Ministry of Railway and financially supported by the Ministry for its expenses in teaching, administration, construction, etc, without costs of scientific research from enterprises.

2.3.4. Intellectual property

The highly centralized planned economy system did not advocate intellectual property. Although Chinese government successively promulgated 5 regulations to reward inventions including Interim Regulations on the Protection of Invention Rights and Patent Rights, the ownership of intellectual propriety rights had been left in the hand of the state and could be used for free by all state-owned units around the country. Many people didn’t understand the meaning and function of intellectual property, and some even believed that intellectual property was ill-adapted to social public ownership. During the time of planned economy, confined to the system and wrong ideas, the function of intellectual property was unable to be brought into full play as it should have been.

2.3.5. Management mechanism and organization

At that time, universities operated student recruitment and job assignation strictly in accordance with related plans made by the government. Departments in charge of teaching affairs sent students to take internship in factories under scheduled teaching program. There was no need for an university to develop cooperative relationship with industrial sector, and also, no ad hoc government organization established to take charge of the cooperation between the universities and industries.
3. Cooperation between higher engineering education and industry in China in the era of market-driven economy

Since the 1980s, Chinese mainland gradually transferred from planned economy to market economy.

3.1. Goal of higher engineering education

During the time of market economy, the main objective of engineering education is to serve the socialist modernization by combing education with productive labor and making receivers of education fully develop morally, intellectually and physically in order to become builders and successors of the socialist cause.

3.2. System circumstance of higher engineering education

3.2.1. Status and relations between engineering educations and industries

Along with the establishment of socialist market economic system, the original mode of practice teaching directly controlled by the government under planned economy began to face severe challenges. On market economy conditions, enterprises universally adopt modern enterprise management system under which enterprises have full authority for management and take full responsibilities for profits and losses. Thus, costs and benefits become the life of enterprises, and they therefore resists to be forced to offer intern jobs for college students. As a result, universities can no longer rely on government power to arrange students to go to internship in enterprises but have to find out new points for connection between themselves and enterprises. Although student enrollment is still subject to the government’s strict instruction, job assignment for graduate has been replaced by job-hunting in recruitment market. And institutions of higher education have also gradually been granted limited authority for management. Due to the shortage of educational funds and poor knowledge of society of University-Industry Cooperation, internship program for engineering students in industrial sector has been blocked. On the other hand, however, the increasing needs for industrial
development and the rapid improvement in University-Industry Cooperation in terms of scientific research have contributed to the development of internship projects for engineering students.

3.2.2. Functionality of government and market in coordinating relations between education and industry

During the process of transition from planned economy to market economy, the government has experienced a gradual change in its function. Instead of taking a leading position, it now plays a role of coordinator and servant. It is now on the way of building proper legal and developing environment for University-Industry Cooperation, making policies to encourage the cooperation, using market mechanism to help universities find out new binding point with enterprises and attracting more enterprises to be actively engaged in cooperative education for the purpose of healthily advancing University-Industry Cooperation. The unceasing development of market economy also make industrial sector, education circles and other circles gradually realize the essentiality and necessity of University-Industry Cooperation. Ideas about and demands for University-Industry Cooperation introduced by a large number of multinational companies and foreign companies have particularly carried University-Industry Cooperation forward.

3.3. Influence of high speed development of higher engineering education and Chinese higher education system reform in recent years

3.3.1. Ownership transfer of some universities from Industrial Ministries to Ministry of Education or Provincial Education Departments

In pace with the setting up and constant perfection of China’s market economy system, the government’s function has changed greatly. Around the year of 2000, the state made large-scale adjustment on educational system for the second time since the foundation of the P.R. C. As a result, all institutions of higher education originally belonging to industrial departments under the government have been put under central and local administrative departments in charge of education. For example, Beijing Jiaotong University has been cut ties with the Ministry of
Railway and put under the Ministry of Education. The transformation of upper competent authorities for educational institutions has put an end to the long-standing indeterminacy of education and industries’ function, making their functions, tasks and positioning in society more reasonable. Of course, this transformation may also to some extent weaken the natural connection between industrial sector and universities formerly belonging to industrial department. For example, Beijing Jiaotong University used to be completely supported financially by the Ministry of Railway, with its specialty settings entirely in accordance with the needs of railway industry and job assignment for graduates oriented at railway related profession. This natural association has to some degree assured the cooperation between the University and Railway industry. The currently implemented all-round talents-oriented education operated by universities under educational authorities at different level is more suitable for citizen education, but it is necessary to fully improve college students’ academic ability and practical ability and enable them to be qualified to the work in industrial sector through improving University-Industry Cooperation under new circumstances.

3.3.2. Mergence of universities

To make rational use and allocation of educational resources for the purpose of promoting the benefits and quality of education as a whole, from 1990 to August 2004, the state implemented a series of policies for the mergence of institutions of higher education. The formerly 612 colleges and universities have been merged into 250. In this way, cooperation between universities in teaching, scientific research in varied ways has become very popular, which has benefited the further enhancement of their creative power in science and technology and laid solid foundation for inviting enterprises to participate in cooperative education and build up new model of University-Industry Cooperation. Take central South University for example. It grew out of 3 government industrial department owned colleges and local schools and is now one of the key university supported by the state’s “985 Project”. After years of practical exploration, it has achieved great results in University-Industry Cooperation and initiated Academic-based Company, a new model of cooperation.

3.3.3. Large scale expending of student recruitment

In early 1999, the Party Central Committee and the State of Council made a weighty decision of enlarging enrollment of higher education according to the strategic policy of “developing the country through science and education”, which lifted the curtain on the transition of education from elite education towards
popular education. It has been beneficial to the improvement of cultural quality of employees in China and created conditions for meeting the development of enterprises. Unfortunately, enlarging enrollment has also caused the insufficiency of educational resources and the downgrading of teaching quality, as well as other problems, in particular, the severe shortage of resources for practice teaching in engineering education.

3.4. Development of cooperation between higher engineering education and industry

3.4.1. Education

On market economy conditions, higher engineering education ought to face the actual demands of enterprises and set the goal of making creative talents with international vision, strong innovative mind, scientific knowledge structure, comprehensive practical ability, communication ability and team work spirit. To realize this objective, institutions of higher education should create opportunities of internship for undergraduate students, graduate students and doctoral students via a variety of models and ways of University-Industry Cooperation.

3.4.2. Research

The source of scientific research no longer comes only from the government but also enterprises, in particular those of high applying value. Teachers and graduate students’ involvement in the research and development of enterprises has on the one hand been helpful to their study and research through practical work and on the other hand, helped settle key technical issues for enterprises. Cooperation and interaction between higher education and industries have to some degree reduced the contradiction between the waste of intellectual resources and research results of universities and the difficulty in solving technical issues by enterprises. At present, however, only a small number of research results have been transferred to productivity. Take Tsinghua University for example, only 25% of its research results have been signed to transfer to enterprises, and only 30% of these transferred results have achieved final success. Namely, only 7% research results of the University have finally been effectively turned into productivity, while other research results have failed to be commercialized. This proves that it has become an important task for universities to create an effective transference model of research results and conduct research and development according to the needs of
enterprises under market economy condition.

3.4.3. Funding

Educational funds of universities are now not only dependent on the government but also to a large degree on enterprises. Investigation shows that expenditure on scientific research in key universities accounts for 50% of the total educational expenditure, and 50% of which comes from enterprises. This demonstrates that University-Industry Cooperation plays a decisive role in the development of higher engineering education.

3.4.4. Intellectual property

Following the launch of Reform and Opening Policy, China began to really integrate into the international trend of intellectual property and has formed rather complete legal system of intellectual property protection. Universities of higher education in China have also been aware of the importance of intellectual property. For example, Tsinghua University has set up a special organization to be responsible for problems related to intellectual property in contracts involving University-Industry Cooperation, so as to reduce the legal risk in the implementation of contract on the basis of protecting rights of both sides. However, it is still a problem needed to be further explored that how to build up an effective legal system of intellectual property protection with the assurance of all parties’ rights and at the same time, to increase the enthusiasm of inventors.

3.4.5. Management mechanism and organization

In order to strengthen University-Industry Cooperation, some universities have established cooperative committees among universities and industry, and open offices in special charge of University-Industry Cooperation. Some universities set up board of directors and invite representatives from industrial sector to join in, working together in the discussion and consultation on vital problems such as direction for school running, course settings, quality of teaching staff, contents and methods of teaching, practical base, student enrollment and job assignment, etc. For example, Suzhou Industrial Park Institute of Vocational Technology (SIPIVT) has followed the school running model of Nanyang Polytechnic, of Singapore, and established a board of directors consisting of representatives from local government, famous multinational companies, and well-known institutions of higher education both at home and abroad as soon as the institute was founded. The institute exercises a leadership structure that rests with the director of the institute to hold liability under the board of directors, the highest organ of power.
of the institute. As the board has fused resources from three sides including the government, industrial sector and the Institute, it has been strongly supported by the three parties in policy-making, educational funds and teaching, etc. With regard to the transference of research result, many universities have set up special offices for University-Industry Cooperation, which have played active roles in the transference of research result. In teaching area, however, schools and departments as well as educational administrators have taken leading roles in the mechanism of University-Industry Cooperation, without special organization to be responsible for the cooperation related teaching affairs.

3.4.6. Industries run by institutions of higher education

During the past 20 years, industries run by institutions of higher education in China have developed significantly, which has been viewed as a great innovation. By entering the market, many research results achieved by teachers and graduate students have been commercialized. Many universities have started companies and factories, which have created conditions for practice teaching to some degree. However, the interfusion of academic mechanism and industrial mechanism that resulted from the vague positioning of education and industries is unfavorable to both education and industries. The government and society has now realized this problem and started out to separate university-operated industries from universities in respect of operation and management and keep them developing in health way. Owning to the natural connection between universities and their own industries, universities have attached importance to University-Industry Cooperation. Take Tsinghua University for example, each year, some tens of enterprises controlled by Tsinghua Holding Co. Ltd. sign contracts worth nearly 100 million RMB with Tsinghua professors, and provide internship base for students at different levels. The Tsinghua Holding Co. Ltd. owns 29 companies with more than 50% shares, among which 6 are listed companies, and 55 are partly-owned companies. The business they run covers a wide range of industries involving information technology, life science and technology, technological service, as well as energy, chemical and environment protection, etc., and have been serving as platform for the transference of research results of the university. Thus University-Industry Cooperation has made great contribution to the rapid development of both education and industries of the university.
4. Incentives of cooperation between higher engineering educations and industries

University-Industry Cooperation is extremely important to the development of universities, industries, society as well as students’ career development and whole life. It is demanded by varied aspects of society from different angles.

4.1. Student side

4.1.1. Practical ability

University-Industry Cooperation enables college students to be more engaged in practical operation in enterprises, to put their academic knowledge into practice and get deeper understanding of what they have learned, and finally, to search jobs they are interested in and can be qualified to. While advancing their practical ability in this way, they are laying solid base for their prospective career development.

4.1.2. Financial support

By going to internship in enterprises, college students can not only advance their practical ability, but also get rewards that help reduce their financial burden. For example, students of the School of Software of Beijing Jiaotong University can earn a monthly salary of 1200-1800 RMB by taking internship, which have to a large degree relief their financial difficulties. In order to obtain high quality talents, some enterprises have set up special scholarships in universities to award excellent students. In Suzhou Industrial Park Institute of Vocational Technology, over 10 enterprises invest about 200000 RMB every year as encourage and awards for excellent students and teachers.

4.1.3. Work experience

To college students, participating in University-Industry Cooperation program is an effective way to contact themselves into society and get good understanding of society. Accumulating work experience through practical work in enterprises will be very beneficial to their employment on graduation and help them treat employment in a correct and practical way, and shorten the time they need to get used to their prospective jobs. In the School of Software under Beijing Jiaotong University, practice teaching is regarded as one of the most important link in teaching. The school’s cooperative educational partners offering internship sites
for students include many famous IT corporations such as MicroSoft, IBM, Lenovo, Digital China, UFIDA. Field work in these corporations has helped students accumulate work experience and easily adapt themselves to work environment there. They are therefore very welcome by these enterprises. Take graduate students of 2003 in software engineering for example, most of them have been employed by enterprises where they did field work or got more suitable jobs in other enterprises, with 100% employment rate.

4.2. University side

4.2.1. Recruitment of excellent students

As stated in 4.1., University-Industry Cooperation is conducive to the cultivation of students’ practical abilities, the reduction of their financial burden and the accumulation of their work experience as well. All these advantages are very attractive to quality high school students. Under the increasing heavy pressure of employment, high school graduates take employment rate and quality as important factors for consideration when they choose universities. Therefore, utilizing University-Industry Cooperation to improve college students’ ability to succeed in job placement and raise the reputation of universities in industrial sector will help attract more high school students with good character and scholarship, thus forming a favorable circle for higher education.

4.2.2. Curricula design

Most universities tend to be engaged in basic research, without enough experience and knowledge in applied research and the development of commercialized products. Through University-Industry Cooperation, however, they can get feedbacks concerning teaching quality and curricula design from enterprises, with more awareness of directions for industrial research and higher sensibility to technological market, and narrow the gap between education and industries on the basis of actual needs of enterprises. For example, Shanghai Jiao Tong University constantly makes adjustment to specialty settings in automotive engineering. According to the development direction for modern automobiles, it has opened such elective subjects as New Advancement in Automotive Engineering, Automobiles and Environment, Automobiles and Energy Resources, White Body Manufacturing Process for Automotives, so as to widen the horizon of students.
4.2.3. Technology transfer

Institutions of higher education have great advantages in research and development, with quality and strong team and advanced facilities. Due to the shortage of funds and experience as well as other reasons, however, their research results usually fail to be transferred to productivity successfully. University-Industry Cooperation is conducive to the complement between universities and enterprises, as well as the enhancement of the proportion of results transference.

4.2.4. Teaching circumstance

In order to increase their notability and establish long-term cooperative relations with institutions of higher education, many enterprise are willing to provide the institutions with advanced teaching facilities or co-establish experimental bases with them. For example, there are 1300 large-scale multinational enterprises located in Suzhou Industrial Park, with great superiority in equipment and technology. During the past few years, they have accumulatively presented a large quantity of equipments worth over 10 million RMB to the institute, and companies such as Boshi, Nokia, Siemens, Samsung have set up 80 high level labs of their own there.

