D. Globalization: Transnational Dependences in Innovation

Intel China Labs: A Key Element In A Global Effort

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1. Intel and the World.

China has emerged as not only a major market for Intel, but also as an integral part of the company's worldwide manufacturing, R&D and venture capital efforts. This presentation will focus primarily on Intel China Labs and their relationships with both China's academic community and Intel R&D labs in other countries.

Intel is a global company: 60% of its sales are outside the United States. The company manufactures in 7 nations and has R&D labs in 8 countries. In addition, the company has a multi-billion dollar venture capital portfolio that includes investments in numerous countries, including China.

Research and development has always been a very important part of Intel, as shown in Figure 1. Today, Intel focuses its R&D activities in four key areas: Internet, Communication, Computing and Silicon Manufacturing. Intel has a worldwide R&D Network. Over 7,000 Scientists and Technologists are working in research centers located in many counties. The Internet has made the globalization of the company much easier. In R&D, for example, it is not uncommon for teams in the U.S., Israel and China to be working on different aspects of a product's development and to be sharing data on a daily basis.

2. Intel China Labs

Intel has established several R&D centers in China, especially in the 1990s. These R&D activities have become part of the global R&D network of Intel. In 1993, the Intel China Software Lab was established in Shanghai. In 1998, Intel launched its first China Research Center. In the year 2000, Intel opened three different research centers in China. They are Intel Internet eXchange Architecture Development Center (2000), Flash Applications Development Center (2000), and Wireless Lab (2000). Now these research centers are part of the unified organization for Intel's R&D activities in China.

2.1 Intel China Software Lab (ICSL):

Intel China software Lab is the earliest Intel R&D Lab in China. The Lab was established in Shanghai in 1993 and now has about 100 engineers working in the Lab. ICSL writes system software, and works closely with Intel hardware development teams worldwide and with the customers. This Lab focuses its research and development in system infrastructure software, telecom Linux and other operating systems, video analyzer tool kit and performance primitives for Intel PCA.

2.2 Intel China Research Center (ICRC):

Intel China Research Center was established in Beijing in 1998. This Research center focuses its research in the fields of Audio/visual processing as well as media platform requirements and workload analysis. This research center collaborates with Institute for Computing Technology, Chinese Academy of Sciences (CAS) on the Itanium Processor Family Open Compiler project. The Center has already filed 15 patents and disclosed 28 patents. There are 11 papers from ICRC accepted by world-level journals.

2.3 IXA Development Center:

IXA Development Center is an application reference design development center for OEMs. And it is part of Intel customer technical support in China. IXA Development Research Center also works in the fields of IXA S/W development and IXA University Program support.

2.4 Flash Application Development Center:

Flash Application Development Center, (Flash ADC) is co-located at Intel's Pudong factory site in Shanghai. Flash ADC focus on the research of flash technology especially in silicon design and flash file system.

2.5 Wireless Center:

Intel has three worldwide wireless centers located in Beijing, Tokyo, and Stockholm. The mission of the Beijing Wireless center is to assure compatibility of Intel wireless products with standards and work with design engineers at Intel customers and development partners.

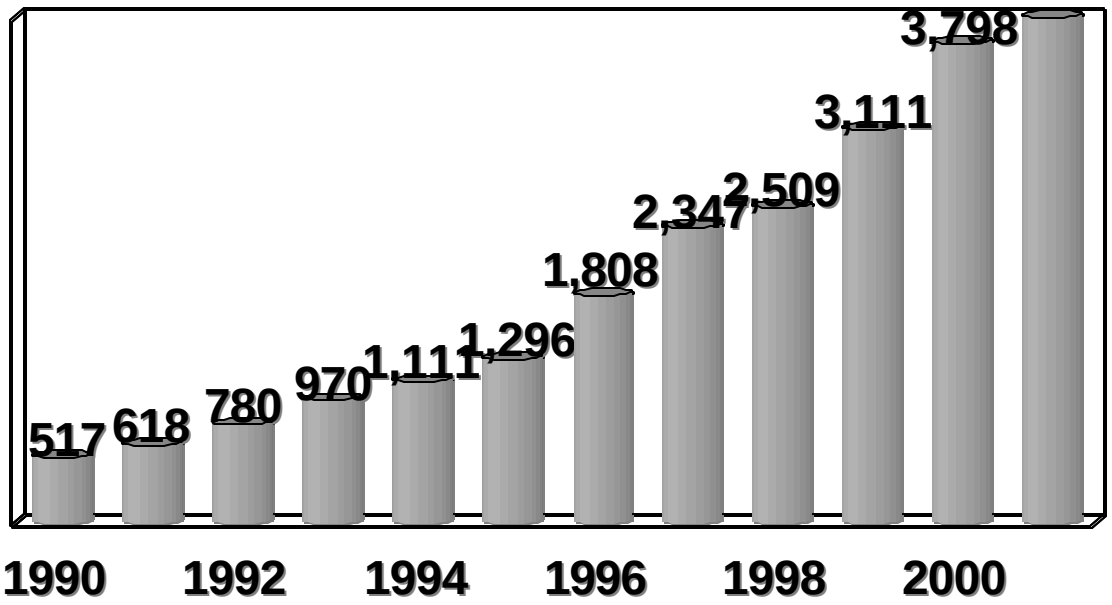
3. Support Long Term Academic Research in China

In addition to its own research activities, the company sponsors long term academic research at several universities in China, ranging from distance learning research at Shanghai Jiaotong University to e-business curriculum development at Tsinghua University. Different programs, such as failure analysis, distance education, natural language processing, and E-Business curriculum development, are coordinated by the Intel China Labs Research Council. The company has donated 26 laboratories at 8 target universities in China. These labs are periodically updated with new computers based on Intel microprocessors.

In the last few years, Intel has made big investments to support worldwide innovation. About $500 million has been invested in the Asia-Pacific area, with approximately one-third of the total in China. Intel made this investment decision for strategic and financial reasons. The portfolio of the investment includes Longshine, a telecommunications system integrator, LinkAir, a G mobile wireless technology and iFlyTEK, a Chinese language synthesis technology.

Intel believes that R&D investment in China can provide value beyond just financial area. It has enhanced the linkages between Intel and China.

Fig.1 Increasing Commitment to Research & Development



Motorola Technology Innovation and Management in China

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Motorola has become the largest and most successful foreign-invested enterprise in China through more than ten years' development here. The technology innovation is the source power for the development of the enterprise. Motorola has been committing itself actively to setting up the mechanism of the technology innovation, promoting the advanced system of technology management and cultivating the local outstanding internationalized talents of technology and management in China. For the better promotion of implementation and development of the strategy of technology innovation, we are willing to exchange experience and cooperate with the colleagues in China in the hope of gaining more help and advices.

1. Motorola Research and Development (R&D) Strategy in China

Motorola is a high-tech company, and the technology development has laid a good foundation for the success of the entire enterprise. Motorola set down four business strategy when it first entered China, and the first of which is the technology investment and the technology transfer. More than ten years have passed since it entered China, and Motorola has boasted 15,000 employees now and its business income in China has reached to USD 4.5 billion; as what is pointed out by *FORTUNE* in its survey report, the second of the key factors upon which Motorola has built up its success is the long-term support from the local R&D force. All this has testified the correctness and successfulness of the four business strategy. The new goal of the company is to have the business income in China reached USD 10 billion by the year of 2004. Based on the experience in the past and the goal in the future, we have developed such a technology strategy as that: first, the technology research and development in China should be closely attached to the business goal; second, strengthening in China the training of the technical talents of high quality to build up the competitiveness of our global R&D; third, reinforcing the R&D alliance, promoting the partnership with the Chinese technology circle in the technical cooperation and attracting the technical talents of the world-class.

2. Introduction to Motorola China R&D Institute

The Motorola China R&D Institute (MCRDI) was set up at the end of 1999 based on two important reasons: the first is the rapid R&D development in China and the fact that

there were more than 700 technical researchers in the company in 1999; and the second is the strategy of making China prosperous by technology and education advocated by the Chinese Government greatly enhanced the confidence of Motorola in the long-term technology investment in China. The establishment of the Motorola China R&D Institute under this background demonstrated our long-term commitment to the technology investment and the technology development. The Chairmen of MCRDI Board were assumed by Mr. Dennis Roberson, Chief Technology Officer of the Corporation for total Motorola and Mr. P.Y. Lai, Chairman of Motorola (China) Electronics Ltd. The Institute also set up an advisory committee. In order to tie the Chinese R&D team as an important part in the global R&D organization, we need a mechanism linking us with the world. The senior executives joining the Chinese technical advisory committee would help us set up such a linkage quickly, so we invited the top executives of Motorola to be the members of the advisory committee. At the same time, since one of the important missions for the establishment of the Institute is to participate in making China prosperous by technology and education, we should make the technology innovations jointly with many Chinese research organizations. Therefore, we also invited some notable scientists and celebrities to be the members of the advisory committee to assist MCRDI in becoming an active participant in the strategy of making China prosperous by technology and education.

The Institute not only engages in the basic technical research for the long-reaching goal, but also in the high tech development, such as semiconductor device, process technology, software technology, chip design, and the product technology development as well as the research and development of the manufacturing technology, etc. Viewing from the technical ability, MCRDI has now possessed the most intact technology strength from the research of semiconductor device, material, process, and IC design in the lowest layer to the development and research of 2.5G, 3G communication equipment and system. Now we have had a team of more than 1,000 engineers, and the technology investment of 2001 in China reached to USD 64 million. Motorola held the meeting of its global Board of Directors in Beijing in November 2001, and approved the most challenging plan of Motorola further developing and promoting the technology innovation in China. The content of the plan is: the company hopes that it will have 5,000 R&D engineers in China by 2006, and simultaneously the investment will be accumulated up to USD 1 billion.

Our technology development in China is operated on the model of CoE (Center of Excellence). CoEs refer to our establishing and developing the local technical core force in some selected important fields. The labs in China are responsible for supplying the important technologies to all parts of the world, and it is not only a key integral part of the entire global research, but also the important core and basis for promoting the Chinese market and the business development. For speeding up the establishment of

technology CoEs in China, we are working hard to cooperate closely with other labs around the world to use their advanced experience and models, and at same time gain many modes for innovation which can accelerate the development of the Chinese local content, enabling many research centers to grow up in very short time and become the influential technology component in the world. Mode of CoEs is a very important direction for development, which enables us to concentrate our ability to make progress towards the direction and in the fields that we have more advantageous competitiveness, and develop by selectively combining the local technical resources and make the success.