4.2.5. Financial support

As educational funds granted by the government are going down, universities have to seek funds from the society. In such circumstance, financial supports from enterprises have become more and more dominant in their financial resources. For example, Central South University has dramatically increase its funds for science and technological research—from 500 million RMB in 2003 to 600 million RMB in 2006—by establishing Academic-based Company , a new model of University-Industry Cooperation, in 2000. This model has given vigor to the development of the university. Tsinghua Holding Co. Ltd. is a state-owned limited liability company solely invested by Tsinghua University under the approval of the State of Council. In the past over 20 years, Tsinghua University has accumulatively invested 234 million RMB in the company. In return, the company has turned in 849 million RMB in cash to the university as well as its schools and departments, 3.6 times of the original investment. This has strongly supported the teaching and research of the university.
4.3. Industry side

4.3.1. Recruitment and training

Cooperating with universities and offering Internship opportunities for students will effectively help enterprises reduce the costs of pre-job training and shorten training period as well. Through University-Industry Cooperation, an enterprise will be able to employ quality graduates suitable for its needs, and create opportunities for its staff to pursue advanced study in universities. For example, according to the demands of enterprises, Suzhou Industrial Park Institute of Vocational Technology has created a “order driven” training model——not only selecting qualified students for enterprises, but also cooperating with them in designing laboratories, setting specialties and courses and working out teaching programs. The model has been very welcome by enterprises in Suzhou Industrial Part. The institute’s average employment rate has been over 98% for 8 years in row and about 1/3 graduated have obtained employment in the world’s top 500 enterprises.

4.3.2. Enhancing innovative capability

Whether an enterprise can survive the fierce market competition is to a certain degree dependent on its creative power. Given the shortage of funds and person for research and development, it is the most effective way for an enterprise to enhance its creative ability by directly obtaining research results and experience from universities. According to statistics, since 1999, the contracts signed by enterprises under Tsinghua Holding Co. Ltd. and the university are worth nearly 500 million RMB, accounting for 27.3% of all contracts on scientific research of the university. This has contributed a great deal to the development and fund-collecting of scientific research as well as the creative ability and core competitive ability of enterprises, and laid solid foundation for the development of core technology and product with self-owned Intellectual Property by creating a new turning point for economic growth.

4.3.3. Resolving technological difficulties

In nowadays, universities have transformed their functions from merely doing basic research and teaching students to serving the society such as furnishing technical assistance and advice as well as research for enterprises. Resolving technological difficulty and realizing research results transference have become a common model of University-Industry Cooperation. For example, computer
intelligent fuzzy control system developed by Central South University for controlling the electrolytic process of aluminum has been widely applied in over 40 aluminum factories and created immediate economic benefits of over 700 million RMB for these enterprises.

4.3.4. Making up for the deficiency in facilities and personnel in R&D

Transformation from basic research to applied engineering and testing demands a large number of equipments and human resources. A research and development center of certain scale is a very heavy burden for an enterprise financially. Gaining needed resources through working together with universities can make up for the deficiency in facilities and personnel in research and development. For example, Hunan Shanhe Intelligence Machine Ltd., an academic-based company specialized in electromechanical engineering (established in December, 1999 and completed reform of ownership in 2002) under the assistance of Central South University, has made good use of the advantages of research and development of the university and put over 30 new products with self-owned intellectual property in market during the past 5 years. So far it has accumulatively finished value-added industrial output of 1 billion RMB. Presently, the demand for these products in international market has exceeded the supply. In 2005, export volume of theses products has reached 10 million USD.

5. Obstruction of cooperation between higher engineering educations and industries

5.1. Mentality and conception

University-Industry Cooperation is of vital importance to the development of education and industries in China. It should be promoted not only by several universities or industrial sector but also by the whole society. Compared to developed countries, Chinese society as a whole lacks basic ideas and knowledge of the importance and necessity of University-Industry Cooperation. The whole society must view University-Industry Cooperation at higher level and consider it as an essential condition for building harmonious society, giving up the outdated idea that it is school’s responsibility to cultivate talents and University-Industry Cooperation is just research and development cooperation between university and industries. Parents in the society are concerned over education more often with
tution fee, student recruitment and diploma than the educating process, content, method and the results of educating, but actually, University-Industry Cooperation is an unavoidable way of cultivating engineering talents with true skill and genuine knowledge.

5.2. Legal aspect

University-Industry Cooperation involves economy, intellectual property, labor protection, taxation, personnel affair and so on. It cannot develop in healthy way without related laws and regulations of the state, as well as policies, accreditation system, coordination of relation and financial support given by the government. Although the government has drawn up policies concerning University-Industry Cooperation, there is still a long way to go to set up a complete system in terms of this.

5.3. System and mechanism

So far the government has not established necessary system and mechanism to enhance the development of University-Industry Cooperation, nor has it organized long-term and deep-going research on the mechanism, model, methods, implementation rules and law of it. As the whole society can hardly understand University-Industry Cooperation in a scientific way, the cooperation is sometimes blind, which is an important reason why University-Industry Cooperation in China cannot last for a long period. Successful University-industry Cooperation can only be achieved by establishing partnership between the government, enterprises, society and institutions of higher education. In China, the government plays a particularly important leading role in guiding and promoting this partnership. Only by benefiting all participators including college students, institutions, enterprises and the society and creating multi-win situation, can University-Industry Cooperation in China be sustained.

5.4. Funds for University-Industry Cooperation

Educational funds for higher engineering education in China is rather limited, sometimes even not enough for funding students to travel to enterprises where they do field work. University-Industry Cooperation should therefore be financially supported by the government as well as enterprises——after they benefit from the cooperation.
6. Policy suggestion on cooperation between higher engineering educations and industries

6.1. Publicizing

We should energetically publicize the significance of University-Industry Cooperation through a variety of media (television, broadcasting, newspaper, magazine, conference and internet), as well as its importance to the establishment of complete system of talents training and scientific & technological innovation, its necessity to building up harmonious society, its influence on the development of higher engineering education and industries. We should also actively introduce advanced international experience in University-Industry Cooperation and typical successful models in this area in China. Making University-Industry Cooperation well-known to the public will help people realized that it is an important affair related to the future of not only the state and the nation, but also every citizen.

6.2. Legislation and policy

The government should draw up corresponding laws and policies to encourage and assure the healthy development of University-Industry Cooperation. For example, proceeding from China’s current situation, the government should define the obligation and function of enterprises in University-Industry Cooperation (e.g. tax deduction policy), to draw up laws and policies regarding University-Industry Cooperation—especially in higher engineering education (e.g. policies on practice teaching, requirement on the qualification for engineering teachers with industrial work experience, intellectual property protection, etc). Only in this way can favorable macro-policy environment be made for University-Industry Cooperation.

6.3. Research Funds

The state should use the Natural Science Funds, Social Science Funds and Research Funds of the Ministry of Education to set up funds for research projects on University-Industry Cooperation and make deep-going and systemic research on various aspect of University-Industry Cooperation, such as history of University-Industry Cooperation in developed countries; legal foundation for
University-Industry Cooperation; models, mechanisms and laws of University-Industry Cooperation in different types of education; features of implementation of University-Industry Cooperation in different specialties; influence of University-Industry Cooperation on the market for labor; influence of University-Industry Cooperation on industrial upgrade, and; influence of University-Industry Cooperation on building a harmonious society, etc. All these researches will enable us to understand the law of University-Industry Cooperation in an all-round and scientific way and help University-Industry develop sustaninably and healthily nationwide.

6.4. Organization and management

It's necessary to establish a national organization consisting of college students and representatives from the government, enterprises and universities, with the mission of promoting University-Industry cooperation related research, implementation, accreditation, etc. There also should be organizations in universities and industrial sector in charge of the management of University-Industry cooperation related activities.

6.5. Investment in University-Industry Cooperation

According to practical experience of developed countries, costs of University-Industry Cooperation in such links as teaching, management of students, university-enterprise relation will increase as it push forward. The government should increase investment in University-Industry Cooperation in order to make sure that universities have enough funds to start the cooperation. Only when University-Industry Cooperation begins to take shape can a university be self-support with the economic benefits resulted from the cooperation.

6.6. Promoting education globalization

The integration of global economy has furnished University-Industry Cooperation a wide international background. In fact, this cooperation is an important aspect of the internationalization of education. While advancing the cooperation, the government should also vigorously develop internationalized education, so as to make talents training in China to couple with (be integrated into) the development of world education and economy, to make China’s engineering talents qualified for jobs of multinational companies in both China and any other countries.
Reference


[4] Learning from Experience: Enhancing Co-operative Education and Career Services at the University of Waterloo, University of Waterloo August 31, 2005


Acknowledgement

This research is financially supported by the project of UNESCO Office Beijing, Group T Leuven Engineering School and Suzhou Industrial Park Institute of Vocational Technology. In the process of investigation and survey, we are strongly supported and assisted by leaders and staff members of Tsinghua University, Shanghai Jiaotong University, Central South University, National Taiwan University of Science and Technology, Group T Leuven Engineering School, Suzhou Industrial Park Institute of Vocational Technology, Tsinghua Holding Co. Ltd., NOKIA (Suzhou), Schneider Shanghai Research & Development Center, Philips Shanghai Center of Applied Technology, etc. We are sincerely grateful to them for all their support and help.

Appendix: Best Cases Study on Cooperation between Higher Engineering Education and Industries
Best Case Study on Cooperation between Higher Engineering Education and Industries

UNESCO Chair on Cooperation between
Higher Engineering Education and Industries
Preface

UNESCO Chair at Beijing Jiaotong University on cooperation between higher engineering education and industries was set up in February, 2005. Since then, the UNESCO Office Beijing entrusted Beijing Jiaotong University with the project entitled “University-Industry (U-I) Partnership in China: Present Scenario and Future Strategy”. In its implementation process, we did plentiful investigations and researches at universities and enterprises in China and foreign countries, then analyzed and summarized the history and current situation of cooperation between Chinese higher engineering education and industries. At the beginning of December, 2005, we held seminar on U-I cooperation in Suzhou. The aim of this seminar is to summarize historical experiences, exchange ideas, discuss with each other, learn advanced experiences, and put forward new future strategies. The attendees include not only famous or representational engineering universities in China and foreign countries, but also delegates from industries, educational institutions and media. Some delegates have given keynote speeches, who are from Tsinghua University, Shanghai Jiao Tong University, National Taiwan University of Science and Technology, Group T Leuven Engineering School of Belgium, Suzhou Institute of Vocational Technology, Beijing Jiaotong University, and Suzhou NOKIA. Besides, the delegates had a deep discussion on the strategies of university-industry cooperation, and brought forward many valuable ideas and suggestions. In a word, the seminar is extremely successful.

As the appendix of final report on this research project, here we have embodied summaries of successful experiences on U-I cooperation from six higher engineering colleges and universities, which are just a miniature of numerous U-I cooperation fruits in China and foreign countries. In order to develop systematical and sustainable U-I cooperation nationwide and make it play a huge role in talent cultivation and technological industrial innovation, we should summarize experiences in U-I cooperation, and upgrade them to system, mode, regulations and operation procedures, which will become the law, guidance and operation manual of U-I cooperation practice and will be promoted nationwide. Like western developed countries, insisting on U-I cooperation practice and theory for more than hundred years, we will make Chinese U-I cooperation become the foundation of our harmonious society.

Cha Jianzhong, Ph.D.
Chairholder, UNESCO Chair on Higher Engineering Education and Industries
Professor, Beijing Jiaotong University, P.R. China

Johan De Graeve, Ph.D.
Co-Chairholder, UNESCO Chair on Higher Engineering Education and Industries
President & Professor, Group T Leuven Engineering School, Belgium

December 2005, Beijing
# Table of Contents

To Explore the Harmonic Interaction of the Industry-and-University Partnership ......................................................................................................... 35
Tsinghua Holdings Co. Ltd.

University-Enterprises Cooperation Cultivate Innovative Talents with International Competitiveness ................................................................. 41
Shanghai Jiao Tong University

Innovative Administrative Mode: Accelerate Transformation of Fruit, Promote Development of Knowledge ............................................................. 51
Central South University

University and Industry Cooperation: the Way to Cultivate Software Talents in New Era ...................................................................................... 59
Beijing Jiaotong University School of Software

A Probe into the Educational Mode of Cooperation between Higher Vocational Engineering Institutes and Enterprises ............................. 73
Suzhou Industrial Park Institute of Vocational Technology

Enterprising Engineering Education: Partnership of Group T & Entrepreneur ................................................................................................. 84
Group T Leuven Engineering School
To Explore the Harmonic Interaction of the
Industry-and-University Partnership

Wang Tao, Song Jun, Lin Qingkuai, and Rong Yonglin
Tsinghua Holdings Co. Ltd., Beijing

Abstract: It is of very exceptional signification that universities serve the society with its advanced science and technology. The appearance and growing of university owned industries in China, on the one hand, indicates that the university sponsored enterprise itself is an important way to transfer college technology and the primary carrier of the high-tech industrialization; on the other hand, it shows the importance role universities play in the social economy development, especially the research-oriented universities. This paper, taking Tsinghua University industry as an example, discusses in detail the interactive partnership between university sponsored industries and universities, and affirms adequately the promotional function of the university sponsored enterprise in the industry-and-university interaction.

Keywords: university sponsored enterprise; technique transfer; industrialization

On Feb. 1, 1980, Tsinghua University founded the first university technical enterprise in China---Tsinghua University Technique Service Corporation, which signifies the outset of Chinese universities founding technical enterprises. According to the statistical data from the web of science and technology development center of Ministry of Education, the gross income of university sponsored industries all over China has come to 82.667 billion in 2003, of which 15.87 billion belongs to Tsinghua, accounting for about 19.2 percent of the total number. In the 25 years of development, Tsinghua industry has experienced success, loss, applause and criticism; but as an pillar of university sponsored industries, Tsinghua industry is getting stronger gradually, becoming the main support to Tsinghua University for its function of serving the society. The vigorous advancement of China’s economy brings opportunities for the development of the university technical industries.

Universities enjoy some advantages in founding technical enterprises: scientific research, talents and information superiority, as well as broad social relations and alumni network, which ordinary companies do not have. Universities can be regarded as the “virtual academy” of enterprises, and it brings continuous power and energy for the development of enterprises. However, at the same time, university sponsored enterprises have some disadvantages, such as: lack of professional management, while most professors cannot well perform the role of managers; universities cannot take infinite risks; and invisible capital takes up a large share in the initial investment, etc.
In retrospect of the process of industry development, we have realized the importance of system innovation, that is, in order to promote benign interaction between industries and universities, the development of university sponsored industries must be based upon the principle of “constant development, professional management, serving the society, and increasing the return”, and three relations must be treated correctly, namely the relation between payoff and research investment, between accumulation and return for stockholders, and between development and normative management.