3. Intellectual Assets Have Become the New Growth Point for Promoting Company's Development

Motorola has a history of dozens of years in the technology innovation, and its many labs in USA have the history of about 50 years, which in fact has accumulated many technical assets, intellectual assets and intellectual resources for the company. The company for long emphasized in doing business that the profits came from the net assets, however the company made a new strategy adjustment in recent years and put forward a new operation direction – ROIA (Return on Intellectual Assets), and that is how we can make the Intellectual Assets become a new growth point for our current sale operation. The Intellectual Assets refer to the knowledge, information, intellectual properties of the whole company and the experience it possesses, and also include the creativity of the experts and engineers of the company and the special skills of the employees. The composition of all these parts can contribute a summation of competitive advantages for the company. What does the definition of intellectual assets mean to the R&D staff like us? It means that we should change our traditional R&D concept. We cannot think we have completed the job when we only finish the design of a technology, but during the development of the technology, we should also pay attention to how many intellectual assets we have created for the company. For example, how many patents can be generated from that, what new technologies can be further developed on these new patents and how much the new creative technical force will be generated and integrated during the fulfillment of the technical task. As to our R&D department, the standard to evaluate an R&D achievement is not based on the completion of a single task but on the combined achievement of many aspects.

4. Creating A Environment for Technology Innovation

The Motorola China R&D Institute now boasts more than 1,000 of young and vigorous R&D staff with the higher education backgrounds. There are abundant potential innovations and inventions in their daily research. In order to inspire the enthusiasm in creation and innovative spirit, we set up in recent years series local programs in China for

encouraging and assisting the technology innovation to consummate and develop the maturing technical R&D environment in China.

A. Setting Up Local Patent Committees

The Institute has set up three patent committees concerning three major technical fields: communication, software and semiconductor. The main task of the patent committees of the Motorola China R&D Institute is to help and encourage the engineers to quickly grow into the innovators. Therefore, we energetically cultivate the concept and soft environment of recognizing and discovering the patents in the labs and research centers, and invite the senior experts to come to China to make exchange and training on patent disclosure. Many research centers and labs take the patent work as the important agenda of the daily work. The engineers usually bring with them the notebooks to take down the new whims. Each department has a monthly patent meeting to accelerate the process from a new idea to a patent. At the same time the local patent committees may assist us in acquiring more patents we need from the important innovative fields, and greatly speed up the process of patent application, reducing the time delay by applying through the overseas patent committees and the problems such as the language obstacle.

B. Science Advisory Board Associates

Motorola established Science Advisory Board Associates (SABA) in 1970 to create such chances as enabling the preeminent technical staff to get together, exchange their ideas and learn from each other, which at the same time is also an honor to the technical experts who have made prominent contribution, and promotes the self-development and improvement of the R&D staff in trying to become the members of SABA. Now more and more R&D people in China are playing an important role in the technology development of the whole company, so we are now pushing forward the program of accelerating the generation in China of the members of SABA. Although we now have three SABA members, they are the experts sent to work in China. We believe that, through our efforts, there will be many excellent Chinese experts becoming the members of SABA before long.

C. Technical Training and Mentoring Model

In order to make our local technical staff develop into the developers of the advanced technologies, we have drawn out the prolific programs for the overseas trainings. We have also adopted the Mentoring Model to speed up the cultivation of the local talents. This system not only enables the Chinese talents to quickly learn many technologies and experiences, but also helps them learn and absorb the advanced working

methods, cultural concept and the other important experience as how to communicate and get along with others.

D. Program of Technical Ladder

The Technical Ladder is established in China for the promotion of the local talents. It offers the promotions on technical posts for those talents who have the potentials for development and have made important technical contributions, and provides for them a systematic evaluation and implementation procedure. The evaluation on the talents is composed of several aspects, i.e., technical contributions, ability to instruct the others, ability of leadership and organization, ability for team work and ability to understand and respond to the market and customers, etc. Our Technical Ladder enables an R&D engineer to be promoted from Engineer to Senior Engineer, Principal Staff Engineer, Vice President of the Technical Staff and Executive Vice President of the Technical Staff. In such broad a space for development, the career development of the engineers in Motorola has indeed a very attractive prospect.

5. Innovation of Technology Management

Motorola has made a bold and resolute reform on its organizational structure since 1996. It has been transformed from a technology-oriented company to a market- and customers-oriented high-tech company. As in the market with very furious competition, only those companies that put the needs of the market and customers at the most important position can survive and develop. This transformation brings about many new problems and challenges to the technical departments of the company. The division of the departments in the past was based on the different technical products, and the marketing people were assigned to sell the products for which the company can provide technology.

The new system is constructed based on the market, and it is very important to associate the development orientation and projects of R&D of the technical departments with the needs of the market and customers, and at the same time it is really a big challenge to the technical departments on how to maintain the competitiveness on the price for the researched technologies. The innovation of the technology management appears to be very important on how to enable the new company system to strengthen rather than weaken the technology innovation and development, and enable the technology to play its due basic core role in a company system which is market-oriented.

The technology management is a systematic process of management, referring to every aspect of the overall process from the invention and creation to the technical R&D and the product market launching. The technology management secures the mutual

connection of each key phase and the solution to the possible problems that arise during the transition of each important phase. It plays a very important role in the effective management to the whole process from the investment to the return, and it promotes the coordination of the cooperation between the departments, enabling the new technology to turn as quickly as possible into the new product and realize its commercialization through the overall and consecutive managing methods. The Technology Board composed of the principals of different departments is responsible for the establishment and the execution of the technology management procedure. The Chairman of this Board is assumed by the Chief Technology Officer of the company.

The three important components of the technology management are the technology planning, technology development as well as commercialization activities. In the making and the management of the technology plan, there are the establishment of the technology strategic vision, the portfolio management and the generation of technology roadmaps. In the stage of making the technology plan, we integrate from different angles the opportunities for the technology development, and at the same time we should clarify three issues: which direction we are going to, how we can attain the expected goal and how we can secure the success. We can only define the strategic investment and the goals after we take the consideration of all these. The next is to make the comprehensive balancing. It is because we need to balance many things when making the decisions, and we should prepare many analytical data when selecting the technical projects and analyzing their priorities, such as the analysis of the competitive advantages, the analysis of the technical risks and so on; when balancing these data, we should balance the limitation of the finance and of the resources. In addition, the technology today may not be always developed independently, and we should decide on whether we should buy or develop it by ourselves. The main point we should consider in the resource management is what core technologies we need, and we should make comparison of the existing technologies with the needed technologies, i.e., the management of the resources. And the last we should do is to define the strategic goal, timetable and the whole plan we should fulfill for the technology development by the resource allocation management through the comprehensive balancing. The timetable is not only the commitment of a technical department, it also includes the commitments of departments of marketing, the business and the production as well as the whole enterprise, and sometimes we need to sign the agreement with them to guarantee these commitments.

In the stage of technology development, we split the project into 7 phases, including discovery, feasibility study, module design, integration, prototype development, and technology transfer, etc. The production process is the process from the R&D to the commercialization in which a product is further consummated and improved. In the realization of transformation from technology to products, the management of the

technology development phase shall play a very important role. When the research enters into the phase of the module integration, the researchers should start to tie up with the people in production and marketing, and simultaneously concern themselves with the factors of its success rate and cost, etc. In the integration phase, the research by researchers and engineering technicians on its producibility and yield levels in the batch production is indispensable. In the prototype development phase, the technical team needs a big volume of information on the customers' demands, enabling our prototypes to meet the customers' demands to the utmost.

Under the perfect and strict technology management system, the former serious contradictions and disjointing between the technical department and the departments of marketing and customer service are gradually eliminated. Their participation enhances the ability for quickly transforming the high tech into the new products, which enables the company to have many good products with very high competitiveness and realize much better return rate for the technology investments.

6. Experience and Apprehension

Motorola has accumulated much experience from the implementation of the technology and management innovation in China, and made many achievements in the aspects of establishing the internationalized technology research centers, setting up, introducing the advanced technology management systems and the execution systems and training the local internationalized senior personnel of R&D and technology management, and at the same time has gained deep understanding of all these.

A. Internet Enables China to Have the Same Ability as the Whole World to Implement Technology Innovation and Management

The Internet technology enables China to have the same ability as the other countries in realizing the technology innovations. The most important of all is all the technology information is globally shared within Motorola. The development tool we are using is also the globally unified platform. What the technology departments in China are short of is the innovation experience and the accumulated innovation ability. We need to make much greater efforts to make more creations if we should attain in very short time the same ability and level as the labs in USA and Europe, or otherwise we would lose the competitiveness and be forgotten by the global technology research family. So we should introduce the systematic technology management system and quality control system. The project management procedure, software engineering management standard, and the repeatedly improved and evolved management procedures redeveloped on synthesizing the above models for the different organization layers have achieved very good result. The Internet-based management enables us to understand the causes of our failures and

successes from bulky accumulated data and information, offering us more scientific and more accurate methods for our future decision-making and improvement.

B. Technical Leader Should Be An Innovator

The leadership is very important. Innovation has risks, which usually lays the obstacle for the technical leaders. As the leaders of the technical departments, they should have new ideas, broad vision, enthusiasm for innovation, and can influence and inspire the people around them to achieve the targets together.

In 1996 when we established the first chip design lab in Beijing, I, as the technical supervisor in the Division of China, was challenged by many colleagues from USA and Europe many times on why should set up the chip lab in China and what China could do to the IC design. We had nothing at that time, such as the talents, experience, capacity and design environment, etc. An idea of Global Design Model flashed across my mind, that is to say the engineers in the Chinese labs can input the IC design and completed tasks they have fulfilled during the day into the shared computer system before their duty off while that is the time to start work for the labs in USA. So the system engineers in the labs of USA can immediately integrate the design results the Chinese engineers have completed that day into the chip system and continue the work of next step; when it is the time for duty off in USA, the Chinese labs just start their day's work…. Since the time is very important for the technology development, this new model of global consecutive development shall greatly reduce the time for the task fulfillment. This new idea has helped me, as the technical leader, introduce many advanced technical projects into China. Now, we can not only apply this model of global consecutive development in the IC design, but also introduce it to the device research and production, the simulation technology as well as much more technology development in the other fields.

C. Confidence has been greatly built up for Motorola China R&D Institute in Technology Innovation

Motorola China R&D Institute is becoming one of the important global R&D bases of the company. The Chinese engineers are able to offer the world the leading technologies in many important fields, and Motorola is gaining the confidence in the technology innovation in China. So we have set the goal for 2006: the accumulated investment will amount up to USD 1 billion and the R&D people will reach 5,000. This target is really challenging, and it also demonstrates that China is making for the world in the technology aspect and plays an important role in the world technology development.

In recent years, the Chinese engineers have made many and very important achievements. Taking A6188 mobile telephone that we call the handset of Taiji for

example, it not only integrates the complete functions of a mobile telephone, but also has the functions of PDA and Internet connection. The entire design concept from design to production of the handset is accomplished totally by the Chinese local engineers. This product not only has caused great sensation in China, but also been demanded in big quantity in Europe, and well received in USA. We are now developing CDMA handsets of next generation. Beside this, we also have many very advanced accomplishments and these are topping in many fields in the world. So we are confident to work together with every circle in China to meet the bright future of science and technology.