![Figure 1 Tsinghua university-industry interactive mode](image)

As showed in figure 1, the industrialization of university scientific and technological achievements is actually the process to socialize the achievements. This process is realized by three main bodies through two circulations according to two basic technique transfer modes.

As for three main bodies, they refer to Tsinghua University, Tsinghua Holdings and social investors.

1. **Tsinghua University** is the source of technology as well as the power source of Tsinghua university sponsored enterprise development. In 2005, Tsinghua University ranks first in the nationwide university comprehensive evaluation by the cuaa.net, the 21st century talents newspaper---university weekly and learning.sohu.com. The strong scientific research strength of Tsinghua University is the root and foundation of university-industry benign interaction.

2. **Tsinghua Holdings Co. Ltd.** is the only assets management corporation on behalf of Tsinghua University to hold, manage and supervise its invested enterprise (holdings). Tsinghua Holdings was restructured on December 18, 2003 by integrating...
and merging Tsinghua University Enterprise Group, Tsinghua Science Park Development Center and the Tsinghua Unisplendour (Group) Co., Ltd. After the restructuring, Tsinghua Holdings Co., Ltd. becomes a limited liability company wholly owned by Tsinghua University. For Tsinghua University, Tsinghua Holdings is the propellant of technique transfer and the manager of university owned property; for social investors, Tsinghua Holdings is the agent of Tsinghua technology and the ideal cooperate partner of high-tech industry.

3. **Social investors** are the side demanding techniques and the investor of capitals, at the same time, they are our good cooperate partners. Tsinghua university sponsored enterprises have core techniques and are good at research, while social enterprises, especially state-owned enterprises, have high-qualified management team, remnant assets, technician team and sales network, but always short of mechanism and techniques, the combination of which can be of significant power.

The two basic technique transfer modes are as follows:

1. **Technique promotion mode.** This mode is the process of industrializing university’s basic theory research and national key highly sophisticated achievements. It is mainly applied by enterprises in new technology or national key sophisticated technology fields, such as Hangtian Tsinghua Satellite Technology Ltd. researching nanometer satellite, Chinerge Co., Ltd. researching the civil use of nuclear technique, Bitway Networking Technology Co., Ltd. researching IPV6, Beijing Visionox Technology Co., Ltd. researching organic electroluminescence and so on. All these companies are founded upon a certain technology. Their features are: (1) high-tech. The programs are basically national key scientific and technological projects or the most sophisticated projects in the world. (2) high research cost. These projects are prosperous, but still far away from industrialization. As a result, at the beginning of the establishment of enterprises, the capital investment is huge while the profit is small. (3) high dependence on relative colleges of the university. At the initial stage of enterprise operation, professors are basically the lead. This kind of enterprises accounts for a considerable proportion of Tsinghua enterprise system, at the same time is the significant embodiment of recompense from Tsinghua industry to the university and society. The experience can be concluded as follows: we supervise these enterprises for three years according to the above three principles to see their prospect. If they may have a prosperous future, we would give them strong support and capital investment during the next three years. If not, we would think of giving them up to avoid further loss.

2. **Market promotion mode.** According to the demands of markets, enterprises propose some research subjects which will be finished by university teachers according
to scientific research contract. This mode is the same to the real university-industry cooperation mode, and is applied in some mature enterprises which have been initially marketized, such as Tsinghua Tongfang Co., Ltd., Tsinghua Unisplendour Co., Ltd. and so on. Tsinghua University sponsored industry’s scientific research contracts with Tsinghua University add up to nearly RMB500 million yuan since 1999, taking up 27.3% of the total contracts. Only in 2004, the contract values reach nearly RMB80 million yuan, which highly promotes university scientific research development, opens up the channel of raising research outlay, and builds up enterprises’ innovation ability and competitiveness. For this kind of cooperation, Tsinghua Holdings Co., Ltd. will gradually reduce university’s shares in these enterprises through the equity transfer and the introduce of strategic partners and make these enterprises socialized.

The combination of Tsinghua University’s strong scientific research power and university sponsored enterprises’ excellent financing ability will create the industrialization opportunity and form new point for economic growth. Particularly, the key scientific research achievements of Tsinghua University will in turn promote the development of relative university scientific research after the establishment and industrialization of enterprises. This is the process that technique promotion and market promotion gradually melt with each other during developing. For instance, van container inspection system, as high-tech project in the Eighth “Five-year plan” of China, involves several different subjects, such as accelerator, nuclear detection, image, automation, computer, network and so on. Since 1994, after three years’ hard work, we have achieved preliminary technical success, during which the government invests RMB 5 million yuan, and the research team raises another RMB 5 million yuan by itself. However, that’s far from enough. The industrialization of this technique still needs the reinvestment of a large amount of capitals and technicians. In 1997, after going public, Tsinghua Tongfang began to support this project and established Nuctech Co., Ltd. with the collected capital of RMB30 million yuan as the initial investment. In 1999, the first Tongfang Nuctech fixed van container inspection system was put into use formally in Tianjin. Now, Tongfang Nuctech has become a professional company producing container inspection system and it has the largest sales volume in the world with altogether 104 sets. The products are sold to 28 countries and regions and the sales amount exceeds RMB 3 billion yuan., which makes the company one of Tsinghua’s pillar industries. At the same time, the technical research contract between Tongfang Nuctech and Tsinghua University reaches RMB 500 million yuan. The industrialized project “mobile container inspection system with accelerator as its radiation source” completed by Tongfang Nuctech and Tsinghua University has won the firs award of the national scientific and technical progress in 2004.
There exist two levels of university-industry circulation in Tsinghua University sponsored industry interactive mode:

First, the interactive circulation between Tsinghua University and Tsinghua Holdings. The University carries out the scientific researches through investing capitals and talents. After the initial success of these researches, Tsinghua University can authorize Tsinghua Holdings to operate the following work by investment, or Tsinghua Holdings can purchase the right to use the techniques directly through technology transfer contract. The relationship between Tsinghua University and Tsinghua Holdings is the same as the relationship between the party investing and the party invested. Tsinghua Holdings Tsinghua Holdings can reciprocate the university through forming university-owned assets and dividends, and also support the industrialization of university achievements though signing contracts.

Then, on behalf of the university, Tsinghua Holdings seeks for social resources and undertake the task of conformity and operation, which forms the university sponsored enterprise at the first stage. Based on this, Tsinghua Holdings carries out further capital operation and technique investment, and gradually socializes the mature enterprises through the sell of stock ownership and re-financing, during which Tsinghua Holdings achieves the realization of stockholder's rights and capital calling-back. This circulation is the university-industry interactive circulation between Tsinghua University and social enterprises, by which Tsinghua University gets its techniques industrialized rapidly. On one hand, Tsinghua University gains the research outlays for the next step through contracts; on the other hand, the profits return back to Tsinghua Holdings and further back to the university through other forms.

In the two circulations, Tsinghua University raises large amounts of capitals from society to support its academic construction, at the same time, serves the society with its techniques, while social investors get technical and market returns. Tsinghua Holdings, in the circulations, plays the very important role of promotion and gets itself stronger in this process.

“Develop high-tech, realize industrialization” is the key link for comprehensive universities to realize three main functions---teaching, research and social service. In the 20 years’ development, though there exist some problems, it has been proved by facts that the development of university industry is fast and successful. The existence of university industry increases the proportion of industrialized university scientific research achievements and strengthens the financial support for scientific researches through stock returns. On the premise of stick to the right direction, university industry needs to enhance the university-industry interactive mechanism research and it will definitely welcome a more splendid future.
References:


University-Enterprises Cooperation Cultivate Innovative Talents with International Competitiveness

Chen Guanlong, Zhao Yixi, Xu Min
Shanghai Jiao Tong University, Shanghai

Shanghai Jiao Tong University (SJTU) with more than 100 years’ history has made outstanding contributions to industrial development and engineering education in China. She has also set up its goal to cultivate talents with models of broad-solid foundation, integrated knowledge, open-mind and innovation.

Because of the economic globalization and the world manufacture center transferring to China, China will become powerful world manufacturing country from great world manufacturing country as well as how to cultivate high-level innovation talents with international competitiveness will be a great task of Chinese high engineering education. Major questions that Chinese mechanical engineering talents face are: Lack of innovation spirit, not powerful to solve real-life problems, limited knowledge structure and lack of international views.

On the basis of powerful engineering disciplines, under the support of solid scientific research strength, starting with cultivation for students’ innovation spirit and practical capacity, SJTU greatly reformed the concept of cultivating mechanical engineering talents and teaching mode; the aims of mechanical engineering school of SJTU are to build up engineering senses, develop capacity of study and cultivate innovative senses; in addition, depending on the quick development of manufacturing of Shanghai, the said school will organically combine with engineering education, engineering practice and engineering research to improve comprehensive engineering capacity of students in all aspects.


As a multi-science synthesis, modern mechanical engineering will more and more rely on society, economy, environment, laws and culture background; engineering training includes design, manufacturing, operation, construction, development, management abilities in accordance with modern industrial production level, includes training of innovative spirit and comprehensive capacity in accordance with level of
modern sci-tech development; includes cultivation for quality consciousness, safety consciousness, competitive consciousness and cooperative consciousness in accordance with market economy. Characters of a researching university decide target to cultivate talents, which is talents with creations, including pioneer international views, strong innovative consciousness, science-based knowledge structure, comprehensively practical capacity, team and cooperative spirits and capacity of communications and exchanges.

2. Construct Teaching System and Environment to Cultivate Mechanical Engineering Innovative Talents

School of Mechanical Engineering of SJTU has made full use of resources and advantages of school to construct teaching system and environment, focusing on the comprehensive capacity cultivation of modern mechanical engineering. The key of teaching has been transferred to pay more attention to cultivating comprehensive capacity, establishing study model of exploration and research, cultivating study interest, developing study capacity and creating research and discussion atmosphere from simply imparting knowledge as the major.

2.1. Platform and Modularizing Design of Curriculum

Using the model of famous overseas universities for reference, taking the advantage of Shanghai Jiao Tong University cooperating with the University of Michigan to reconstruct mechanical engineering school, keeping the tradition and characteristics of Jiao Tong University, we reconstruct the mechanical engineering academic platform of innovative talents cultivation with wide and solid base and interdiscipline, regarding engineering theory and engineering practical education as core of the platform. The platform covers five undergraduate programs: mechanical engineering & automation, thermal energy & power engineering, industrial engineering, nuclear engineering & nuclear technology and aeronautical & astronautical science & technology. Under these programs, there are 12 specialty directions: mechanical design and manufacturing, vehicle engineering, mechatronic engineering, manufacturing of micro-electro- mechanical systems, plastic deformation engineering, power mechanical engineering, refrigeration and cryogenics engineering, thermal engineering and etc. We recruit students according to the general concept of discipline, during the undergraduate period, we take the“2+1+1” education model. That is, during the first two years, all the students take the same courses. Until the third year, they choose different degree programs, and the fourth year, different specialty directions. By
choosing different courses of the platform and modules, students can satisfy the cultivation task and specifications of different programs. The platform focuses on general education concept, including five modules: humanities and social sciences, core subjects, program subjects, technical electives and practical sections; Construct a series courses of mechanics and thermal dynamics, design and manufacturing, information and control, engineering management and market and environments; technical electives are mainly composed of theoretical courses of different specialty directions and free electives to whole school students.

2.2. Reinforce the Construction to the Technical Electives with the Latest Technologies

For example, for vehicle engineering specialty direction, because sedans development becomes main trends in modern automobiles, we also constantly adjust the courses. In recent years, we have successively construct elective courses of the latest development of automobile engineering, automobile and environment, automobile and energy sources, as well as autobody manufacturing processes and so on to expand views of students. At the same time, we integrate scientific research result and experiences of teachers into teaching and activate great enthusiasm of study and exploration as well as cultivate engineering consciousness of students by using sci-research result to enrich teaching contents.

2.3. Pay Attention to Cultivating Capacity of Engineering and Improving Teaching Methods and Means

We opened teachers’ views and improved their teaching methods and means through introducing original English textbooks, training the junior faculty by sending them abroad to attend in advanced studies and learn teaching experiences, as well as attending long-distance lessons. During teaching, we embody engineering background and pays attention to students’ engineering capacity. It makes students learn to abstract and analyze the problems according to engineering phenomenon or testing data to find out the essence of problems. According to their own experiences and knowledge accumulation, teachers instruct students to study effectively, cultivate students’ interests of study and scientific and precise spirit, develop capacity of study and train engineering capacity.

3. Construct Engineering Practical Section with Research and
Enhance Cultivation of Engineering Diathesis

3.1. Supporting by the main enterprises of Shanghai Automotive Industry Corporation (Group), we set up the off campus classroom of engineering practice and provide internship opportunities to the students

As an automobile manufacturing base, Shanghai has very good industrial background. ME School of SJTU established steady partnership with Shanghai Automotive Industry Corporation (Group), Shanghai General Motors, Pan Asia Technical Automotive Center Co., Ltd., ZF Group and etc., which provide professional internship opportunities to the students.

College instructors and enterprises’ instructors worked out together the detailed internship instructions and plans for the students. Students made full use of their summer vacation to internship. Three to five students worked as a group to involve in the production and operation activities of enterprises as assistant technicians or probation engineers. They were supervised by both college instructors and enterprises’ engineers.

Students were distributed into different technical departments of several automobile enterprises to practice their excellent professional skills and comprehensive diathesis and gained very good evaluations from enterprises. Some students trained the new software and optimized the layout of manufacturing line (students grasped the new software faster than employees of enterprises); some students assisted work of functional evaluation team of manufacturing engineering department, they deeply understood the meaning of functional evaluation and learned the essential methods of measurement and evaluation; some students accomplished a new testing list and evaluated the L-CAR in roads test according to the relative data from headquarter of North American General Motors Corporation and investigation report of J.D.POWER. They hereby gained the title of “Excellent Trainees” issued by the department; Some students cooperated to work out operating software, which was put in use by the department.

Organic combination between engineering theory and practice helps cultivate comprehensive engineering diathesis of students. By their first-hand practice experiences, students knew how to solve real-life problems by the theories and knowledge they had already learned. So they become inquirers of knowledge from accepters of knowledge. Their capacities of creation, discovery, cooperation and their
interests of scientific research were greatly cultivated, their practical skills and views of science were greatly enhance. At the same time, the real-life engineering practice makes students understand the society better, substantiate their thoughts, improve their skills and strengthen their social responsibilities.