Globalization of Innovation[1]

Cathleen A. Campbell[2]

Innovation and technology represent two pillars shoring up the U.S. economy. Since World War II, science and technology advances have accounted for approximately 50% of the U.S. economic growth. Underpinning this leadership is a strong national commitment to invest in Research and Development (R&D) and to create a hospitable environment for businesses to invest and perform R&D. The continued commitment to technology has fueled the recent economic expansions – resulting in high-wage jobs, world-class exports, and productivity growth. Many will agree that continuing innovation is necessary to realize the advances of information technology, bio-technology, and nano-technology. Both the continued commitment to technology and continuing innovation are critical to the long-term global competitiveness of the U.S. It is important to consider these two concepts in the context of global knowledge creation in R&D.

Globalization is an ongoing phenomenon, not only in terms of the migration of people, the openness of markets, and the linking of economies, but in the steps leading to commerce – the research, manufacturing, and marketing of technology. The end of the Cold War ushered in a decade of political changes, open borders, and accessible economies. This coupled with the advances of the technology forces, especially Information Technology (IT), led to the three revolutions – communications, computational, and commerce. These technology-fueled revolutions resulted in the wave of open systems and co-mingling of ideas and approaches. To neglect the globalization phenomenon could result in effects on the U.S.'s R&D capacity.

As countries achieve excellence in R&D, they become attractive partners for researchers, businesses, and investors around the world. One significant aspect of globalization is that many of the inputs to innovation – people, infrastructure, and investment, often flow seamlessly across political borders. This paper describes the international trends in six indicators that are representative of the movement towards globalization of innovation. The indicators are research personnel, R&D investments, scientific publications, U.S. patents, alliances, and industrial R&D expenditures. While

[1] This paper provides a summary of the presentation. Detailed information on the data and source material is provided in the presentation.

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these indicators are not absolute, they show the changing participation of nations in the R&D enterprise.

Research Personnel:

While the U.S. leads in the number of personnel employed in the research sector, per capita increases in employment in the R&D sector can be seen in Japan, Sweden, Singapore, Australia, and Ireland. While it is not easy to determine the sectors of increases of the research employment, it is clear that countries with larger per capita employment of S&T workers are significant investors in the R&D sector.

Another aspect of the scientific workforce is the number of graduate in sciences and engineering. U.S. universities have known for a long time that Asia out-produces engineers in comparison with the other major nations, and that the number of foreign students in engineering in U.S. universities is growing.

R&D Investments:

Many countries around the world have increased their investments in research and development. In 1950, the United States contributed approximately 40% of the world Gross Domestic Product (GDP) and carried out about 70% of the world's R&D. In 1997, the United States contributed 27% of the world's GDP and carried out about 40% of the world's R&D. While no nation surpasses the U.S. investments in R&D in pure dollars alone, many of them surpass the U.S. in R&D intensity, which is a measure of R&D investments as a percentage of national GDP. Two trends are noted in this statistics: first, the number of countries approaching U.S. R&D/GDP levels has grown and second, some of these countries are newcomers to the R&D world and have done it in a short period of time. Some examples of these trends are:

- Countries like Sweden, Japan, and South Korea all invest a greater amount of R&D as a percentage of their GDP than the U.S.
- Newcomers in the performance of R&D – countries like Singapore, Taiwan, Australia, and Ireland have made strong commitments to understanding the R&D infrastructure and emulating the U.S. in creating incentives for technology and innovation.
- The United Kingdom, Israel, Egypt, and Jordan are incorporating technology and innovation policies as a critical component of their overall national economic and investment strategy.
- Canada has established an aggressive R&D target in their national science and technology plan – they plan to double the government's current investments in R&D by 2010 and want to rank among the top five countries in the world in terms of R&D performance.

- China plans to increase R&D investments to 1.5% of GDP by 2005, up from 0.83% of GDP in 1998.

These trends suggest that during the next decade or two, R&D investments will grow around the globe rather than in just a handful of countries. It is also clear that countries around the world are realizing the value of investments in R&D and maintaining or increasing this investment is a key aspect of their national innovation strategies.

Industrial R&D:

Monitoring industrial R&D flows into and out of the U.S. is also another measure of the shifting trends in the R&D enterprise. Increases and decreases in flows reflect changes in the needs of commercial R&D. There are several reasons why companies choose to locate and perform R&D outside their national borders. Desires to tap into quality workforce, proximity to market, and R&D excellence overseas. Discussions with several R&D directors of major U.S. companies at a recent roundtable held by the Technology Administration in the U.S. Department of Commerce revealed that this rationale continues. Company directors emphasized that in addition to the traditional incentives of favorable tax credits, many countries offer incentives such as; fully equipped laboratories, workers, and research funding.

Recent analyses of these flows over the last two decades shows that U.S. R&D investments made abroad have increased. In 1986, the U.S. spent $4.6 billion in R&D overseas, in 1997 that number had increased to $14 billion. A majority of these external investments are in Europe, followed by Canada, and finally, Japan, and primarily focused in the chemicals, instrument development, and machinery sectors. But this flow is not just outward. Between 1986 and 1997, foreign R&D investment in the United States increased from $6.5 billion to $19.7 billion. The top countries investing in the United States were Germany and Switzerland, followed closely by the U.K. Three major industries (drugs and medicines, industrial chemicals, and electrical equipment) accounted for over 50% of the investment.

Alliances:

Alliances can be viewed as another measure of globalization. Firms use alliances or other forms of cooperative activities to increase their market share, their core capabilities, and enter new technology domains. While alliances at the national scale are common, increasingly alliances at the international scale are viewed as critical to a company's strategic interests. The National Science Foundation reports that the number of new international technology alliances has grown tremendously in the last 20 years. While the

greatest growth has been in the IT sector, alliances in biotechnology, materials, automotive, and chemical sectors also show increases.

The trend to form alliances is also seen in the academic sector. An increasing number of universities have begun seeking overseas partnerships to increase their base of students and to leverage research capabilities abroad. In recent discussions at the Department of Commerce, university presidents and deans noted the movement towards setting up foreign campuses, and the ease with which they can recruit students for study in science and engineering. MIT, for example has established study and research partnerships with Cambridge University and Singapore University. The Cambridge-MIT Institute (CMI) supports faculty and student exchanges, as well as workshops and collaborative research projects in the physical sciences, engineering, IT, etc. The CMI has two industrial sponsors, British Technologies and British Petroleum, that have committed 5 million pounds over five years to support interdisciplinary research. Another such example is the partnership between the University of Maryland and China's Ministry of Science and Technology. Both entities have agreed to establish a science park at Maryland's College Park campus, where U.S. and Chinese researchers and entrepreneurs come together to engage in collaborative technology discussions and programs.

Finally, globalization also extends to government research and development. The motivations behind governmental alliances in R&D are to share knowledge and equipment, access foreign natural resources, and tap into specialized skills needed for interdisciplinary research projects. The Rand Corporation reports that the U.S. federal government spent approximately $4.4 billion on international cooperative research and development in fiscal year 1997. Much of this funding went towards cooperative activities with Russia, followed by Canada, U.K., Germany, and Japan. The figure represents a marked increase from the $3.3 billion in fiscal year 1995.

Scientific Publications:

Another indication of the trend towards a global research enterprise is the authorship of scientific publications. From 1995 to 1997, approximately 515,000 articles were published around the world. U.S. authors published 34%, followed by Japan at 9%, and the U.K. at 8%. While the U.S. maintains a significant lead over any other country, other countries account for 66% of worldwide publication. While this measure does not account for the journal type, the quality of article, or the specific area of research, it shows that other countries are publishing scientific material.

Patents:

Patenting trends also attest to the growing global nature of the research enterprise. In 2000, the United States led the world in both the total number of US utility patents awarded and also the number of utility patents awarded per million of population. However, the number of foreign-origin patents comprised 46% of all patents granted in the United States in 1998. Of this 46%, Japan and Germany accounted for 60% of the foreign-origin patents in 1998. Other countries with high patents per capita in the US patent system include Taiwan, Switzerland, Sweden, and Israel. This interest by worldwide inventors in obtaining patents, both within the US patent system and the European patent system is expected to continue.

Discussion:

What do these trends mean for the national R&D capacities of a nation? What do they mean for industrial organizations that are trying to grow in a globalized economy? It could mean more opportunities for U.S. companies – new markets give U.S. companies the ability to increase technology exports, they give companies the opportunity to tap into research excellence and talent around the world, at competitive costs. This can result in increased knowledge flows and revenue that could ultimately keep the R&D companies healthy and creative.

But it also means more challenges. Companies need to be aware of competition that may be located half-a-world away and must be able to move quickly to take advantage of opportunities in order to compete on a global basis. Finding innovative partners or keeping up with evolving technical centers of excellence in other countries can be difficult, particularly for smaller companies that lack the resources to maintain a significant presence overseas. The challenges facing U.S. technology firms operating in other countries can be daunting, particularly when the business climate is still evolving or government policies that impact technology innovation and business ventures are not clearly articulated or implemented.

In summary, it is clear that the investment and performance of S&T is international, and that in order to compete at the global scale, research enterprises must be prepared to handle the opportunities and challenges of globalization. It is also clear, that research organizations in government, industry, and universities have started to adjust their S&T strategies and taken this into account, by creating global bi-lateral and multi-lateral partnerships.

E. Innovation in Small and New High Tech Enterprises

Managing Technological Innovation Process of Complex Product System: Pattern of Chinese Firms

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Abstract This paper analyses the innovation processes of complex product system (CoPS) in China. First, the definition and the scope of CoPS are introduced. Because CoPS is high cost, high technology, highly customized and systematically complex, its innovation process has remarkable idiosyncrasy. Project is the core of CoPS's innovation as well as the focus of this paper. Then the authors bring forward their own innovation process model for CoPS, which combines the flow of innovation and the innovation system together. Taking a typical CoPS innovation project in Hangzhou SL Software Co., Ltd. as an example, the authors elaborate on the innovation process of CoPS based on this model. Technological innovation of CoPS is a new issue to china's enterprises, for which the authors put forward some useful referential principles to manage it.

Keywords: Complex Product System; Technological Innovation; Innovation Process Model.

1. Definition and Scope of CoPS

Complex product system (CoPS) is high cost, large scale, high technology, engineering-intensive product, subsystem, system or infrastructure.[1] Figure 1 situates the scale of CoPS along the traditional spectrum of production processes in the classical framework of Woodward (1958). CoPS contains all project/one-off and small batch production goods. [1]

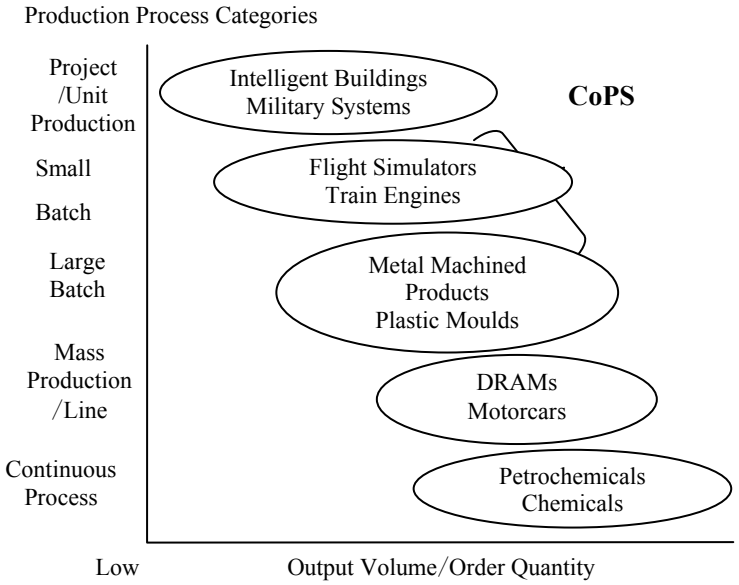

Figure 1 CoPS are high cost, project-based (or small batch) industrial Categories [1]. (Woodward, 1958)

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Compendious as it is, the framework of Woodward neglects the important dimension of the uncertainty of technology. The model of Senhar, Hughes and Walker provides a complement to it. As showed in figure 2, CoPS comprises high-tech and super high-tech component and systems, covering C2, C3, D2 and D3. For array/system of systems, it is excluded from CoPS, unless it can be supplied under one definable project [2].

Product/System Scale

	A Low-tech	B Medium-tech	C High-tech	D Super High-tech
4 Array/System of Systems	A4	B4	C4	D4
3 System	A3	B3	C3	D3
2 Component	A2	B2	C2	D2
1 Assemble	A1	B1	C1	D1

Technology Uncertainty/Novelty

Figure2 Two Key Dimensions of Project and Product [2]

2. Peculiarities and Importance of CoPS

As a new issue of innovation research, the most prominent difference between CoPS and "simple" product lies in their production methods. CoPS, upstream capital goods [1], are project or small batch production besides their systematic and hierarchical structure, software-intensive, and customization features.

Although the output of CoPS is very low, the total production of CoPS industry still makes up a large part of Gross Domestic Production of a nation because of its high unit large scale and price. It is reported, 21 CoPS-related industries contributed as much as 11%(value-added) to UK's GDP [3]. It is most important that CoPS is capital goods. It creates the basis for the production of goods by high volume, mass-production industries and in the supply of modern services [4]. They provide the infrastructure, which makes a modern economy and society viable [4]. The competence of innovation of CoPS indicates the general technology level of a nation.

3. Innovation Process model for CoPS

Owing to the peculiarities of CoPS, the two clearly interfaced phases, R&D and production, were not set apart in its innovation process. These two stages are integrated together in CoPS project. The project is not only the center of the innovation and production of CoPS, but also the center of research.

The peculiarities of CoPS also require a special theoretic model to explain its innovation process. This model must be a combination of flow and system. Many scholars have put forward their models of technological innovation. The most representative are the dynamic model of innovation patterns based on product life cycle described by James M Utterback [5], framework of technical innovation audit of Vitorio Chiesa [6] and model of successful innovation factors of Robert Cooper [7]. But, it is a pity, when applied to the extraordinary industry of CoPS, these models cannot describe the innovation process of CoPS well. Therefore, we advance a new model of innovation process of CoPS, which is illustrated in figure 3.

This model has a clear description to the core innovation flow of CoPS: from the initial of innovation to R&D (including product innovation and process innovation) and then the diffusion of innovation. This flow needs to be subdivided. The initial of innovation is subdivided into opportunity identification and product conceptualization. Product innovation is divided further into three stages: component R&D, system R&D and system integration. The diffusion of innovation here, it must be pointed out, does not mean manufacture and sales as defined in the traditional innovation theories, but the fixture and debugging in delivering a project.

This model represents the high systematism of innovation project of CoPS as well. The surrounding system consisting of innovation strategy, organization environment and innovation resources constructs the infrastructure for the core flow of innovation, under whose joint action, the firm achieves innovation performance.

According to the above model, we study the technological innovation process of CoPS in Hangzhou SL Software Co., Ltd. SL Software is established in 1993. Now it is one of the largest security exchange software developer. The general innovation performance of SL Software is very high. The success rate of its self-launched innovation project is as high as 50%. Furthermore all of its customized innovations succeed. The rapidity of SL's innovation is another embodiment of its high innovation performance. The time to market of new CoPS of SL is 20% less than its competitors. Moreover, SL spends only 70% time of its rivals to get profit from new developed CoPS.

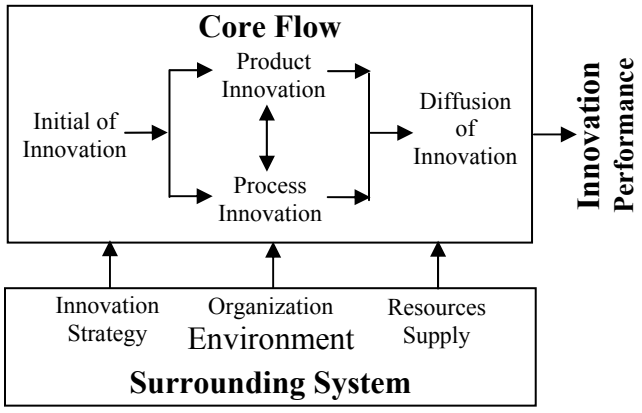

Figure3 Model of Innovation Process of CoPS

SL security exchange system is a large software system of enterprise level. Its unit price is about one million RMB. This software system is developed and completed by his project team with fairy high technology level. These traits are consistent with the characters of CoPS. There are many innovations in the system. The total solution of enterprise accomplishes the replacement of computer exchange over manual deal, so that the efficiency and reliability are improved apparently. It supports trade through telephones or web, which extends the trade time to 7×24 hours. This system conforms to open structure standard and is easy to be transplanted to new environments. During the development of this system, SL Software introduces and exercises the Capability Mature Model (CMM). CMM helps SL to cut its cost and shorten the development cycle. This can be regarded as process innovation of software design. According to above, the security exchange software system is chosen as the typical case of innovation of CoPS.

4. Core Flow

The technological innovation of CoPS is co-initiated by user and produce, namely a user-producer driven innovation [1]. In the innovation flow of security exchange system the marketing and sales departments are the major innovation initiators within the firm. Frequent communication with users and customers occurs during marketing and sales activities. Thus the inspiration of innovation is generated. The blueprint of innovative product, which means the system analysis in software project, is conceived by marketing department with the help of internal R&D department. It must be pointed out, that the innovation inspiration acquired by marketing or sales department is the need of user and customer in essence. So this project is also a typical market-driven innovation[8].

In R&D stage of innovation, the internal R&D is the dominant (only) source of information and technology acquisition. This derives from the intensive participation of user and customer in the initial stage. The innovation path is agreed ex-ante among producer, customer and user [1].

The innovation of CoPS focuses on product design and development [1]. Process innovation is not the emphasis, especially in software development. The traditional manufacture does not exist in software development, let alone the traditional process. But the adoption of new software development methodology could be looked upon as process innovation. SL introduces and executes the CMM during the development of security exchange system. This is the process innovation SL accomplished. Technology source of CMM is internal R&D.

To CoPS, the innovation and diffusion collapsed [1]. Internal R&D dominates the diffusion stage. At the same time the sales department plays a bigger role and regains the position of the main source of information.

5. Surrounding System

(1) Innovation Strategy

Product development is the core of innovation strategy of CoPS. The most important purpose of innovation is to provide new product or service, to improve the quality and to increase customer satisfaction. While cost cutting, market penetration and market development are less considered.

(2) Organization Environment

Project is the fundamental unit of innovation of CoPS. Most firms in CoPS industry are organized encircling the project team or a matrix structure. The transfer from functional structure to matrix structure is on the way in SL.

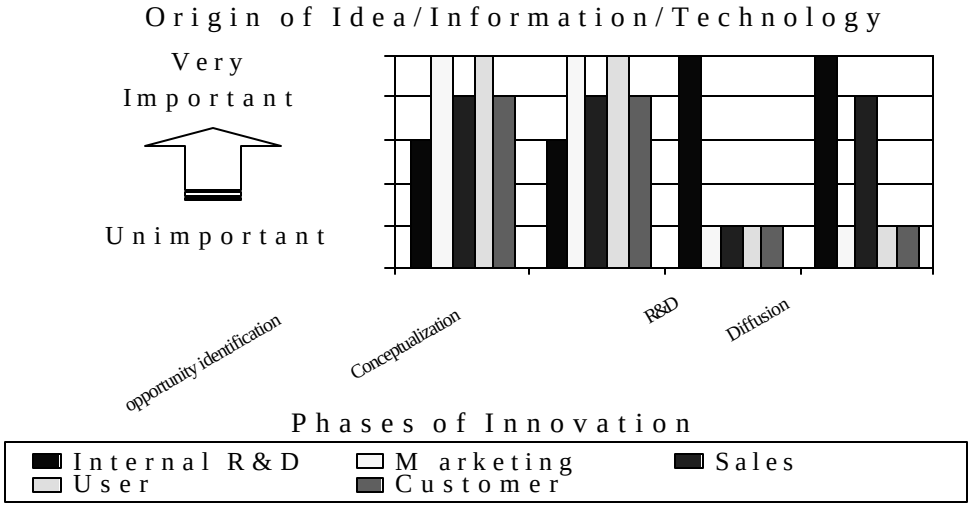

Figure 4 Idea/Information/Technology Acquisition

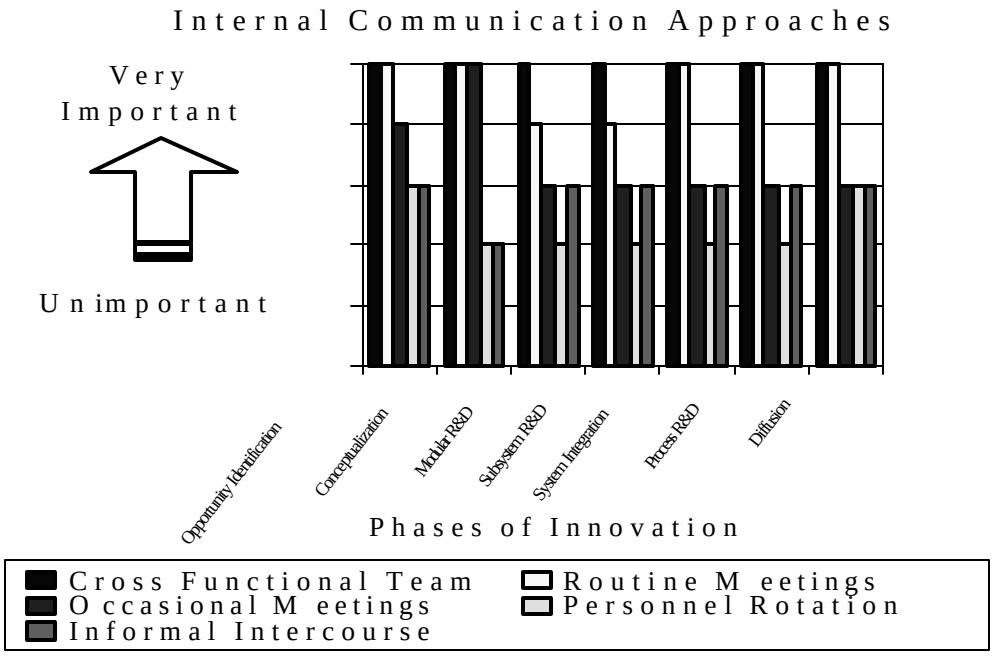

Figure5 Internal Communication Approaches in Different Phases of Innovation

Tight cooperation enhances the acquisition of exterior information. In contrast to mass-production industry, in which information is fed backed through price mechanism, immediate feedback to the innovation project is prevailing in innovation of CoPS to come over the high uncertainty [2]. In the case of SL, the immediate feedback is always important during the whole innovation flow. At the initial stage, because the market