3.2. Reform and Reconstruction of Practical and Experimental Sections inside the university

ME School of SJTU strengthened construction of experiments and practical sections using the state funds of “211” and “985” Projects. For example, because of the widely application of information technologies in design and manufacturing of automobiles, as well as rapid development of automotive electronics, we added experiments and projects in information and control aspects for vehicle engineering students, trained them to grasp the core technology of electromechanical integration. During experiment courses, we reduced validating experiments, increased experiments with design, synthesis and innovation, such as CAD/CAM experiment, application of commercial engineering software, comprehensive experiments of mechatronic control theories and technologies, which trained students in experimental methodologies, process design and technologies, cultivated comprehensive practical capacities of engineering.

3.3. Realize Integration and Improvement of Knowledge and Capacity in Diploma Projects

Diploma project is the final phase of undergraduate education, an important process of sublimation for all learned knowledge, it deepens the combination of study, research and practice and is the key to cultivate all-rounded diathesis and innovative capacity.

The faculty of ME School of SJTU has made full use of their research strength. Supporting by manufacturing enterprises of Shanghai, they suggest design projects which are related to their scientific research with instructors from enterprises. Students can not only apply all they learned into practice, but also know some latest information in the said fields and know what they should improve in their further study. Using real-life engineering problems as students’ diploma projects can promote the combination of theoretical study and engineering practice; students are trained to solve real-life problems with professional method. Through team work, students’ learn how to cooperate with others.

For example, one thesis project about the research of real-time control system of
welding and assembly line was sponsored by Shanghai Volkswagen Automobile Company, Ltd. Students went to enterprise and did customer survey, analyzed phenomenon, put forward the design requirements, set up mathematical models, did simulation and experimental validation. During the whole procedure, they cultivated their capacities of engineers. Especially when students saw their efforts had improved the efficiency of production, they were greatly inspired and then became more interested in scientific research. After they graduated, these students decided to go to graduate school.

3.4. Implement Double-Tutorial System between School and Enterprise to Offer Space to Students for Their Individual Development

Besides instructing course selection of students, college tutors also offer students opportunities to involve in research and innovative activities, they introduce research method, key technologies and transform of research achievement to students. Professor Lin Zhongqin from Technology Center of Autobody Manufacturing, gave a presentation about “Autobody Manufacturing Technology” to students, taking modern technology of autobody manufacturing as topic, analyzing situations at home and abroad and introducing in details about exploration and innovation of vehicle engineering in the field. Students also participated research group of tutors studied and did research work with graduates and PhD candidates. The academic environment cultivated sci-research interests and capacity of students.

Tutors of enterprises pay more attention to introducing rapid development and demands for modern manufacturing industry, advantages and weakness of Chinese manufacturing, requirements of knowledge, diathesis and capacity to students from enterprises. They offer engineering background to students, suggest thesis projects to students according to demand for real production and scientific research, and instruct students to improve engineering sense and capacity in the sections of internship and thesis project.

Through four years’ successive practice, we improved comprehensive engineering diathesis of students and advanced the cultivation of engineering capacity in all aspects.

4. Advance Engineering Diathesis and Comprehensive Capacity of Students
Through overall training and cultivation, engineering diathesis and capacity of students have obviously been improved. The following contents are taken from the reports of students’ internship:

**4.1. Establishing career goal based on development of Chinese national automobile industry**

Learned to position right in the job market: Production practice can help students to transfer their career goal to realistic from ideal one. Through practice, students are involved in the operations of enterprises at their early stage of study, so that, based on their own conditions, students can have a realistic picture and plan for their career in their future life. In the process of practice, students feel thirsty for working, enthusiastic to work and self-satisfied with achievements. Within two months of practice in industry, students have never wondered around, paid no attention to anything worth to, like they did in the past, but have totally new meaningful feeling about their life and work. In the practice, I also deeply realized my lack of knowledge; knew what to do and what to learn for the next semester.

Learned basic principles how to make yourself a good person: Through practice, we learned what it really means by seriousness, humbleness, broad bosom, optimism, enthusiasm, charity, diligentness and thriftiness. Actual enterprises’ lives give a vivid lesion to us as no-experienced students.

**4.2. Unlimited development of knowledge, capacity and diathesis**

Study in engineering practice: Engineering practice allows students deepening theoretical knowledge learned in classroom, getting first hand experiences on first-class manufacturing technology, advanced production management and complete control system, which makes students deeply understood that study cannot be limited only to book knowledge, but also should include the latest techniques and advanced technological development. In the past, students felt it like an idiot when studying automobile structure and automobile theory without any experience for automobile, but now feel very realistic in the practice.

Study with Exploration: Practice needs to integrate team work, multidiscipline, from question to solution, needs students to apply their theoretical knowledge and skills, needs initiative study and hard working. In practice, students may work in the fields they are familiar with or not; but in any cases, it is necessary for them to understand the concrete circumstances of enterprises. They thought they could use the knowledge learned from books in the practice right away, but found that to solve the practical problems in daily operations of an enterprise needs much more knowledge
and skills than they learned. Problem solving in practice requires us continuous studying and researching. Students have showed their strong motivation of study by consulting with experienced experts and published materials, and apply them right away in practice.

4.3. Increase innovative consciousness and capacity

Cultivate innovative consciousness in practice: Shanghai automobile industry has quickly been developed due to hard work and innovation; Advanced management methods and concept of enterprises embody the constant innovative spirit of enterprises. In the course of practice, students realized that advanced manufacturing technology is developed based on continuous improvement and optimization. This observation motivated students to study the advanced courses and gradually cultivated self-study capacity by summarizing practical knowledge with consciousness.

Advance innovative capacity in practice: in the course of practice, students tried to combine the separated and shallow theoretical knowledge from classroom and practical knowledge in practice for creation; for example, students can shorten working time of one-third by using symmetrical methods to measurement of parameters; they can put a tedious data design by systematic method. Even if for some trivial tasks, such as document management, students also tried to figure out the best ways to greatly improve efficiency to store files.

4.4. Intensify Cooperative Spirit of Team Work

Learn Cooperation: In today’s fast development of scientific technology, creation of any new product and new technology of one enterprise is a result of collective cooperation of many different disciplines and persons. Every person will know their characters and then exert capacities of self-design, self-creation, self-optimization and self-organization. In the course of practice, students need to constantly adjust themselves to adapt to the whole and cooperation with others, mutual support and mutual cooperation, which is embodies by classmates deeply. For example, in 2004 summer holiday, in practice of Shanghai General Motors Co. ltd. Student Xu Shuo finished two systematical programs and formally put them into use in practical department before the end of practice. When summarized practice, he said that software program was product of collective wisdom; firstly, they are result from my cooperation with another classmate; initially, we didn’t know anything about software, also confused with the functions of the software and the need of the system for the software. We try to figure out this little by little though practice. When we were programming, one person with clearer mind in charge of coding and another person checked, revised and improved the code. If two persons have different ideas for the
programming, they worked their own codes then compared each other. That’s to say that if there is no two persons team work with good faith and cooperation, any of us can’t develop the software for theses two systems. Secondly, two systems are result of collective efforts by all classmates. If they can’t point out our leak, if they can’t put forward all kinds of requirements, if they can’t put forward all kinds of rational suggestions to us, it is impossible for us to reach the level of our system.

Learn Communications: In practice, student must learn exchanges information in engineering language and also study to communicate with teammates, which is no way to learn in the classroom. Some students said that through PDCA methods of enterprise, they greatly improved presentation skill. At the end of internship, the enterprise evaluated students by giving grade; one student got “average”, much lower than his won estimation. After his self-criticism, he frankly communicated with the person in charge and eliminated the misunderstanding between them. Although he didn’t change grade of enterprise, student felt that he had much harvest from the internship.

5. Achievements of university-industry cooperation

5.1. Among students with internship in major programs of vehicle engineering, near 50% were employed by backbone enterprises of automobile industry after graduation. All graduates have broad vision, good spirit of team work and reinforced knowledge. Because they received systematical engineering training in enterprises, they showed good study ability and capability to solve real world engineering problems. Good engineering diathesis makes those students stronger market competitiveness and adaptive to bear responsibilities in their work. Those students are welcome by enterprises and appreciated with their great potential.

5.2. Every year, more than 20% students continue study for higher degrees and become important sources for graduate study; Due to their solid foundation from their undergraduate study, after graduation, most of them are employed by Shanghai Automobile Group and become backbone of R & D and production management.

5.3. Production practice and the final project for thesis fully reflect university-enterprise cooperation and partnership among education, industry and research institution. This gives students sufficient opportunity to obtain necessary engineering experiences. University and professors broaden research and application fields, and enterprises also can resolve some problems encountered in their production and development. The multi-win situation benefits all partners in the cooperation, so all partners agree to set up permanent engineering practice bases for student internship. Shanghai General Motors Co., ltd sufficiently recognized this cooperation as
successful model, and they increase the position for student internship to 75 in 2005 from 36 students in 2003; Tens of enterprises affiliated to Shanghai General Motors Co., Ltd are benefited from this university-enterprise cooperation model by recruiting selected students as future technological backbone of enterprises.

(1) Enterprises can make right judgments on students’ potential and attitude towards work through working period of internship, so enterprises would like to contact students at early stage of education to know the students better. They also would like to share the responsibility in cultivation process for talents, and make their contribution with financial resources, human resources and material resources.

(2) The university-enterprise cooperation gives student opportunity to get to know enterprises during their study in university. This privilege allows them to contact enterprises earlier than other candidates for job, so they are motivated to study and work harder for future career. Through practice, students can easily find their shortcoming, can learn allot of good habit which will benefit them for future study and career.

(3) The university-industry cooperation can improve the quality of engineering education and provide high quality talents to industry, can pave the way to transfer the results of fundamental research and key technology development to industries for higher productivity and industrial innovation, therefore can meet the challenge of globalization of both economy and education.
Innovative Administrative Mode: Accelerate Transformation of Fruit, Promote Development of Knowledge

——Practice and Probe of “Academic Based Company” in Central South University

Tang Xinxiao
Central South University, Changsha

Abstract: Combined with the construction of scientific and technological park of national universities, Central South University has made a series of innovations on its system and formed innovative mode of “academic based company”. This paper introduces formation of this mode, summarizes the important role which it plays in arousing the enthusiasm of technicians, in attracting capitals, in promoting the transformation of fruit to industrialization and academic based construction of university, and also shows the achievement in recent years.

Since Ministry of Science and Technology and Ministry of Education promoted the construction of national university scientific and technological park, our university has made a series of innovations on our system according to our own concrete condition, and has gradually formed the innovative mode of “academic based company”. The main character of “academic based company” is: on the basis of the academic discipline advantages of our university, we establish scientific and technological enterprises with social investor evaluating our fruit of scientific research to buy a share. And in this way, we make full use of modern corporate system to carry through more efficiently the fruit transformation and the industrialization of high-tech, and promote development of our academic based construction as well. On the mode of administration, our professors, who are responsible for technical guidance or organizing R&D, usually hold the post of directors in enterprise or technology chief inspectors. The general manager, who takes charge of organizing production, marketing, and daily affairs, is appointed by investors or both parties together. Our five years’ practice proves that the mode of “academic based company” plays a more and more important role in the activation of university’s resources, optimizing resource distribution, fruit transformation, industrialization of high-tech, academic discipline development, and so on.

Firstly, we sparkplug people foremost, and pay attention to
“Academic based company” builds a new mode for starting a business.

In the first place, the cognition of “three most wastage” establishes the ideological foundation of “academic based company”.

In virtue of long time’s bondage of traditional ideas and system, the immense intellectual and technological resources of our university have not been activated completely. To some extent, current scientific and technological system restricted our university's work, especially the scientific and technological fruit transformation and development of high-tech industrialization. After nationwide conference on technological innovation, according to construction of scientific and technological park in our university, we had a concrete discussion on how to efficiently activate our intellectual and technological resources and how to form an effectual innovative technological system and guarantee state properties. Finally, we arrived at agreement: the most wastage of human resource in university is that scientific and technological personnel lacks enthusiasm of R&D; the most wastage of intangible assets in university is that scientific and technological fruit cannot be transformed efficiently; the most wastage of tangible assets in university is that we do not make full use of experimental equipment.

The cognition of this three most wastage liberated the mental restriction of our teaching and administrative staff, and established benign ideological foundation for fruit transformation, high-tech industrialization and formation of “academic based company”.

In the second place, the policy of scientific and technological personnel as individual shareholder built the producing environment for “academic based company”.

As the development of state restructuring economic systems, the role that university plays in the strategy of developing the country by relying on science and education has improved a lot. Previously, our university bore project of scientific research and strived for scientific achievement. While nowadays our university strengthens transformation of scientific and technological fruits and high-tech industrialization. How to arouse and protect the enthusiasm of scientific and technological personnel has become an important problem for us to solve. So according to some national policies, our university drew up Central South University managerial measures on becoming a shareholder of technology. We distributed our technical stocks mostly to relative scientific and technological personnel. The publication of this policy has broken through the subordinate status of scientific and
technological personnel in the long-term profit distribution. It shows our socialist principle of distribution on the basis of labor and our value of “people foremost”. Through this modern system of property right, we have not only materialized the intangible assets of university to increase our contributions to society, but also protected the deserved profit of scientific and technological personnel by laws. This measure has also greatly aroused and protected the innovative enthusiasm of our scientific and technological personnel. All these built a benign environment for “academic based company”.

In the third place, “one academician group” promoted the high-tech industrialization in our university.

Now there are 15 academicians in our university. For decades, working diligently, these academicians have undertaken many great scientific research items and obtained a lot of important achievements. They contributed themselves to the construction of country and development of our university. Estimably, when our country carried out the strategy of developing the country by relying on science and education and required further fruit transformation and high-tech industrialization, they again led our university to high-tech industrialization. In recent five years, there are 8 academicians in our university investing scientific products and making them industrialized. For example, Prof. Huang Boyun, an academician in Chinese Academy of Engineering, led our academic group to set up a academic based corporation——Hunan Boyun New Material Co., Ltd. For five years, they have produced almost 50 kinds of new products dominated by “brake material”. Except some domestic urgent needs of aviation and spaceflight, some products have been exported to western developed countries like Russia. And in order to meet the further demand of country’s development, national Committee of Development and Reform has classified “aviatic brake material of high-powered charcoal” and “automobile brake material of high-powered environmental protection type” into demonstrative projects of industrialization. The successful industrialization of the former one made our country become the fourth country in the world which has the ability to produce this material. And then in 2004, this project won the first prize of national technical invention, which broke through six years’ vacancy of this prize. At present, the corporation has constructed a high-tech industrial group in Hunan Province, and has a potential future.

In one word, under the guidance of our academicians and on the basis of our academic discipline superiority, our group of academic discipline buys a share with technical fruit and cooperates with social investors, which raised an innovative upsurge and promoted the healthy development of “academic based company”.
Secondly, we strengthened the elements combination, promoted fruit transformation, and made “academic based company” become a new growth point of regional economy.