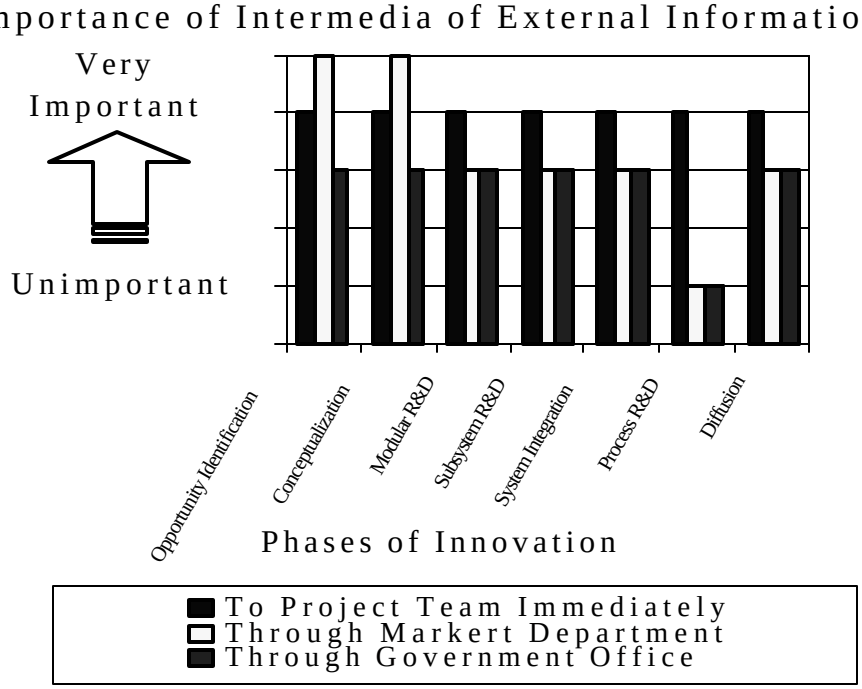

Figure 6 Approaches of External Information Feed back in Different Phrase of Innovation

department undertakes the initiator's role, it is also the main feedback loop of information. Since the security exchange system is applied in a strictly regulated industry, the government, namely Security Exchange Committee, also provides much information. (Figure 6)

Sources Supply

Innovation of CoPS requires lots of resources to support it. As showed in figure 7, non-material resources are most important to innovation of CoPS. The human-related factors, such as technician, marketing experts and the support from top managers, are especially crucial. The equipment, marketing channel and other elements significant to mass production are minor factors here. The function of purchasing is nearly ignored.

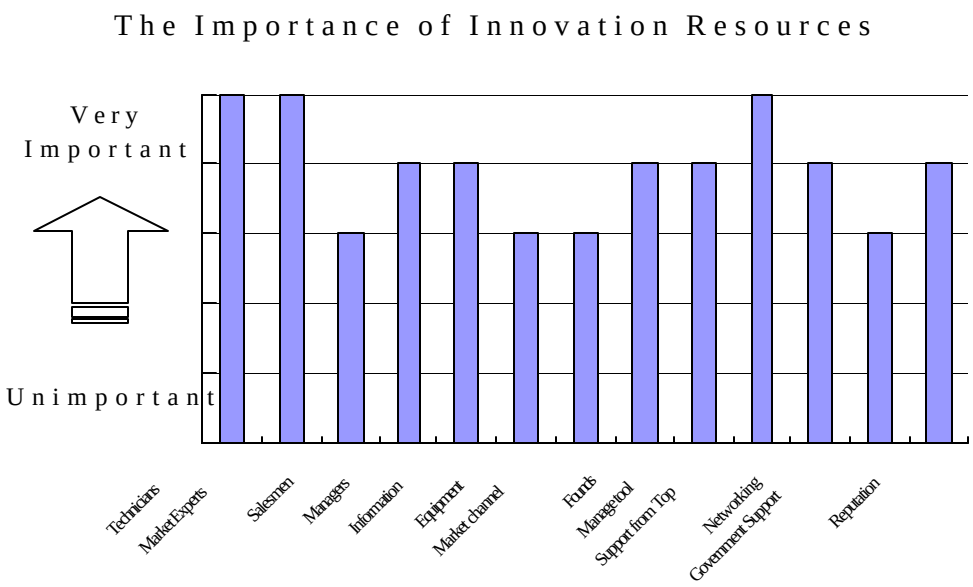

Figure 7 Importance of Innovation Resources

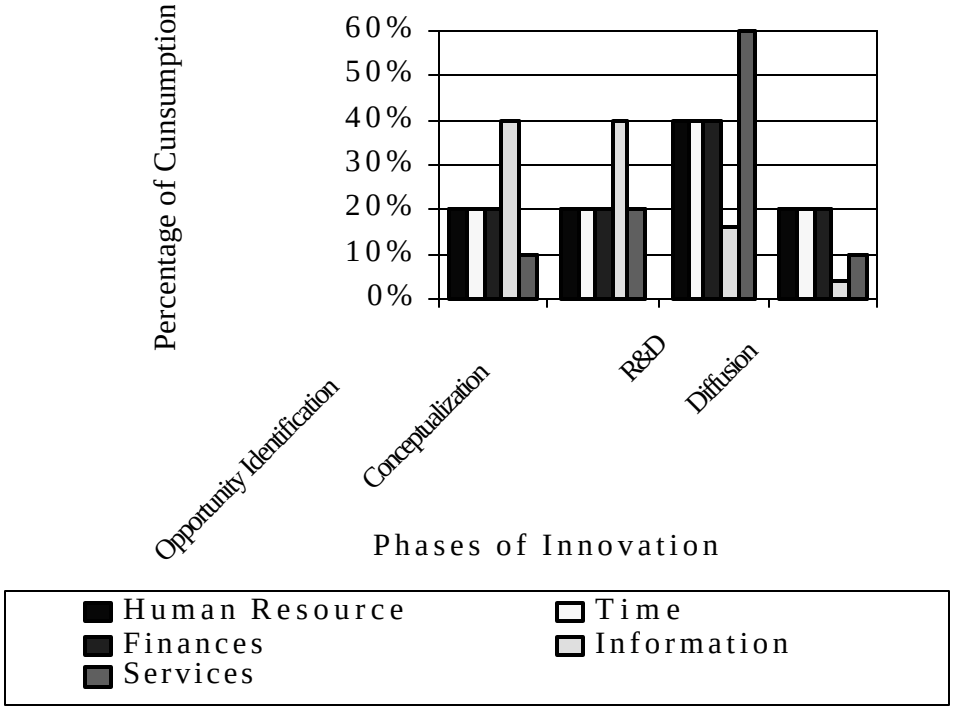

Figure 8 Consumption of Resources in Different Innovation Phases

To those gradually consumed resources, for example human resources, time, financial resources, and services, its consumption is not equable among phases. Though information is not consumptive (it is still existent after used), but the demand for it is also uneven.

It is believed that information is intensively needed in initial phase implicated by our survey in SL Software. Opportunity identification and product conceptualization stages occupy 80% of information usage. The personnel and time are devoted nearly equally into the project during the whole innovation process, and that the requirement for founds vibrates with them synchronously. The demand for service fluctuates heavily. It rises to its peak in the R&D phase, and contributes much less to diffusion.

6. Conclusion

1) The emphasis of innovation management is project management. It consists of managing the flow of the innovation project and creating the infrastructure for the project.

2) High degree of participation of user and customer is one of the most remarkable characters of innovation of CoPS. Producer in company with end-users and customers initiate the core flow of innovation of CoPS. The marketing and sales departments generate most of innovative inspiration and conception. Internal R&D is the main source of technology. The innovation and its diffusion, which are clearly interfaced in mass production industry, overlap each other in CoPS industry.

3) The innovation strategy apt for innovation of CoPS is demand-oriented and focuses on developing and improving product. Cost-cut is nearly out of count.

4) The organization form for innovation of CoPS is centered on the project team. Cross function team and routine meeting are the most effective approaches of internal communication. Loosely coupled multi-firm cooperation helps to keep the balance of specialization and responsiveness of the innovation team. It also lends itself to feed back information into the project team immediately. Non-material resources, especially the human resource, are most crucial to the success of innovation of CoPS. The need of resources is not equal during innovation process. The initial phase and R&D phase consume most of resources.

Chinese firms are faced with the strong impact brought by the entrance into WTO and globalization of economy. Understanding the innovation process of CoPS in depth will strengthen the competitive competence of Chinese firms. And, therefore, it will also consolidate the basis of the national economy.

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Some Exploring Research on Chinese State-owned Enterprise's Sustainable Innovation Process

-Operation Patterns, Trends and the Management Mechanism

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Abstract Enterprise's Sustainable Innovation (ESI) is a challenging problem faced by worldwide enterprises and academia. Supported by the NNSF of China, The author has devoted to research on the theory and practice of the Chinese State-owned Enterprise's Sustainable Innovation (CSESI) process for years. This paper briefly reports some exploring work on the Operation Patterns, Trends and the Management Mechanism of the CSESI process.

1. Introduction

Innovation and Sustainable **Development** are important issues of the contemporary management science. In practice, China has accepted innovation and the sustainable development as the Nation's basic policies. However, the enterprise's sustainable innovation and development of the Chinese state-owned enterprises, is still an important problem either in practice or in theoretical research.

Here, **Enterprise's Sustainable Innovation (ESI)** means a process in which an enterprise has (had) continually implemented innovation projects (which are include of introducing new products/process techniques/developing new markets/acquiring new materials sources/realizing new organization or new institution and/or their inside diffusion) for a long period and made a continually significant benefit growth during this period (Xiang G., 1996, 2000).