In the first place, “academic based company” provides a good implementing carrier for the combination of knowledge and economy.

With the development of human society, knowledge becomes the most pivotal production factor. And the combination of science and technology and economy is a social tendency. Nowadays, if a university still restricts its scientific and technological activities on campus, knowledge will not be able to become the key production factor. However, under traditional system, despite that enterprises needs the new technology of university to explore new product, they dare not to invest blindly due to lacking of digestion to new technology. While due to lacking of exploring funds and abilities to exploit market, the new technology of university can but be outside market. All these lead to the separation between knowledge and economy. And in this sense, “academic based company” not only has high return rate brought by high-tech to attract social capitals, but also has modern enterprise system to realize the efficient combination of talents, technology, capitals, and administration, etc. For example, on the basis of academic discipline of metallurgic physics and chemistry in Central South University, university cooperated with social investors by providing technology to set up Hunan Ruixiang New Material Corporation, Hunan Shanshan New Material Corporation, and Hunan Haina New Material Corporation. Since 2001, these corporations have successively realized the industrialization of nearly ten kinds of advanced battery materials, such as lithium cobaltate, CoO4, and so on. In 2004, they realized sales income about 600 million, taxes about 67 million, and many products were exported to international market. The amount of exporting reached 5 million dollars. And these corporations provide more than 650 posts and maybe become the industrial base of energy materials in Hunan.

In the second place, “academic based company” has greatly shortened the industrialized period of high-tech.

In the past, due to lacking of some middle experimental conditions, our university has difficulties in enlarging research scale of some research fruits, and many fruits have to be rested on the lab. This condition delays the time of development and transformation. Through the enhancement of ability to do scientific research, the investment of social capitals and U-I cooperation, “academic based company” provides great advantages for the middle experiment and extending experiment of research
fruits. It makes our scientific and technological fruits more perfect and mature. And it
greatly shortens the industrialized period of our high-tech. In recent five years, our
university made full use of “academic based company” and realized the transformation
of research fruits. For example, relying on electromechanical engineering in our
university, we set up a “academic based company” ——Hunan Shanhe Intelligent
Machine Co., Ltd. (set up in December, 1999, and completed reconstruction in 2002).
For five years, this corporation has published about 30 new products with independent
intellectual properties, realized industrial increase exceeding 1 billion yuan, and turned
in taxes nearly 50 million yuan. In 2004, the total value of sales reached 360 million
yuan. At present, the demand of products exceeds supply in the international market.
And it is assumed that the amount of exporting will reach 10 million in 2005. Besides,
the corporation provides about 700 posts and now has become a leading enterprise of
advanced manufacturing in Hunan.

In the third place, “academic based company” provides new running mechanism
for transformation of technical fruits.

For years, there exists a perspective in government and society that the
transformation rate of technical fruits is low. Despite that it cannot be completely due
to university, the lack of efficient transformational mechanism restricts our
transformation of high-tech fruits. While “academic based company” was set up on the
basis of modern corporate system and was operated according to industrialized and
marketized mechanism. So it provides a good transformation mechanism for high-tech
fruits. For example, “the computer intellectual illegible control system” in our
university was explored aiming at controlling the process of aluminium electroanalysis,
whose application can bring remarkable economic benefit to industry of aluminium
electroanalysis. In the face of upgrade reconstruction of control system of about 8000
electrobaths, our university found great difficulties in human resources, finance, and
market. But under the “academic based company”, our university has set up Changsha
Yexiang Scientific and Technological Development Corporation with social investors.
And at present, the corporation has the ability to produce 8000sets of intellectual
modules for measure and control and 2000 sets of intellectual controllers, and the
ability to provide after-sale technical services. The products have been applied in more
than 40 aluminium factories. And the direct economic benefit reached 700 million
yuan.

In recent five years, the 140 million yuan intangible assets of our university
dominated by technical fruits have brought about 750 million yuan financial
investment, by which produced more than 60 technical enterprises. Among these
enterprises, there are 6 enterprises with production value more than 100 million yuan
and 14 enterprises with some scale. In 2004, the amount of sales in “academic based companies” reached 1.5 billion yuan. There are more than 20 corporations obtaining various national or provincial praises for their achievements. And many “academic based companies shows their strong tendency of development, and becomes a new growth point in regional economy.

**Thirdly, “academic based company” improved our abilities to do scientific research, opened our mode of school running, and infused new energy into academic discipline development.**

In the first place, “academic based company” strengthened the foundation of open type mode of school running.

Today’s university is not a simple place just for learning and teaching yet. Talent cultivation, scientific research and social service have become an indispensable function of any university. Exerting the technical superiority of university to serve society and making full use of social resources to develop the mode of school running, is not only propitious for university to contribute itself to society, but also benefits the development of university. “Academic based company” makes the conception of “knowledge capital” and “innovation” acquainted by teachers and students. And it provides benign mental foundation for open type mode of school running. “Academic based company” provides more abundant contents of research subjects and more financial supports for talent cultivation, especially for graduate students. And it also strengthens the adaptability of our students. For example, Hunan Shanhe Intellectual Machine Co., Ltd. provided 40 students of relevant majors with an innovative platform, and Hunan Ruixian New Material Corporation provided 30. Moreover, “academic based company” broadened the contact channel between university and society, enlarged social influence of our university, increased social investment to our university, and provided benign social environment for our open type mode of school running.

In the second place, “academic based company” improved our ability to do scientific and technological research.

Through the better guarantee to the interest of scientific research personnel and the enlargement of fruit transformational approaches, “academic based company” greatly inspired the enthusiasm of our teachers to take part in scientific research. Our university cooperated with social capitals and also accumulated capitals by the corporation we set up. By doing so, our ability to do scientific research has been
improved greatly, and some problems in choosing subjects, looking for cooperative colleagues, and raising funds for research and exploration, have been solved. For example, our study on mineral processing has remarkable academic discipline superiority. And for years, we commit ourselves to the study on it. Although we have obtained some achievements, the demand of high investment on technology restricted the further development of this study. After we carried out “academic based company”, depending on this academic discipline, we set up Changsha Guanhua Biochemical Industrial Technology Corporation. In recent years, the corporation invested and built mining and metallurgical and biological engineering building, and added a great deal of equipments and instruments. All these upgraded our ability to do researches and develop study. Since 2000, this academic discipline has been given many financial aids by country, and has obtained many nationwide prizes.

In the third place, “academic based company” promoted the development of academic discipline construction in our university.

“Academic based company” enhanced the whole strength of academic discipline, extended its social influence, and strengthened the construction and development of academic discipline from several aspects. For example, our electromechanical academic discipline is originally not main academic discipline in our university. While in the process of carrying out “academic based company”, this academic discipline cooperated with several domestic large-scaled aluminum processing enterprises and set up Changsha Shenrun Scientific and Technological Corporation. Through reorganizing a non-profit-making unit along the lines of an enterprise to ensure a steady income, the corporation accelerated industrialization of technology on aluminium alloy, and on this basis became the center of preparation technology and equipping work in Ministry of Education. The teachers in this academic discipline set up Hunan Shanhe Intellectual Machine Co., Ltd. And this corporation has undertaken and completed National Program 863 and was conferred as “National Program 863 industrialized base of intellectual robots”. Another corporation that set up by teachers in this academic discipline was named as Hunan Zhongda Chuangyuan Numerical Control (NC) Equipment Corporation. It also realized the industrialization of some advanced technologies. These successful innovations of base construction and high-level projects greatly accelerated the development of our academic discipline and increased the status of our academic discipline. And in recent years, the academic discipline of “machine design and theory” has become national key academic discipline. Now we are reporting it as national engineering research center to higher authority.

Since five years of carrying out “academic based company”, the scientific and technological outlay of our university has increased rapidly. In 2003, it broke through
500 million yuan, and in 2004, it reached 600 million yuan. And also in 2004, our university has obtained 8 kinds of scientific and technological prizes. In 2005, six projects of our university have passed the second round comments and examinations of national scientific and technological prize, and have won two projects. So we can easily see that “academic based company” not only increases contributions of university to society, but also infuse new energy into university.

Today, we have entered a new epoch. In this epoch, knowledge economy will be sufficiently developed, the conception, function and status of university will be reconstructed, scientific and technological work in university will be confronted with opportunities and challenges. We know that “academic based company” of our university is still immature, and needs guidance of leaders and other universities to improve and perfect ourselves. But we believe that insisting on “people foremost” and system and technical innovation, Central South University can certainly coruscate more energies, start new phase of scientific and technological work, and do more contributions to the construction of national economy.
University and Industry Cooperation: the Way to Cultivate Software Talents in New Era
Lu Wei, Li Hongmei, Sun Haishan
Beijing Jiaotong University School of Software, Beijing

1. Introduction

In recent years, China’s software industry scale keeps on increasing steadily, and the industrial team keeps on enlarging, both with a percentage above 30%, primarily forming a set of software key enterprises with an annual sale over billions. However, incompatible with the high-speed development of software industry, the structural problem of software talents stands out. There is critical shortage of software talents at different levels including high-end, inter-disciplinary, international, and software applications in traditional industries. Software engineering education can hardly meet the demands of software industry development, information technology applications and informatics construction.

China encourages the partnership between industries, universities and research institutes for promoting the software talents cultivation. As we all know, software industry is different from other industries. Its specialty lies on that producing of high-end technology and forming of advanced knowledge are not carried out in university labs, but in software enterprises. It is the industry that paves the way for software engineering research. Software enterprises are not only the manufacturing site of the industry development, but also the places for research. The talents trained by universities need to be transferred into productivity through enterprises ultimately. Therefore, our School of Software Engineering has to cooperate closely with software enterprises, speed up the cultivation of software talents and the construction of teaching staff, and establish software education practice bases or software talents training base to develop software education and service. In important programs and scientific research projects, colleges and enterprises will tackle key problems together and train excellent software talents during implementing the projects, putting forward the new education model as “Take Industry Needs as the Goal And Train Software Talents with Joint Efforts of Schools and Enterprises”.

2. Effectively Making Use of the High-qualified School-running Resources, And Establishing Software Talents Training System
We take efficient use of Beijing Jiaotong University’s advantages in electronics and information science, as well as the abundant teaching and researching resources in School of Computer Science and Engineering. Learning experiences from some advanced foreign universities as reference, we establish the following talent training system for our society and enterprises:

2.1. Making use of the university’s resources, targeting right market for talents, and training highly qualified international applied software talents

Since the establishment of School of Software, we treat it as the goal to train high-qualified applied software talents with international competitive capability. The teaching mode of training students’ researching and practical problem-solving abilities is our core competitiveness. We put our emphases on the training of project talents instead of computer science research. Facing plenty of training modes in Chinese software vocational colleges, we think that talents trained in software colleges should not only be specialized in skill, but also have strong theoretical foundation and the innovation ability.

Beijing Jiaotong University (BJTU) enjoys the academic advantages in electronic information engineering and transportation among Chinese universities. The computer science program in BJTU has a long history and is abundant with teaching and researching resources, which have been used for basic education of undergraduates and graduates, cooperating with enterprises, with strong theoretical foundation and the project innovative ability.

2.2. Establishing the new mode of training software talents through college and enterprise cooperation

A common mode of university-enterprise cooperation for software education is that enterprises invest capitals for facility of campus and colleges provide working staff and place. This mode meets problems from different sides during implementing. First, shareholders of enterprises consequentially focus on the profits of their investment, which is very different goal from the intention of software talents training. In this way, though colleges have less financial burden, but it does not worth the candle. Second, colleges realize that the value of software enterprises lie not only on the powerful economic strength, but also on the valuable technical resources, practice opportunities and new ideas. The cooperative enterprises cannot be restricted to one or two companies as investors. Instead, we should find more software enterprises to work with
their wisdom. Taking the leading role by university side, we make proper use of these
technical resources to run our School cooperatively.

Currently, we have three cooperative modes:

(1) Holding school enterprise cooperation seminar regularly, discussing the training
direction of software talents and the construction of practice base, and inviting famous
experts in this field to be commissioners in teaching guide committee of School of
Software. Now, we have 21 cooperative partners inside and outside the country,
including Microsoft, Hp, SUN, Digital China, and China National Computer Software
and Technology Service Corporation.

(2) Sending teachers and students to attend enterprise training, and bringing the
training contents to school classes; inviting senior technical experts or managers in
enterprises to be our teachers. For example, adding the HP OPENVIEW training
contents into network curriculums after receiving the training; adding the SUN training
contents into operating system classes after receiving the training. Now we have 60%
of the specialized course taught by invited teachers who undertake the high-tech and
practical courses.

(3) Building labs and students practice base together with enterprises. We use the
donated hardware and software as well as technicians to build labs, such as HP
network labs, Digital Art Lab. Besides, we build students practice base with famous
software companies, such as Digital China, UFIDA, CVIC SE, Worksoft Creative
Technology Ltd, and Ensemble International.

2.3. Establishing software talents training bases, and training software
talents according to needs of local economy and industries

At present, our School builds student practice bases with software enterprises in
Chengdu and Suzhou respectively. The training bases can hold about 100 students for
centralized training in software engineering and digital arts. Centralized training focus
on enterprise’s projects in a real production environment. And the workflow is
controlled by enterprise engineers. Students are trained to increase their researching
and working abilities in actual projects. Our School also trains software talents at
different levels according to customer’s needs, such as Master of software engineering
for software project management and inspection, which is particularly needed to solve
the problem of information talents shortage in large enterprises.

2.4. Strengthening international cooperation, and exploring the new
method to training international senior software talents
Cooperating with Carnegie Mellon University in USA, School of Software imports a whole set of software engineering curriculum system of CMU, which enjoys a high reputation in this field. This system puts practice in theoretical study in order to improve students’ ability to apply theories in solving actual problems.

School of Software also adopts the computer talent training ideas of Waterloo University, whose computer program ranks first in North America. The model is called Co-op education, and the basic arrangement for co-op students is to switch in between the industry and school for every 4 months for working and studying within total five years for undergraduate study. In this way, students experience a rebirthing process when they study at school again after working in industry. Therefore, their adaptive and working abilities are much higher than those of students only studying in classrooms in other schools. Now, constrained by our university management system, this model cannot be implemented in our school. However, we have figured out an innovative way to carry out actual practicing education cooperated with enterprises as the following. Students finish their undergraduate courses in the first three years. They have enterprise projects practice in the last three weeks in each term from their second year study. Junior students carry through a totally enclosed type of actual practice in software industry for 40 days. At the last stage of training, we require that students must accomplish six-month enterprise practice during which they have to finish their thesis for degree. In graduate education, adjunct professors from outside of the school are enough to offer help, and the training experiences are considered as complements of class study. At the same time, students have to finished an applied software project in enterprises, and then come back school to summarize and finish their thesis. Hereby, we achieve the teaching mode of study-practice-summarize-restudy-re-practice. And it turns to be much better than the previous practice education we had before.