The most valuable quality of the enterprise's innovation is its sustainability. Observing the Chinese state-owned enterprise's practice by the basic concept of ESI, we could find that it is a fact: since the reform and open-door policies implementing, some excellent State-owned enterprises have successfully overcome various obstacles existed within the transition process from the Planning system to the Market system and realized more than ten years sustained innovation, obtained sustained profits growth and developing for themselves. For instance, since 1981, the Yuxi Hongta Group Corporation (the former Yuxi Cigarette Factory) had realized the ESI for as long as 19

years. The annual profit plus taxes continually increased from 118 millions RMB yuan in 1981 to 20.8 billions RMB yuan in 1998 and the annual average increasing rate was 33.3%. During this process, it contributed 120 billions RMB yuan profit plus taxes.

Moreover, it developed from a middle enterprise to the leading one in the Chinese tobacco industry with largest scale production ability and the world-advanced equipment (Xiang G., 2000). Generally speaking, in everyone of the relative fast-developing industries in China, we could find there exist one or more excellent State-owned enterprises that have (or had) successfully realized the ESI process and got sustained developing like the Yuxi Hongta Group. For example, the Baoshan Steel and Iron Corporation in the steel and iron industry, the Legend Group in the computer industry and Haier, Changhong, Chunlan, Konka and so in the family electrical equipment industry. These excellent State-owned enterprises have become leading ones in the recent Chinese economy's sustaining developing process.

However, in fact, the most difficulty of the enterprise innovation also is the sustainability. The implementation of the ESI has become a challenging problem faced by the enterprises worldwide. In China, since performing the reform and open-door policies, "technological innovation has become common behavior of the Chinese enterprises" (Ma Chi, et al, 1992). However, the innovation process of most State-owned enterprises is lack of sustainability. Usually, it may be stopped after implemented one or two-innovation project. It is the basic reason for the most State-owned enterprises could not obtain the sustainable benefit-growth that they could not sustain their innovation. Even in the excellent State-owned enterprises, which have realized the sustainable innovation, the top managers also are doing things blindly by lack of the theoretical guidance. Moreover, for reasons of lack of effective motivation, supervision and restraint mechanism, some tragic events, in which few entrepreneurs of the excellent State-owned enterprises had got economic guilty and went to jails, occurred in China. This tragedy resulted serious losses (Xiang G., et al, 1998). The worldwide concerned case of Mr. Chu Shijian, the ex- chairman of the executive board of Yuxi Hongta Group, was a typical one.

So, based upon the sustainable innovation practice of the excellent Chinese State-owned enterprises and learning from the references of the over-sea excellent enterprises experience, to research on the operation patterns, developing trends and management mechanism of the ESI of Chinese State-owned enterprises, is both meaningful for providing the theoretical guidance to further the ESI process and supporting the government agencies to make promoting policies. Moreover, it is valuable to build a Chinese Enterprise's Sustainable Innovation Theory System and enrich the contemporary

innovation theory by combining the basic principles of innovation theory with the practice of the Chinese enterprise's innovation.

By using the basic innovation theory and the systems approaches, we have implemented research on the theory and practice of the State-owned enterprises' ESI process for more then 6 years. Fortunately, under the financial supports of the NNSF of China, the NSF of Yunnan Province, China, and the foundation of Yunnan Provincial Education Committee as well as the cooperation of the government agencies and enterprises, this research work has obtained achievements. This paper will briefly report some exploring research on the operation patterns, trends and management mechanism of the State-owned enterprise's ESI process.

2. The Operation Patterns of the ESI process of the Chinese State-owned Enterprises

According to long-term observation to the innovation practice of the excellent Chinese State-owned enterprises, especially, the systematic investigation and research on the sustainable innovation process of Yuxi Hongta Group and other more than ten excellent State-owned enterprises in Yunnan Province, we find that the ESI of the Chinese State-owned enterprises has following common patterns in the operation.

2.1 Started up by the Nation's Institutional Innovation

The ESI process of the Chinese State-owned enterprises is started up by the Nation's institutional innovation. In fact, the implementation of the Reform and Open-door policy- the most important institutional innovation of this nation after 1949 has started up all the State-owned enterprises' innovation since the end of 1970s.

The excellent State-owned enterprises which have (had) implemented the ESI process could be identified as two kinds. One kind is produced directly under the Reform policy such as Baoshan Steel & Iron (Founded in 1985) and Legend (Founded in 1984). The Nation's institutional innovation pushed these enterprises into the market as soon as they were born. Moreover, the government provided necessary financial resources to start up their particular technological innovation project.

Another kind existed even before the implementation of the Reform and Open-door policy. They are as Sichuan Changhong Machine Factory, Yuxi Cigarette Factory, Kunming Pharmaceutical Factory and Yunnan Internal-Combustion Engine Plant. During the passed planning economy period, in fact, these State-owned factories were only the appendages of the government. They neither had independent economic benefit nor the responsibility for the management losses. So that they had no motivation to

promote the innovation. Moreover, during this period, there was still lack of the basic platform for the enterprise's innovation: the Market Condition.

After the implementation of the Reform and Open-door policy, they have been pushed into the market and become the main bodies of their management and in charge of the profit or loss. These "factories" begin to get their own economic benefit and gradually become real enterprises. Above critical changes awaked the innovation-entrepreneur conscious of some excellent top managers in the State-owned factories-enterprises and motivated them try to make the profit increasing and the enterprises developing by innovating. Otherwise during this time, in order to help the State-owned factories-enterprises to overcome the difficulty of lack of money-capital, the government provided the direct investment, favorable loans or quotas of the foreign currencies to support the particular project (it may be technical acquisition, R & D or technology renewing project) for the State-owned factories-enterprises and start-up their innovation.

2.2 Strong Supports from the Government

The successful sustainable innovation of the State-owned enterprises realized under the strong supports from the government.

In fact, in the beginning of the implementation of the Reform and Open-door policy, the State-owned enterprises had no their own money-capital to invest to the technological innovation project, especially, the necessary foreign currency for introducing the advanced technology and equipment from abroad. The money-capital to start-up the technological innovation project in the enterprises was provided directly by the government investment or favorable bank loans approved and guaranteed by the government. The positive research results highlight that the successful start-up projects of the excellent State-owned enterprises' ESI process obtained strong financial supports from the government (Xiang G., et al, 1997, 2001). In the implementation process of the enterprise's technological innovation, it obtained the policies supports such as payback the loan before taxes, tax deduction or exemption of the R & D investment and the new products sales, the knowledge property protection and so on. It is clear that if had no the strong financial and policy supports from the government, the ESI of the State-owned enterprises would have become failure.

The State-owned enterprises directly were born under the Reform policy such as Baoshan Steel & Iron, was founded by the government direct investment about 20 billions yuan RMB from 1979 to 1985 by introducing foreign advanced technology and equipment. It has realized the ESI by the favorite policies support from the government since then.

The Legend Group which is independently managed by individual people, also started up by 200,000 yuan RMB of the original capital input from the State agency-the Science Academy of China in 1984 when the Nation's science and technology system's reform began to perform. Even though the money input was little, the policy supports are strong and always effective through the whole ESI process for long than ten years. The supports and understanding from the enlightened "Mother in-law"-the Science Academy of China are the critical conditions for its sustainable innovation and development (Zhu Huijiang, 2000).

For the State-owned enterprises that have existed since the planning economy period, the strong support of financial and other policies from the government is a key factor to achieve the ESI realization.

For instance, the ESI process of the Yuxi Cigarette Factory started up from the advanced equipment introduction project in 1981, when the Yunnan Provincial Government arranged and input foreign currency for the factory to buy a set of MK-95 cigarette machine from UK, then achieved significant benefit. In 1985, it performed a "Three Institutes Combined to One" organization innovation by the support of the government and realized effective control of the high quality tobacco leaf raw-materials production and purchasing. In 1984-86, under the strong policy supports of providing the foreign currency quota, guarantee of the bank loan and payback the loan before taxes from the provincial government, the Yuxi Cigarette Factory systematically introduced 16 sets of world advanced level equipment (cost 23 million USD) from abroad. By using the high quality material and advanced equipment, the Yuxi Cigarette Factory developed several famous brands of the cigarette products such as "Hongtashan", "Ashima", "Yuxi" and "Hongmei" and put them into large-scale production. These products are welcome by consumers and obtained high speed and sustained growth of the benefit. In 1988-1994, the Central Government implemented a price-control loosing policy for 13 brands of the famous cigarette products in China, in which 4 brands made in the Yuxi Cigarette Factory. Under this policy, the Yuxi Cigarette Factory began to make large amount profit for itself and accumulated billions RMB as the strong found base for its further invest of technology equipment acquisition. Generally speaking, the government's strong supports have always effectively taken place from the ESI start-up to the implementation process of the Yuxi Cigarette Factory (Xiang G., et al, 1997).

Since developing the YQ4100 Diesel Internal-Combustion Engine product in 1992, the Yunnan Internal-Combustion Engine Plant started-up its ESI process and has successfully implemented it up to now by the strong policy supports from the Yunnan Provincial Government. Its new products developing and commercialization project had been accepted into the province's "Torch Plan" and get 48.4 million yuan RMB to this

project. Since 1994, the enterprise has implemented a technology renew plan by inputting 160 million yuan RMB under the favorable loan and policy support. The enterprise introduced worldwide advanced KW Casting Production Line from Germany, founded CIMS and Manufacturing Center, then formed large-scale production ability to produce the advanced series-products. The production and selling amount of the YQ4100 series products which have strong competition ability in the dominant market from 2000 sets in 1991 increased to 60,000 in 2000 and will reach 100,000 sets in 2001. This enterprise has realized 10 years sustained and high-speed growth of the production, selling, sales and profit and become the excellent enterprise with very strong ability to sustain its ESI process in the Chinese mechanical industry (Zen Yinkun, et al, 2001).

Above cases highlight that the supports from the government is very important for the State-owned enterprises to realize their ESI. Otherwise, the State-owned enterprise actively search then obtain the supports from the government, is a key factor for it to achieve the success.

2.3 The Dynamic Systems Integration of the Innovation Project Clusters

After the Start-up, it is a key for it to sustain its ESI process that the enterprise could continually implement and realize the new innovation projects.

Usually, the Start-up project of the ESI process realized by taking a breakthrough of solving a "neck-bottle" problem in the production or management process and then obtained significant benefit. The achieved benefit (It has never been obtained even imaged before!) encouraged the top manager's stronger willingness and spirit for further innovation. Otherwise, the breakthrough of solving a "neck-bottle" problem broke the ordinal balance in the production-management system and created new unbalance. That is, created new "neck-bottle." Under the driving power of the entrepreneur spirits, the enterprise's top managers continually launch and implement the new innovation projects to overcome the faced new "neck bottle" or unbalance. This is the critical mechanism of the ESI process forming.

Further research found that the successful ESI is not a simple process formed by the innovation projects simply one plus one by the time horizon but a complex process formed by the continually dynamic systems integrating of the innovation project-clusters of the multi-kinds (it may include of the innovations of the products, process, Market, materials, organization, institution and management and so on) and multi-projects. It has following characters: (1) From the start-up project, there exists close relationship and reaction within all the projects. The realized project not only created new unbalance and became a basic reason factor for further innovation project, but also provided fundamental condition to perform succeeded project. The total ESI process becomes a

dynamic integrating system of the multi-kinds and multi-projects innovation project-cluster; (2) The benefits of the whole ESI process not only include of the sum of benefit created by each project itself, but also the benefit created by the systems integration effect of the projects or project-clusters reaction within the ESI process.

The ESI processes of the Yuxi Cigarette Factory and the Yunnan Internal-Combustion Engine Plant are these typical dynamic integrating systems of the innovation project cluster (Xiang G., 2000, Zen Yinkun, 2001).

Moreover, the ESI process-the dynamic integrating system of the innovation project cluster is a man-made system and the entrepreneur is the major founder. The entrepreneur-ship and outstanding leading ability are the most important driving power to format the system and achieve the systems benefit. Otherwise, the excellent entrepreneurs who understand above dynamic system's law of the ESI process well, could be able to achieve the satisfied system benefit of the ESI process by actively coordinate the relationship between the projects or project clusters in the ESI process.

2.4 The Particular Entrepreneur-oriented

Observing the ESI process of the State-owned enterprises in China, we could find that a particular excellent or outstanding entrepreneur usually promotes the successful ESI process of a State-owned enterprise. For example, the Baoshan Steel & Iron Group's with Li Ming, the Legend Group's with Liu Chuanzhi, the Haier Group's with Zhang Ruiming.

The long-term economic construction-oriented and stable social environment gradually formed under the reform and open-door policy, provides a great space (that never existed before!) for the excellent or outstanding leaders of some State-owned enterprises to realize their ideas by using their talents and ability. It gives them such an opportunity to devote to successfully promote the ESI process and development during a long period. However, for the situation of the extra-scarce of the entrepreneur resource and the weakness of the mechanisms to foster and acquire entrepreneur during the transition period, the ESI of the State-owned enterprises is too depending on the particular entrepreneur. That is in large extent, the particular entrepreneur impacts the ESI process. If the particular entrepreneur is out of the office, the ESI process will be waved seriously even stopped. In fact, after the top manager changed in some State-owned enterprises that realized the ESI process, the benefits continually gone down in a relative large extent (Jia Ke, 2001).

In one side, this Particular Entrepreneur-oriented ESI of the State-owned enterprises highlights that some excellent entrepreneurs have been produced in the reform and

innovation process of the Chinese State-owned enterprises. They provided great contribution to realize the ESI of their enterprises and played a critical role to promote the ESI. However, in other side, it shows that there are usually no suitable successor to the particular excellent entrepreneur for reasons of the delay of the systems reform and the mechanisms construction of the intelligent people's foster and collection. So, it lead to the ESI of the State-owned enterprises too depends on the particular entrepreneur. That also shows in the resent time, the ESI in the Chinese State-owned enterprises still has some accidental and fragile characters.

2.5 The Value-priority Directed Strategy

Our research finds that most successful ESI of the State-owed enterprises have a common character in their strategies that may be various in particular implementation: the Value-priority Directed Strategy. The State-owned enterprises that implemented the ESI process usually devote to build excellent brands of their own critical products or services. As the results, some Chinese Famous Brands, such as Hongtashan, Haier, Legend, Changhong, Yunnan Baiyao have been developed by these enterprises and officially affirmed by the Nation's Business Administration Management Beau and then have enjoyed the wide legal protection in China even worldwide. These enterprises keep to try their best efforts to increase the products' function, to improve the quality, so that to satisfy consumers and achieve the goal of raising the value of their products even the enterprises themselves given by the consumers. These efforts of raising the value may lead to the cost increasing. However, if they obtain the accept and welcome of the consumers, the raising of selling price may higher than the raising of the cost and the business may enjoy the sustained benefit growth and market developing in a long period.

So, the Haier Group pointed out that it devotes on Value-bottle but never cares to the Price-bottle (Yan Jianjun, et al, 2000).

The products' "High Quality Strategy" implemented in 1980-90s by the Yuxi Cigarette Factory, is a successful case of the Value-priority Directed Strategy. This enterprise had input 5 billion RMB to raise its products' quality and function from the improving in equipment, manufacturing techniques, materials and management during 1981-1996 period. Its major product brands "Hongtashan," "Ashima," "Hongmei" and "Yuxi" are welcome by the consumers. The selling price of "Hongtashan" from 3-yuan RMB a peck in 1988 increased to 12-yuan RMB (much higher than the price of "555" or "Malboro" in the Chinese cigarette market) in 1996. The "Hongtashan" had been honored as the Number One of Brand in China in 1997. In tern, the enterprise obtained 15 billion yuan RMB profit and contributed about 65 billion yuan RMB taxes to the government (Xiang G., 1997).

3. The Trends of the ESI in the State-owned Enterprises

We think that the ESI in the Chinese State-owned enterprises has following developing trends.

3.1 Devoting to the Enterprise's Development coordinated with the Environment: The Green & Sustainable Innovation

This is an important trend for the ESI of the excellent Chinese State-owned enterprises that to go on the path of the Green & Sustainable Innovation and to achieve the coordinated development of both economic benefit and the ecological environment.

Based on the planning economy background, the Chinese State-owned enterprises, especially, in the chemical engineering and other major manufacturing industries, used to concentrate on product quantity and hardly care the environment protection. In fact, the development of a large number of Chinese enterprises resulted serious problems such as pollution, low efficiently consuming on energy and raw materials.

With the society progress, China has adopted the Sustainable Development and Environment Protection as the nations basic polices. The government has implemented more and more serious constraint and higher requirement on the production process exhausting and the product's characters in healthy and environment protection. These requirements are very important for the enterprise's survival and development even own the authority of "One Vote to Overthrow." So, in search for sustainable survival and development, the enterprises have to perform the sustainable innovation in the sectors of production exhausting matters, the products' quality of the environment protection and the quantity of the low-inside harmful substances as well as the low consuming of the raw-materials and energy. That is, to perform the Green & Sustainable Innovation to satisfy the higher and higher requirements from the consumers, government and environment.

In our research, we find that some excellent State-owned enterprises have realized the important trend of the Green & Sustainable Innovation and successfully implemented it.

A good example is in the Kaiyuan Jiefangjun Chemical Fertilizer Plant, which is used to be the biggest terrible pollution source in the Kaiyuan City, Yunnan Province, China. The production process exhausted a huge amount of waste gas with H_2S, SO_2 and wastewater with phenol, resulted serious pollution to the city and harmed people. However, the director of the Plant, Mr. Sen Shouming, pointed out that the most harmed people just the plant's people and their family because they work and live in the pollution

center. So, this is the most important thing to reduce pollution, the consuming of the raw-materials and energy then achieve benefit from processing the waste gas and water. This enterprise have realized 7 years Green & Sustainable Innovation and achieved significant economic and environmental benefits (Xiang G., et al. 1998, Hong Jie, et al, 1999).

Another excellent State-owned enterprise that has implemented the Green & Sustainable Innovation is the Yunnan Aluminum Industry Corporation. This enterprise has raised the goal of the coordinated development of the enterprise, people in the enterprise and the ecological environment to the enterprise's mission level. Especially, this enterprise treated its developing goals combined with the international standard. After passed the recognizing of ISO9000 to its products quality in 1998, the Yunnan Aluminum Industry Corporation has implemented a large-scale technological process innovation project of 1.5 billion yuan RMB investment to solve the environment pollution and reduce the consuming on energy and raw-materials. Then, it passed the recognizing of ISO14000 to its product quality, environment protection in 2000. Now, this enterprise has determined to realize the recognizing of ISO18000 to quality, environment protection and safety in 2005 as its clear goal of the sustainable innovation (Hong Jie, et al, 2001).

Obviously, these excellent State-owned enterprises that are going on the path of the Green & Sustainable Innovation, highlight a basic direction for the ESI of the Chinese enterprises in the 21-century.

3.2 Devoting to the Enterprise's Management Information Systems Innovation

Since 60s in 20th Century, the Information Technology (IT) has rapidly and continually developed and provided deep and worldwide impact to the globe economy development. The developing of the information technology, especially the network techniques, provides strong technological supports to the enterprise's management innovation. The more and more accurate, rapid and safe MIS has strongly pushed the enterprise's organization and management innovation. Entrepreneurs have recognized the potential benefit of the "creative combination" of the modern computer network systems management technique with other management factors and devoted to the enterprise's IT and management innovation. In fact, more than 280 of the "Fortune 500" have implemented the advanced Enterprise Resource Planning (ERP) system.

Performing the continually innovation on MIS has become a trend of the ESI in the Chinese excellent enterprises. Now, some State-owned enterprises that realized the ESI, such as Legend, Changhong, Konka, Yuxi Hongta, have implemented the ERP system. The goal is to promote the enterprises' sustainable management innovation by the

continually Enterprise Process Improving (EPI) or Enterprise Process Reengineering (EPR) in the ERP implementation process.

3.3. Changing to the Multiple Ownership

Changing to the multiple ownerships is a basic problem of the reform in the State-owned enterprise. It also is the important content of the institutional innovation of the ESI process. Now, under the nation's reform policy, it becomes an important trend that the most State-owned enterprises will change to the multiple ownerships.

In fact, some excellent State-owned enterprises implemented the ESI have performed this change and got success. For example, the Legend Group has realized the multiple ownerships since 1992 by entered Hong Kong Stock Market. The members of the enterprise obtained 35% of the profit sharing property (it became stock ownership in 1999) in this year (Zu Huaijiang, 2000). The Kunming Pharmaceutical Corporation has realized a "State-owned But Uncontrolled" pattern in 1995 by reorganizing the Kunming Pharmaceutical Factory with enterprises of other kind ownership. The State-owner and another Group-owner shared same amount stock of 36.8%, plus other 3 corporation-stock owners; they founded an active executive board and management agency. In this ownership-structure, the State is still a large stockowner but is not a controlling stockowner. It kept the important impacts of the state-owner and promoted the active function of other kind owners and formed an active operation mechanism. After this reorganizing, the enterprise has realized sustained and rapid growth in production, sales, profits and taxes (Zhong Jing, 2000).

Above exploring on the multiple ownership shows that the changing from the unique State-ownership or the obsolete-controlling State-ownership to the relative-controlling State-ownership even uncontrolling State-ownership, and introducing the institution innovation such as the stock-ownership for managers, technicians and critical workers to optimize the enterprise's property structure, is an important developing trend. However, according to the basic socialism-system with the main body of the public ownership, the change process would be gradual and limited objective.