3. Setting up an active and interactive dynamic curriculum system and deepening the teaching reform

3.1. Setting up an active and interactive dynamic curriculum system

School of Software sets up three different training programs of Bachelor, Master of Science in Engineering and Master of Engineering in the field of software engineering. We make the training plan according to the development of software industry, at the same time impenetrate lectures on the front edge technology all through the teaching course, and train the students with strong theoretical foundation, software design development ability, project organization management ability and foreign language
speaking ability. However, because the software industry develops so fast and the new techniques, theories and thoughts update even faster, the curriculum system and training plan we set down just now may fall far behind the industry by two years. This is also a realistic and serious issue. Then how to solve it? We propose an idea to set up an active and interactive dynamic curriculum system. First, “active” means we are not restricted in universities. Instead, we must actively seek for new ideas and thoughts, actively serve for enterprises and find out their talents demands. “Interactive” means we must negotiate and discuss with enterprises on the collected information, and design the curriculum system and training plan together. We work together with enterprises and hold school-enterprise cooperation fairs regularly. Till now, we have held two school-enterprises cooperation fairs, and modified the curriculum system in time according to the discussion on talent knowledge structure. As we are updating the curriculum system constantly, we can guarantee that the system keeps pace with the industry development.

3.2. Introducing and Actively Spreading Advanced Teaching Programs and Curriculums

The school uses advanced thoughts and methods in software talents training for reference and connecting them to its own teaching scheme. It has successively introduced curriculums, lectures and experiments from abroad and invited foreign teachers from America, India, Ireland, Australia and other countries. In 2005, the school imported a complete set of software engineering teaching program from Carnegie Mellon University in USA. For a long time, it invites two Canadian teachers with rich experience in software engineering teaching to give lectures in the school.

3.3. Innovating Educational Ideas and Promoting New Teaching Methods

Teachers of the School of Software Engineering are required to use real cases in project teaching, analyze and summarize successful and unsuccessful cases collected from cooperative software enterprises, and finally, apply them in classroom teaching. By exercising project training advocated in all practice teaching program, and making students participate in team project or personal project for the purpose of better understanding the whole procedure of software development, the school has set up proper work norms and deepened the students’ understanding of what they have learned. Meanwhile, we try to popularize bilingual education and directly use foreign teaching materials and courseware in teaching, inviting foreign teachers to give
lectures to students. At present, about 50% specialized courses of the school are bilingual courses or operated by foreign teachers.

3.4. Strengthening the Teacher Team

Quality teacher team is a foundation for software talents training and the lifeline of our school. By cooperating with enterprises outside, we have succeeded in building a quality teacher team. Firstly, we advocate the share of teaching resources in computing and other specialties including basic subjects set by the university, and have arranged out-of-school teacher training for 20 times; Secondly, we invite experts from influential enterprises both at home and abroad to take the position of part-time professor or visiting professor; Thirdly, we invite foreign technicians and teachers to conduct short-term courses and give technical lectures to students. So far we have sent over 20 teachers out to receive qualification training and training program in software engineering.

4. Building Practical Environment and Enhancing Practical Ability of Students by Developing Software Project.

Software engineering is a science with strong practicality, which needs frequent operations in learning process. In order to assure the quality of experimental learning, we have created many kinds of specialized learning situation for students.

4.1. Building Good Practical Environment and Strengthening Practical Ability Training for Students

The school has invested 3 million RMB to build up a practice teaching base of 400 square meters for students to use for free, using a software system worth over 10 million RMB presented by Intel, Microsoft and HP to establish a company-style practice teaching platform. At present, the school possesses a software engineering complex lab, a digital art lab and a software project training lab. We take the reference of operational environment of software companies in these labs and build a real developing environment with operational procedure like that in software companies. In particular, we follow the open mode of labs of Microsoft, so as to make these labs convenient for students to use. Presently, the three labs are available to students for 14 hours a day, even in holidays, with utilization rate of 80%.

4.2. Setting Up Practice Teaching Base in Enterprises So As To Enhance the Practical Ability of Students
The school has cooperated with such IT companies as Sun, Microsoft, Digital China, UFIDA to build 6 practice bases for engineering students. So far, about 200 students have been given the opportunity of doing practical work in these bases and taking part in the development of real engineering projects. In this way, they have improved their practical abilities much more than those who have got no such opportunities.

4.3. Setting Up Innovation Bases and Science Society for Students, in order to Cultivate Their Innovation Ability and Career Developing Ability

The school supports students to establish self-managed society in software engineering in an operational way of company, and help them invite exports from enterprises to act as their technical advisors. Among different student organizations, the Science Society has achieved a series of outstanding achievements and developed many excellent innovation teams of students. Its team won the 22nd places in the Digital Art contest in worldwide Imagine Cup (2005), a global contest held by Microsoft. The JAVA technical team won the third place in National JACA Program Design Contest. The wireless video monitoring system of bank developed by our contestants in Huaqi Cup Software Design Contest has been successfully applied to 3G application and registered at Patent Office followed by the registration of a company. The society has cultivated many talents with rich knowledge of both software technology and business operation, such as Zhou Juyue and Gong Xiaoming who have independently established the Qigou Electronic Business Co. Ltd.

5. University-Enterprise Corporation Mode for the School of Software

Since the commencement of the School of Software of Beijing University of Transportation, we have been investigating on more possible new modes of corporation between enterprises and the university. By far we have achieved an unique model of enterprise-university corporation. Centered on the Committee of Enterprise-University Corporation, we integrated strength of enterprises and university in an effort to provide guidance on reform of curriculum, to establish learning-by-doing education system as well as to enrich training experience of students. Figure 1 is to demonstrate the enterprise-university corporation system that’s carried out in our school.
5.1. Centered on the Committee of Enterprise-University Corporation, curriculum is developed on the most updated bases

**Attendance**

1. school: subject matter expert, faculties and teaching staff (once every two years)
2. enterprises: management staff, HR staff, and technical staff (once every two years)

**Topics**

1. expectation from enterprises on the students
2. Direction of theories of software industry that’s heading
3. Build up of training center at enterprises
4. Feedback from students after training and employment

The meeting of the Committee of Enterprise-University is held twice year, at end of each semester. Summarization of experience is accumulated and direction is set for the following semester. Four major topics are covered at the meeting:

(1) Discussion on the enterprise need of talented students,

(2) Discussion on the application of technology in current enterprises, theory on software engineering, and forward looking of technology development,

(3) Summarize experience accumulated at the training center of enterprises and effectiveness of teachers from enterprises,
(4) Summarize development of students of the school of Software after their participation in On-site practical training at enterprises.

Among the aforesaid four points, point one and two serve as the guidance of our short to mid term goal on student education. They are also useful reference when updating our curriculum in class and for On-site practical training. Combing the training experience and development of students at enterprises, the later two points are useful in determine effectiveness of our education system.

The Committee of Enterprise-University Corporation is made up of: representatives from school who are on duty teaching staff and administration faculties and representatives from enterprises who are management staff, chief of HR, and chief of technology. Our experience testified that all of the above mentioned three components from enterprise are important. Because:

(1) It is necessary for us to understand the goal and operating results of the enterprises so that the decisions from the meeting can be acknowledged by people from enterprises and can be carried out smoothly.

(2) It is important that we stay updated with the technology and development process being adopted by enterprises. This information comes from chief technology officers from the enterprises.

(3) We need support from HR Department of enterprises to arrange training, employment of our graduates and to be updated with the development of our students.

We were able to engage 87 experts from software industry to be our professors through coordination of the Committee of Enterprise-University Corporation. This highly professional team helped us to develop training courses and high-end classes and ensured the quality of our courses.

During our two years of teaching and training practice, we established our education system that’s closely following development of software industry thank to the support from the creative and informative organization: the Committee of Enterprise-University Corporation. Our education system introduced opportunities for our students not only to enhance their practical capability but also improved their knowledge on basic theories. According to our survey, compare with freshmen and sophomores of other traditional schools, students from the School of Software are more involving, creative, proactive, and better team player. Two years of application of the new teaching method in fundamental education brought us following achievement:

(1) Three first class academic papers are published by under graduate students.

(2) One winner in the contest of Mathematical modeling in the United States.

(3) Two winner of top award in the contest of Mathematical modeling in Beijing.

(4) Five winners of top award, nine winners of the second award, and twenty
winners of the third award in the contest of Mathematical modeling at school.

(5) First place winner of CET 4 and CET 6 in terms of passing percentage, highest score, and average score.

5.2. Set up of on-site practical training system through corporation between enterprises and university in light of advanced education concept from foreign countries

On-site practical training is the main component of our practical education system. In reference of “learning-working-learning” principle that’s adopted by the Computer Science Department of Waterloo University in Canada, we customized our own continuous On-site practical training program in consideration of our education system and On-site practical training project at enterprises. Faculties in charge of On-site practical training are all invited from our partner enterprises who are experienced in project management as well as technology management. Meanwhile, our partner enterprises also provide standards and materials in respect of organizing of teams, selection of project, and organizing of project from following four perspectives:

1. Semester end sum-up On-site practical training (20 days)
2. Concentrated, isolated overall On-site practical training (40 days)
3. Open On-site practical training on new technology and new theory
4. Other On-site practical trainings

On-site practical training is the main component of our practical education system. Participation of every student is required and is also integrated in the curriculum. This On-site practical training is designed to evaluate and summarize the curriculum developed for the semester. However, teachers from enterprises would not restrict the training to what’s included in the curriculum of that semester, they encourages students to learn new knowledge on their own and to obtain experience through the training.

(1) Semester end On-site practical training for 20 days starting from sophomores. Participation of every student is required and is also integrated in the curriculum. This On-site practical training is designed to evaluate and summarize the curriculum developed for the semester. However, teachers from enterprises would not restrict the training to what’s included in the curriculum of that semester, they encourages students to learn new knowledge on their own and to obtain experience through the training.

(2) Concentrated, isolated overall On-site practical training for 40 days at the training base of the Software Park at Chengdu starting from the second semester for third graders. This On-site practical training serves the purpose of overall summarization of what’s learned at school under isolated conditions. Students have to organize development team on their own to solve problems using knowledge they have mastered. This On-site practical training simulates the actual need on the market and also introduces real-world management mechanism of companies.

(3) Starting from second week of each semester, there is an open practical training
class on every Saturday, the topic is “New theory, new technology”. On every Sunday there is a forum “Students-enterprises”. The purpose of this open practical training class is to introduce the cutting edge new theories and new technologies into school in the first time and also to supply additional knowledge to those students who are capable of learning more than what school can offer. There is no grade difference in this class, it welcomes students from all grades, undergraduates or post graduates, as long as they are interested in and capable of learning. We would also like to attract graduates from our school who now work in the corporative enterprises to come back to this class. This will further improve the quality of our graduates, shift off burden on enterprises regarding continuous education, and also be helpful to pass the message to those coming graduates. At the Sunday forum, we invite those successful employees from our corporative enterprises to have face to face communication with our students to discuss development of technology.

(4) Other On-site practical trainings. First of all, for most of our classes, assignment at end of each course is to hand in a finished software which is directly related to the course. Secondly, there is a “New software development” project sponsored by the Committee of Technology, which is organized by students from my school. Students participating in the project may choose the direction of research in which they are interested, school will invite subject matter experts from corporative enterprises to give some guidance.

On-site practical training has turned the traditional in class practical training totally upside down. We have accomplished much more by implementation of on-site practical training.

(1) On-site practical training provided students with opportunity of self participation, which helps better identify if students have actually mastered knowledge in class.

(2) On-site practical training is even more suitable in software industry compare with traditional in-class practical training. Students have exposure to corporate culture of software enterprises, understand the market need, understand intensified market competition, gain more motivation to learn. Students also feel more fulfilling when they submit their finished products to the exhibits which is held for summarization of each session of on-site practical training. This is also significant in establishing independence, self-motivation as well as self-confidence for students. In our on-site practical training class, you will see busy yet self-confident students everyday, who are full of youthful spirit.

On the other hand, enterprises who dispatch their technical staff to school as teachers can also benefit from the training. They trained students to meet their talent
need, to be ready for their corporate culture. When students start to work for them, there is much shorter training time needed, hence is also cost effective to the enterprises.

After implementation of on-site practical training for two years, students of the School of Software become more competent. Following is the accomplishment of Year 2002 students after their on-site practical training:

(1) Entered the final round of digital art contest “Creative” sponsored by Microsoft, scored the top 22 worldwide.

(2) Third place award in the National college students JAVA programming contest

(3) Tenth place award in “ACM application programming contest”, Chengdu area

(4) Self developed software application wireless internet video surveillance watch system. Application of patent “stream media processing based on cross platform”.

(5) Participation in the national 863 software development 4 people/time, participation in national level keystone software development 33 people/time, i.e. operation supporting system for China Unicom, information management system for China Grain Reserves Corporation, etc.

5.3. Establish feedback mechanism for internship and employment with enterprises

Student internship and employment vs. feedback from enterprises

1. Internship and employment at enterprises
2. Feedback from enterprises

Internship is the critical step for the enterprise-university corporation. By far 184 people/time of our students have done their internship at enterprises, amounts to 95% of total students. Enterprises who have hired our students as intern include world well know companies such as Microsoft, IBM, Lenovo, Digital China, and Yongyou and so on. Internship is an opportunity to check out the comprehensive capabilities of our students. It is also an important yet inevitable step for students to improve themselves and to adjust themselves to the real world. It can also offer students the benefit of getting more job opportunities. Our students have as long as one year of internship time, so that it leaves enough time for students and enterprises to get to know each other and to mutual select each other. Enterprises can find good talent at lower cost and students can start make money one year earlier to reduce the tuition burden. Post graduate students of Year 2003 had a one year internship and most of them stayed at the intern company or found even better opportunities, employment rate 100%. Under graduate students of Year 2002 just started looking for jobs and by now 80% of them
have received offer from their intern companies.

We keep contact with enterprises after employment of students to keep updated with development of our graduates. Problems exposed by our graduates come to our attention and we take advantage of it to improve our current curriculum. In addition, we also invite graduates who are employed by our corporative enterprises to come back to class for continuous education so that they can serve their companies better. At this moment, both of our open practical training and forum on Saturday and Sunday are open to our graduates who are employed by our corporative enterprises.

6. Summary and Prospect

Since the preliminary stage of the School of Software, it has been trying to cooperate with software enterprises to conduct reform and exploration of new talents training model. Following over two years of experience, it has developed such features in software talents training as below:

6.1. Positioning of the School in the Market

Basing on and being supported by research of engineering technology. Introducing engineering-oriented management thoughts. Aiming at cultivating quality and practical talents with international competitive ability in software engineering talents for the purpose of promoting China’s software industry.

6.2. Cooperative education Model

Using valuable resources of software enterprises to develop a talent-training oriented school-enterprise cooperative education model.

6.3. Teacher Team

Adopting an international open system for employing teachers and hiring both part-time teacher and full-time teacher. Encouraging software engineers and managers of software enterprises to give lectures to students on campus.

6.4. Operational Mechanism

Independently organizing and managing teaching affairs of the school under the guidance of the university and support of related functional department, with greater decision-making power in school-running that aims at keeping pace with the development of global software industry.

6.5. Practical Base

Setting up internship bases in famous software enterprises, as well as practical
bases in software development parks and specialized labs on campus. Encouraging students to organize their own project team and participate in project practice.

6.6. Reform in Education

Preliminarily forming a talents training program and curriculum system combing theoretical teaching, technical training and engineering practice, with organic connection to international advanced curriculum system. Establishing guiding committee consisting of members from both school and enterprises for the purpose of making adjustment to curriculum system at any time according to the development of software industry.

Since we began to explore the school-enterprise cooperative model two years ago, the School of Software has achieved great results that traditional school may spend much longer time to achieve, and successfully transformed from initiative stage to development stage with steady steps, which proves that the school-enterprises cooperative model is successful. While making achievements, we also realize our deficiencies. For example, during the past two years, we basically just use basic courses in computing, high-tech training program of enterprises and advanced foreign teaching program as reference, as a result, the teaching operated in earlier stage was not very normal. Another example, the current goal for enterprise to cooperate with the school is to attract excellent students to take internship there rather than pursue economic benefits. However, once they realize the potential economic benefits in this cooperation someday in the future, the cooperation may not be able to go on further in a deep-way. These problems are in urgent need for settlement. That’s why we are exploring deep-level school-enterprise cooperative model. We wonder if the school can take advantage of its flexibility to build itself into a software enterprise? Because only in this way can we directly come into contact with software industry and get access to high and new technology in this area. Meanwhile, a software enterprise is more capable of training software talents. In that case, students of our school will be able to enter our own software enterprise first to settle technical issues and naturally finish their transition from student to software professional personnel. Software industry is a brilliant industry relying greatly on professional talents. It is predictable that in the next couple of years, software training will be springing up in China. NIT is a world-famous software training company in India, sharing many similarities to our school. Shall we take their operational model and run our school in the direction of establishing a software enterprise in order to train quality software talents? This is a problem worth thinking deeply about.
A Probe into the Educational Mode of Cooperation between Higher Vocational Engineering Institutes and Enterprises

Shan Qiang, Zhao Yibiao
Suzhou Industrial Park Institute of Vocational Technology, Suzhou

Suzhou Industrial Park Institute of Vocational Technology was firstly established in December, 1997. It is a new-style higher institute of vocational technology cultivating skilled workers for foreign-capital enterprises. In recent eight years, our institute has fully used the most advanced foreign experiences of vocational education in Singapore, Germany, and other foreign countries for reference, and has been insisting on the school running policy of facing enterprises and demands, and also has established the school running tenet of “cultivating today’s students for future services by tomorrow’s science and technology”. Besides, we have set up “teaching factory” and “teaching environment of integrated science and technology”, and have formed new-style mode of cultivating talents which is characterized as directorate system, marketization mechanism, flexible educational system, modularizing teaching, and high-tech training. All these were praised by enterprises, government and all circles of society. And now our institute has become countrywide demonstration enterprise of vocational education to train teachers in ministry of education and provincial teachers’ training base of vocational education. In the process of school running, our institute tried its best to establish comprehensive cooperative relationship with enterprises, and obtained plentiful and substantial fruits.

The employment rate of our institute exceeded 98% successively in recent eight years. And now about 82% of students are working in Suzhou Industrial Park, 18% are working in the new parts of Suzhou, Shanghai Pudong, Wuxi, etc. Almost one third of students are working in the worldwide Top 500 enterprises, such as AMD, Solectron, Emerson, NOKIA, Celestica, Hitachi, Samsung, and so on. Besides, there are about one hundred students having been trained in foreign country such as Germany, Britain, Japan, Singapore, and Korea, etc. And our investigation on graduates from our institute suggests that most of our graduates have become the skeleton strength of enterprises. Now many of them are department directors, directors of product line, group leaders, reportorial cadres, technicians, engineers, and trainers for new comers. And enterprises in the industrial park generally think that students graduated from IVT are better than students from other schools in many aspects. They are more familiar with advanced technology, much easier to adapt to the posts, have better work capacity and team spirit, and can have better understanding some administrative conception. All these are
profited from the cooperation between IVT and enterprises. Our measures include things as following:

**Firstly, we established conception of school running aimed at enterprises’ demands, and formed unique atmosphere of enterprise culture.**

Our institute always insists the conception of school running oriented by demands. Our specialty setting is determined by local industrial structure. Cultivating standard of students is determined by employment demands. And our daily administration follows enterprise standard.

In the very beginning, our institute put forward a slogan as “enterprises’ demands, our goal”. In the tenet of “cultivating today’s students for future services by tomorrow’s science and technology”, we try our best to cultivate our students to become applied technical talents with curiousness, lofty character and high skills, who can easily adapt to the work in foreign-capital enterprises.

Whether the goal of school running serves enterprises or not is firstly shown in the adaptation of specialty setting to industrial structure. The industrial layout of Yangtze River Delta has formed gradually. Shanghai mainly focuses on financial trade and technical study and development. City belt of Shanghai-Ningbo and of Shanghai-Hangzhou concentrate on precision machinery, electrommunication, fine chemical industry, measuring appliance and instrument, biological medicine, and so on. In the industrial structure of Suzhou industrial park, electrommunication takes up 43%, precision machinery 27%, modern service industry 17%, biology and material 13%. Now our institute has 28 specialties. And 43% of them are taken up by industrial electron, micro electron, photoelectricity technology, computer network, communication, software engineering, and so on; 30% of them are taken up by mechanical and electrical integration, precision engineering, design and manufacture of mould, automobile applied technology; 12% of them are taken up by modern technology of materials circulation, business administration/management, secretary for foreign enterprise; 15% of them are taken up by animation, visual art, environmental art, practical English. Apparently, students of engineering occupy 75% of school, which is adaptive to the industrial structure of Suzhou industrial park.

In order to promote cooperation between our institute and enterprises, we have set up Department of Development. In this department, most of teachers are administrators of relevant department in foreign-capital enterprises. They have not only profound
understandings of enterprises, but also excellent foreign languages abilities. And the main task of this department is to communicate with stratosphere of enterprises in industrial park and to provide gist for our institute when making cooperative decision.

With regard to teaching environment, our institute uses the mode of “teaching factory” for reference. And in order to shorten the distance between study and application, our experimental equipments in teaching are mostly prepared according to the practical use in foreign-capital enterprises. At the same time, we have set up integrated scientific and technical teaching environment. We combine organically theoretical study, application module and industrial project in a classroom. And in order to make students form a holistic and correlative conception of practical application of knowledge, we design or arrange the layout of our lab according to industrial flow or technical development. Besides, in the environmental layout of inner teaching district, we also try to build the atmosphere of enterprises culture to make students taste enterprises environment and culture in our institute.

Secondly, we organized and set up directorate participated by enterprises, which ensured the development of cooperation between our institute and enterprises from system lay.

Our institute used the mode of school running in Singapore Nan Yang Polytechnic for reference. Since the early years of our institute, our institute’s directorate, which was composed of governmental departments, well-known multinationals and schools, has come into existence. And our institute carries out the dean responsibility system under the guidance of directorate. As the policy maker and supervisor of our institute’s policy, directorate plays a decisive role in the construction and development of institute. Meanwhile, directorate is a ligament for our institute to contact with enterprises and institutions of higher learning. It promotes the demands of enterprises as our goal of school running and helps us obtain the technical support from the institution of higher learning in the process of pursuing the technology up to minute. Generally speaking, directorate fused resources from government, enterprises and schools. And each party provided strong support for our institute respectively from aspects of policy, outlay and specialty. The 12 directors of enterprises are respectively from Germany, America, Finland, Holland, Korea, Taiwan, and so on. There are more details in the following table 1:
### Table 1: Corporate Directors of IVT

<table>
<thead>
<tr>
<th>Name</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Germany) Festo Corporation (China)</td>
<td><a href="http://www.festo.com/">http://www.festo.com/</a></td>
</tr>
<tr>
<td>(Germany) MTU Engineering (Suzhou) Co., Ltd.</td>
<td><a href="http://www.mtu-friedrichshafen.com.sg/">http://www.mtu-friedrichshafen.com.sg/</a></td>
</tr>
<tr>
<td>(Germany) Bosch Automotive Products (Suzhou) Co., Ltd</td>
<td><a href="http://www.bosch.com.cn/">http://www.bosch.com.cn/</a></td>
</tr>
<tr>
<td>(Finland) NOKIA Co., Ltd. (Suzhou)</td>
<td><a href="http://www.nokia.com.cn/">http://www.nokia.com.cn/</a></td>
</tr>
<tr>
<td>(Taiwan) BenQ Co., Ltd.</td>
<td><a href="http://www.benq.com.cn/">http://www.benq.com.cn/</a></td>
</tr>
<tr>
<td>(China and Singapore Joint Venture) CSSD</td>
<td><a href="http://www.cssd.com.cn/">http://www.cssd.com.cn/</a></td>
</tr>
</tbody>
</table>

Annually, through directorate session, directors from enterprises determine and supervise the policy of our institute, and ensure that the direction of school running is consistent with the demands of enterprises. At the same time, our mode of administration gradually coincides with mode of implement in foreign-capital enterprises. In a word, the establishment of this system accelerates the course of institute’s marketization, and shows the bright prospect of our institute and its strong vitality.

**Thirdly, we constructed platforms for exchanges between our institute and the industry to realize zero-distance communication with enterprises.**

We attach great importance to our communication with the industry. Various platforms have been constructed to enhance the communication and exchanges between the school and the enterprises. GM Meetings offer a platform for high level executives from the industry to get together and convey their ideas about the cooperation between our school and the enterprises, which promotes friendship and
mutual understanding while at the same time has always been regarded by the school administration as an important window of the school to display their philosophy of school running. Through efforts made by the school administration in the past years, general managers from foreign companies come to attach greater importance to the communication with the school and often invite the leaders of the school to participate in the activities of their GMs Clubs, such as the Germany GMs Club and the Electronics GMs Club.

Initiated by IVT and established on December 28, 2003, the SIP Association of Doctors is another important platform for senior talents from different circles to communicate and exchange ideas as well as an access for the school to high-level part-time professors and latest ideas and technology. The members of the Association include chairmen, presidents, general managers and department managers from a dozen of enterprises, such as Innosis Technology (Suzhou) Co., Ltd, Suzhou CAS IC Design Center, Bosch Automotive Products (Suzhou) Co., Ltd, Bosch Automotive Products (Suzhou) Co., Ltd, Samsung (Suzhou) Semiconductor Co., Ltd., Emerson Electric (Suzhou) Co., Ltd, and Solectron (Suzhou) Technology Co., Ltd.

Fourthly, we fully exploit the equipment and technological advantages of foreign companies and have established in cooperation with some of them on-campus labs and off-campus training bases.

There are about 1,300 MNCs in the Industrial Park with very strong advantages in equipment and technology. In recent years we have received over 10 million yuan donations of teaching facilities from the foreign companies, which contribute a lot to the establishment of over 80 high level labs, including Emerson Engine Drive, Bosch Autocontrol, Festo Pneumatic & Hydraulic Lab, Charmill W-cut Lab, Fadal CNC, Nokia Communications, MTU Precision Engineering, BenQ Opto-electronics, Simons SMT and Samsung Semiconductor Lab.

We have also established over ten off-campus training bases in cooperation with enterprises using their space and equipment, such as the logistics training bases of the Department of Business Administration with Auchan from France and B&Q from Germany, the semiconductor training base of the Department of Electronic Engineering with Spansion (Suzhou) Co., Ltd., and the micro-electronics training base with Solectron (Suzhou) Technology Co., Ltd.
These off-campus training bases are not only internship fields for students, but also a guarantee of smooth implementation of the school’s “Visiting Engineers” program. It is stipulated by the school that those teachers without work experiences in foreign companies must take a 1 to 6-month internship in foreign companies during their first two years as an employee of the school. All staff of the school shall visit at least six enterprises each year. Companies like Bosch, Philips and SPEC even sent our teachers abroad to receive professional training in Holland, Singapore, Germany or Japan to gain their certifications for trainers so as to establish a long term cooperative relationship with us.

Fifthly, we have set up IVT Education Fund to support poverty-stricken students and invited foreign companies to offer scholarships, study grants and teaching awards.

The average investment in SIP from a foreign company reaches over 30 million US dollars. To fully tap the capital source, we have been inviting the enterprises to set up scholarships and teaching awards in IVT. Those already involved include MTU Engineering (Suzhou) Co., Ltd, Solectron (Suzhou) Technology Co., Ltd, Spansion (Suzhou) Co., Ltd, Bosch Automotive Products (Suzhou) Co., Ltd, Philips Enabling Technologies Group of Suzhou Ltd, SPEC (Suzhou) Co., Ltd, BenQ (IT) Co., Ltd, Jiangsu Fatai Electrical Appliances Co., Ltd, Celestic (Suzhou) Co., Ltd, La Perrine Animation and some other companies, providing in total about 200,000 yuan of scholarships and awards each year (see Table 2). Recently, Canon and Andrew also expressed their intent to offer scholarships.

Table 2: Enterprises and the Scholarships and Awards they provide

<table>
<thead>
<tr>
<th>S/N</th>
<th>Enterprises</th>
<th>Scholarships and Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spansion (Suzhou) Co., Ltd.</td>
<td>Spansion Scholarship</td>
</tr>
<tr>
<td>2</td>
<td>Solectron (Suzhou) Technology Co., Ltd</td>
<td>Solectron Scholarship</td>
</tr>
<tr>
<td>3</td>
<td>MTU Engineering (Suzhou) Co., Ltd</td>
<td>MTU Scholarship</td>
</tr>
<tr>
<td>4</td>
<td>Bosch Automotive Products (Suzhou) Co., Ltd</td>
<td>Bosch Scholarship</td>
</tr>
<tr>
<td>5</td>
<td>Philips Enabling Technologies Group of Suzhou Ltd</td>
<td>Philips Scholarship</td>
</tr>
<tr>
<td>6</td>
<td>SPEC (Suzhou) Co., Ltd</td>
<td>SPEC Scholarship</td>
</tr>
<tr>
<td>7</td>
<td>BenQ (IT) Co., Ltd</td>
<td>BenQ Scholarship</td>
</tr>
<tr>
<td>8</td>
<td>Philips Enabling Technologies Group of Suzhou Ltd</td>
<td>PHILIPS Teaching Award</td>
</tr>
</tbody>
</table>
From the practices of cooperation we have deeply realized that sustainable development of cooperation between institutes and enterprises can only be achieved on win-win terms. What we have been doing is to serve the industry by tapping the full potential of our own resources.

**Firstly, launch contract training classes customized for enterprises in a “BTO (Build to order)” way**

“BTO” education is an important area of cooperation between higher vocational technology institutes and the industry. Based on cooperation between the two parties in all aspects ranging from the layout of labs, arrangement of courses to the design of curriculum, it is oriented to the demands from the enterprises, and aimed at preparing students to be the kind of employees the enterprises really want. It is a three-win training pattern: the enterprises cost less in the recruitment and training of their staff, the school gets less pressure in the placement of its graduates, and the students don’t
have to worry about their future jobs – they can concentrate more on their studies and experience corporate culture in advance. Since its establishment IVT has always been practicing the BTO training mode and in the past eight years we have cooperated with nine companies in launching contract training classes in line with BTO principles (see Table 3):

<table>
<thead>
<tr>
<th>S/N</th>
<th>Partners from Industry</th>
<th>Name of the Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SPEC (Suzhou) Co.,Ltd</td>
<td>SPEC Class</td>
</tr>
<tr>
<td>2</td>
<td>Bosch Automotive Products (Suzhou) Co.,Ltd</td>
<td>Bosch Class</td>
</tr>
<tr>
<td>3</td>
<td>Celestic (Suzhou) Co.,Ltd</td>
<td>Celestic Class</td>
</tr>
<tr>
<td>4</td>
<td>SIP Lianchuang International technology Co., Ltd</td>
<td>Lianchuang Class</td>
</tr>
<tr>
<td>5</td>
<td>Nokia (Suzhou) Telecommunications Co.,Ltd</td>
<td>NOKIA Class</td>
</tr>
<tr>
<td>6</td>
<td>National Semiconductor (Suzhou) Co., Ltd</td>
<td>NS Class</td>
</tr>
<tr>
<td>7</td>
<td>BenQ (IT) Co.,Ltd</td>
<td>BenQ Class</td>
</tr>
<tr>
<td>8</td>
<td>Anhua Precision Technology (Suzhou) Co., Ltd</td>
<td>Anhua Class</td>
</tr>
<tr>
<td>9</td>
<td>Infineon Technologies</td>
<td>Infineon Class</td>
</tr>
</tbody>
</table>

In all the above programs, both parties - the Institute and the company concerned--are involved on a work-together basis in designing the curriculum on top of the qualification requirements for targeted work positions. The whole training process is all-dimensionally open to the company while the company takes part of the teaching responsibility and provides opportunities to IVT teachers for further training, to students for internships and employment. To the enterprises, this kind of flexible mode of cooperative training ensures an easier access to the more suitable and more excellent personnel they want.

**Secondly, develop training programs and polish up employees’ qualities for enterprises**

Targeting at the requirements from the industry, we’ve developed over a hundred training programs that range from management, professional technologies, to languages and special types of work. Each year over 2,000 persons are involved in the in-house training programs we offer for various companies.
We have sponsored the “Foreign Company HR Managers Club” and the “Foreign Company Training Managers Club”, whose members have the privileges to attend lectures given by guest experts. The nearly 60 “IVT Forum” lectures have attracted a large audience including hundreds of managers from foreign companies.

Our Continuing Education Department enrols students on demand. When the industry is in season of production, we provide quality skilled workers to our board member companies; while during off-season times we attract excellent technicians for continuing education - by doing so we help build up a personnel pool for the industry to reduce the risk of sharp ups and downs in production due to the drain of skilled workers.

**Thirdly, do project development and production trial for enterprises to lower their costs in labour and production**

As an institute of high vocational technology in SIP, we boast a strong teaching force with both qualification of teaching and capacity of R&D, which provides a platform for practicing on a deep level the cooperation mode of “Cooperative Project Development”. One of the good examples is the cooperation between IVT and Spansion (Suzhou) Co., Ltd. in developing a series of semiconductor training packages.

Production trial and demo manufacturing is included in the schedule of our “Teaching Factory” every year. In 2004, Taishan Animation from the Department of Arts produced two animation films worth of 2.48 million euros for France and Italy. Lijia Die & Mould from the Mechatronics Department manufactured 20 sets of dies and moulds for foreign companies, the production value being about 3 million yuan. Our Simons production line in the pipeline will be able to do 2-3 million yuan trial and testing for enterprises every year. This kind of cooperation not only provides a platform for integration of production, teaching and research on the school side, but also reduces the costs of operation and shortens the cycle time of new product launching for the enterprises, which in turn helps them win an upper hand position in competition.

**Fourthly, construct a “Teaching Factory” training mode and share with enterprises our teaching resources**

Based on the principles of equality and mutual benefit, cooperation and common
development, we have introduced onto campus offices, labs or workshops from enterprises such as SIP Mate Technology Co. Ltd, Suzhou Lijia Die & Mould Co. Ltd, SIP Weizhi Technology Co. Ltd, Suzhou Shifeng Electrical Appliances, SIP Jite Shidai 3D Analogue Technology Co. Ltd, Suzhou Taishan Animation and Suzhou 3D CNC Co. Ltd. We give first priority to those companies for information and technology support, and rent them spaces for offices and production at a reasonable level. When undertaking their own business of production, those companies also act as training fields for our students where the border between classroom and workshop, teacher and engineer blurs. It is hard to define the space as a school or a factory when you are in it since what in front of you are not only the scenes you can see at real production lines in the industry but also neatly arranged desks and students who are having classes. Take Taishan Animation as an example, the senior animation artists or directors working there are also teachers of our Department of Arts. What they teach students is exactly what the students are going to do in their future career. The educational institution and the production unit are overlaid with each other as a highly merged combination.

Fifthly, stick to ISO Quality Control System and regulate cooperation management processes


Industry Link Management Processes aim at strengthening communication with the industry so as to make sure that the services we offer satisfy the needs of the enterprises. They include measures to ensure initiative and smooth communication between the institute and the industry, and call for full supports from all sectors of the institute to be well informed by the Department of Development of the complaints from the industry.

Industry Satisfaction Survey Management Processes aim at constant improvement of our services through industry satisfaction surveys. The Department of Development will regularly invite the enterprises to make satisfaction assessment on the various services we offer so as to understand the shortcomings and weaknesses in our services,
which lays the ground for our following-up to further improve our services.

School-Running Cooperation Management Processes aim at effective control on our cooperation with other schools or enterprises in running schools so as to ensure satisfying results that meet the needs and expectations from both cooperative parties, students and their parents. They are designed to ensure the teaching quality in programs for customized contract training classes, short-term training courses and other forms of cooperation in running schools.

Curriculum and Specialty Design & Development Management Processes are stipulated to ensure high quality curricula and specialties that meet the needs of our clients. They are designed on the basis of the market demands analysis, the understanding of the needs of students, their families and potential employers, the development of the specialties concerned and the overall development plan of the institute.

Our quality policy is to “offer superior courses and excellent services, prepare our students to ‘be eager to learn and dedicated to career, have a high moral integrity and a good command of skills’, and make constant efforts to satisfy the requirements from the industry”.

83
1. INTRODUCTION

Training engineers is teamwork. At GROUP T Leuven Engineering School this team comprises students, professors and entrepreneurs. GROUP T directs the students to the entrepreneurs via the professors. Why? Because GROUP T wants to train engineers that live up to the entrepreneurs’ expectations fully. Engineers that can be deployed to many different fronts. Who not only have a strong technological base but also have clear-cut Enterprising skills at their disposal and who are furthermore capable of coaching others and will continue to develop themselves in a fast-evolving environment and a globalizing world. And moreover engineers who know what an enterprise is, who haven’t learned this from books but were coached in and by the enterprise.

No passive training can achieve this. That is why GROUP T chooses working methods that make the students and professors take initiative and that stimulate them to cooperation and consultation with each other and with the entrepreneurs across borders. This is only possible by making the enterprising environment as physically present as possible. And by organizing GROUP T itself as an enterprise. As a ‘partnership’ with three partners: students, professors and entrepreneurs. In this article we describe successively how GROUP T is present in enterprises, how the entrepreneurs are present at GROUP T, how GROUP T itself is organized as an enterprise and how the GROUP T engineers evolve to entrepreneurs.

2. GROUP T AT THE ENTREPRENEURS

In the course of the curriculum, the engineering students are increasingly involved with entrepreneurs. In the Bachelor programmes this works as follows:

(1) Company visits: the attention is not only focused on production or technical aspects but also on the company’s mission and strategy, its market position, human resources policy, quality control, training and education, communication and consultation and so on.

(2) Learning experience ‘a day with an engineer’: first year students ‘shadow’ an engineer for a day and observe and take meticulous notes of his/her activities.
Afterwards the students meet as a group to exchange their information and experiences while gaining a broad view on the complex and varied tasks of an engineer.

(3) Integral Engineering Experiences (IEE): these are projects in which students carry out team assignments that appeal to their Engineering, Enterprising, Educating Environmenting and Ensembling qualities. They also learn to bring together and integrate the knowledge and the skills they acquired from their other courses. In the first Bachelor year, the students study the lifecycle of a product and analyze the inner workings of a device or appliance through reverse engineering. In the second Bachelor year they design and build a computer-controlled mechanism and in the third Bachelor year they start up a small business around a product they developed themselves. In each of the projects the assignment is conceived so that an explicit link with one or more companies has to be made. As such, an entrepreneur can act as the coach of a certain project or there is a consultation process with an engineer about how to approach a certain IEE project.

During the master programmes the cooperation with the entrepreneurs is further intensified with:

(1) Specialized company visits
(2) Laboratory and practical sessions at the enterprise
(3) The at-enterprise learning trajectory: in the GROUP T two-year Masters programmes two semesters are completed not at GROUP T Leuven Engineering School but rather at an enterprise where students can further develop into competent start-up engineers. This is carried out through a personal development plan in which students, in consultation with the enterprise and GROUP T, can specify the learning content or the skills and abilities he/she wants to develop further.

(4) During this enterprise learning trajectory the students also do their Masters test, proving they actively have Engineering, Enterprising, Educating, Environmenting and Ensembling qualities. The Masters test begins with a concrete research question and/or a complex problem from professional practice. An enterprise, research institute, university or organization, here or abroad, acts as the customer. The assignment must be of such nature that teamwork is required to achieve results or solutions within the time specified. During the project, the student is coached by a supervisor from GROUP T Leuven Engineering School and a co-supervisor from the commissioning company or organization. The student drafts a report with a formulation of the problem, the methodology used and the results achieved which he/she then presents to a jury that consists of professors and specialists from the entrepreneurial world. In the context of the Masters tests, GROUP T worked with 112 companies during the
2004-2005 academic year. These were divided as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Companies with international activities</td>
<td>51</td>
<td>45%</td>
</tr>
<tr>
<td>Local companies and research institutes</td>
<td>61</td>
<td>55%</td>
</tr>
<tr>
<td>Research institute</td>
<td>27</td>
<td>24%</td>
</tr>
<tr>
<td>Company</td>
<td>85</td>
<td>76%</td>
</tr>
<tr>
<td>Belgian origin</td>
<td>69</td>
<td>62%</td>
</tr>
<tr>
<td>Foreign origin</td>
<td>43</td>
<td>38%</td>
</tr>
<tr>
<td>Listed on stock exchange</td>
<td>34</td>
<td>30%</td>
</tr>
<tr>
<td>Unlisted companies</td>
<td>78</td>
<td>70%</td>
</tr>
</tbody>
</table>

3. THE ENTREPRENEURS AT GROUP T

GROUP T not only goes to the entrepreneurs, the entrepreneurs also come to GROUP T. By way of proof:

(1) Significant representation of prominent entrepreneurs in the governing bodies of GROUP T.

(2) Guest professors from companies who keep students up to date with the most recent developments in their field.

(3) The co-supervisors and jury members of the Masters tests.

(4) Campus recruitment during the Day of the entrepreneur. This is an event during which entrepreneurs come to the GROUP T campus to offer the students projects and jobs. Fifty companies participated in 2005, not only multinationals but also SMEs, research centers, universities, public institutions and so on.

4. GROUP T AS AN ENTERPRISE

Enterprising Engineering Education also means that GROUP T’s natural mission is situated in the entrepreneurial world and effectively positions and organizes itself as a company. As such, GROUP T, as a company, is a member of important employers’ organizations such as the Vlaams Economisch Verbond and the VOKA - Chamber of Commerce. In this context, GROUP T is an enterprise among other enterprises. This is indeed a considerable advantage for the GROUP T engineers. After graduating they don’t have to take the step from school to company. They evolve from one company to another.

5. THE ENGINEER - ENTREPRENEUR
(1) The curriculum at GROUP T is completely tuned for training entrepreneuring engineers. It is therefore logical that Enterprising is an essential area of skill and ability that stretches out over the whole programme and is furthermore continuously gaining importance. Enterprising essentially means being able to develop a vision, formulating a mission based on this vision and creating a sense of mission among colleagues and co-workers.

(2) The curriculum stimulates the entrepreneurial spirit of the future engineer in yet another way. The way is to make students more responsible for their own learning process. As the programme continues, the students are increasingly able to set their own learning targets and are able to undertake activities to develop into a competent start-up engineer. The learning experiences, the IEE projects and especially the at-enterprise learning trajectory with personal development plan bare witness to this. As a result, the student becomes more the entrepreneur of his or her learning.

(3) The GROUP T profile is also evident in the employment of engineers. The illustration below shows that GROUP T engineers not only end up in the ‘traditional’ engineering functions such as ‘production’, ‘development’, ‘maintenance and security’ but, to a large extent, are also sought for customer-oriented jobs. Because of the fast-paced technological advances there is an increasing need for specialists, not only for the development of new products, systems and processes, but also for the commercialization thereof. Also the customer is increasingly involved at the development stage. This leads to a greater demand for customer-oriented engineers. The fact that the majority of the GROUP T engineers are employed in such function is not a mere coincidence. It follows naturally from their programme profile of Engineering, Enterprising, Educating, Environmenting and Ensembling.