3.4 Changing from the Particular Entrepreneur-oriented to Mechanism-oriented ESI

Changing from the Particular Entrepreneur-oriented to Mechanism-oriented is the fundamental problem and trend of the ESI in the Chinese State-owned enterprises. The core of the changing is to form an effective management mechanism to effectively and continually select, use and motivate the excellent entrepreneurs, and also to effectively supervise, evaluate and restrain their behavior. Moreover, this mechanism not only could

effectively manage the top manager, who is in the office, but also could effectively select and use another excellent one to continually promote the ESI as soon as the original top manager is out of the office. Some excellent State-owned enterprises such as the Legend Group, have taken explore on this field and achieved certain experience (Zu Huaijiang, 2000).

Moreover, based on the real situation in China, realizing this change, that is, to build an effective management mechanism for the ESI of the excellent Chinese State-owned enterprises, is a complex and difficult systems engineering process that could not be finished by a one-time project. First, the most important thing is correctly recognizing and grasping the core and key parts and building them in priority. After then, it could be gradually perfected and formed as a system by the improvement in practice.

4. The Systems Framework of the Chinese State-owned Enterprise's ESI Management Mechanism

Based on above discussion and with the real situation and requirements, we roughly provide a system Framework of the Chinese State-owned enterprise's ESI management mechanism (see Figure).

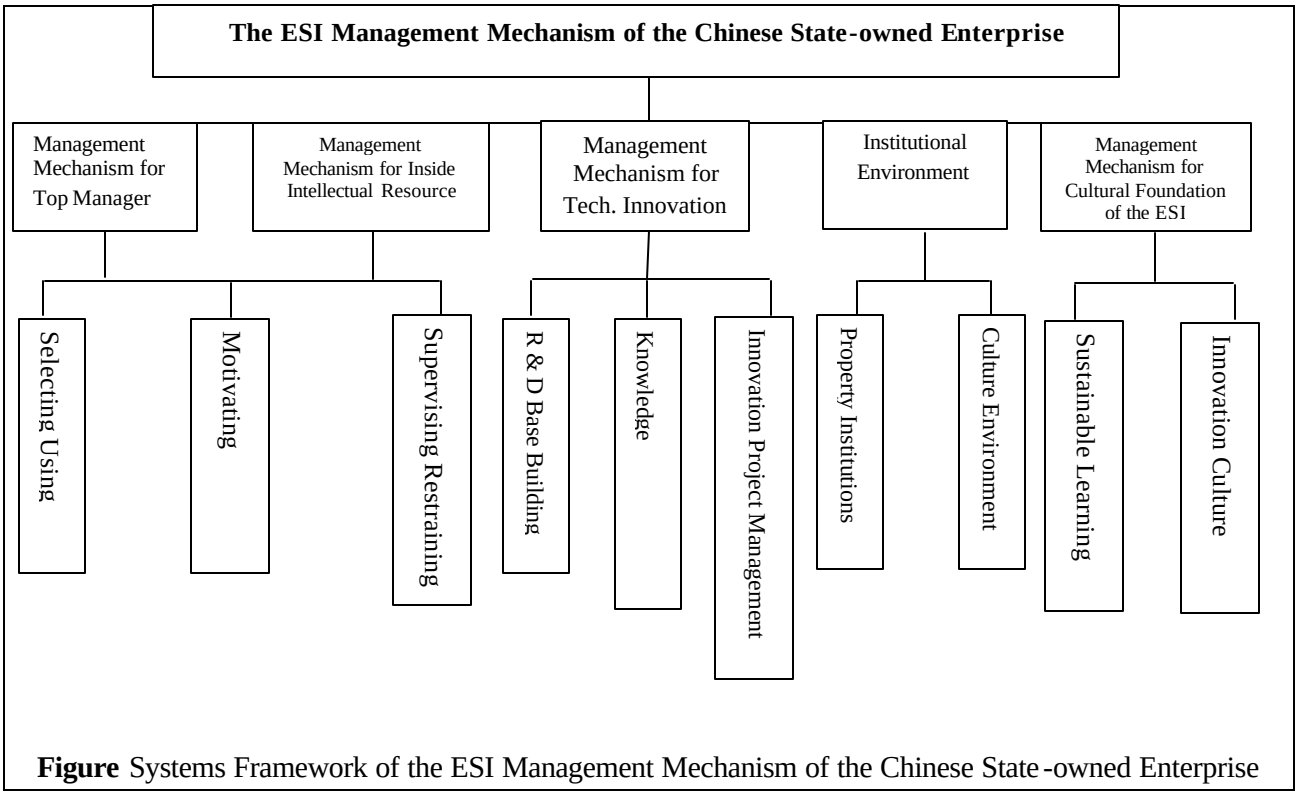

Figure Systems Framework of the ESI Management Mechanism of the Chinese State-owned Enterprise

This systems framework includes of the core and key-parts of the ESI Management Mechanism of the Chinese State-owned Enterprise. The core is the management mechanism for the top manager. Particularly, it is the top manager's selecting, using, motivating, supervising and constraining mechanism. If the core could be effectively built and operated, then the enterprise-inside key parts building and implementing could be able to be promoted by the selected excellent entrepreneur. Adding the institutional environment building promoted mainly by the government, the whole mechanism framework system of the ESI management could be gradually built and performed.

So, the building of the management mechanism for the top manager is the core problem of the ESI management mechanism of the State-owned enterprises. Limited by the volume, we will discuss it further in succeeded papers. Otherwise, we also will discuss some key problems such as institutional environment improving, technological innovation mechanism and the sustained learning mechanism of the ESI later.

5. Conclusion

Both the valuable quality and the hardness of the enterprise's innovation would be the sustainability. The Chinese State-owned enterprise's ESI was started up by the Nation's institutional innovation and the government supports are critical and throughout

all the ESI process." The dynamic systems integrating of the innovation project cluster" pattern highlights the forming mechanism of the ESI and the entrepreneur should devote to achieve the whole ESI process benefit. "The particular entrepreneur-oriented" pattern shows the particular entrepreneur played a critical role to promote the ESI process. That also shows in the resent time, the ESI in the Chinese State-owned enterprises is too depending on the particular entrepreneur and still has some accidental and fragile characters. "The Value-priority directed" strategy shows the core of the ESI strategy. The ESI of the Chinese State-owned enterprises has developing trends as "the Green & sustainable innovation, Innovation on enterprise's management information system, Changing to multiple ownership and Changing from the Particular Entrepreneur-oriented to Mechanism-oriented." The fundamental problem and trend of the ESI in the Chinese State-owned enterprises is to build the management mechanism, and the core is to build an effective selecting, using, motivating, supervising and restraining mechanism for the top manager.

6. Acknowledgements

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Entrepreneurship and High-Tech Innovation: What's governance Got To Do With It?

David M. Hart

Thank you very much for inviting me to participate in this seminar and giving me the opportunity to share some of the ideas that have been included in my new book, which is called *The Emergence of Entrepreneurship Policy: Governance, Start-ups, and Growth in the Knowledge Economy.* I want to stress at the outset that I am drawing heavily in this presentation on the work of several contributors to the volume. You can blame me if there's anything that's unclear in my presentation, but please credit the others whom I will mention with many of the ideas and much of the analysis.

I am going to begin by defining "entrepreneurship" and "governance," which are terms that are used in many different ways and so can be confusing. I am then going to briefly sketch out the history of the debate about what I've come to call "entrepreneurship policy" in the U.S. and outline a broad framework for thinking about the central problem that entrepreneurship policy-makers face. I will then turn to research by three colleagues in the areas of biotechnology, telecommunications, and electronic commerce to make these ideas more concrete and relevant.

"Entrepreneurship" is a word that everyone in the U.S. seems to want to be associated with. Everyone is for it and no one is against it. This leads to ideas like "government entrepreneurship," "social entrepreneurship," "intra-preneurship" (that is, being entrepreneurial within the large organization) and so on. I am going to ignore all that and use "entrepreneurship" to mean simply the processes of starting and continuing to expand a business. It's important to distinguish entrepreneurship according to this definition from "small business," which is the focus of attention for the U.S. Small Business Administration and similar agencies at other levels of government. Some entrepreneurial ventures are far from small and some small businesses are far from new or growing. Entrepreneurship policy is therefore distinct from small business policy.

While I am adopting a relatively narrow definition of entrepreneurship, I want to embrace a rather broad concept of "governance." Governance refers to conscious collective action that can extend well beyond government. It encompasses a lot of government activities but also those of a range of partners, including, as the case may be, businesses, trade associations, community groups, and academic institutions.

Entrepreneurship policy, where policy is conceived of as the conscious action of government, often aims to catalyze better governance.

With those definitions in mind, let me sketch out the origins of entrepreneurship policy in the U.S. Although the roots of entrepreneurship policy might be traced back as far as the antitrust legislation of the late nineteenth century, a more proximate point of origin is the late 1970s and 1980s, when American policy-makers began to take seriously the Japanese challenge in high-technology industries. This concern about international competitiveness produced several programs, such as the Advanced Technology Program of the Department of Commerce, that high-tech entrepreneurs can call upon for assistance. In the same period, the federal government reduced taxation on capital gains and moved forward with deregulation in a variety of sectors, among other things, indirectly spurring entrepreneurship. Relatively few of these diverse efforts were targeted specifically at entrepreneurs; it is only in retrospect that apparently independent threads of policy can be seen to form the beginnings of a fabric that might be called "entrepreneurship policy."

At the state and local level, policy-makers were more consciously concerned with entrepreneurship. The "entrepreneurial state," to use the phrase coined in 1988 by Peter K. Eisinger of Wayne State University in Michigan, arose as a response to the perception that "smokestack-chasing" (that is, offering incentives for firms to locate facilities within the policy-making jurisdiction) was no longer an effective strategy in an age of rapid technological innovation, global economic integration, and federal downsizing. Advocates of a new "wave" of economic development policy argued that states, regions, and localities had to "grow their own" economic base by strengthening existing firms and causing new ones to be born. The example of Silicon Valley, with its knowledge-based economy powered by research universities, start-up companies, and supporting services, loomed large in many of these discussions. While smokestack-chasing did not disappear from the state and local economic development policy agenda, new initiatives that aided entrepreneurship, like public venture capital funds and academic technology transfer offices, were added to it.

Entrepreneurship policy, then, includes an array of efforts at all levels of government, which are not always well-coordinated; indeed, lack of coordination is probably the norm. Broadly speaking, lack of coordination is a good thing, since the needs of entrepreneurs in different businesses are so very different. Still, I think it is possible to encompass all of these efforts in a single general framework. The objective of entrepreneurship policy should be to enhance the "context" for entrepreneurship. It can seek to make the resources that entrepreneurs need to draw on, such as human and financial capital, more available in a particular region. It can attempt to enhance access to needed services, such as legal services and consulting. It can break down barriers to

entry, whether these barriers be regulations or the lack thereof. The general assumption in making entrepreneurship policy is that more entrepreneurship is better (although it might be worth thinking harder about the possibility that there is some optimal level of entrepreneurship that can be exceeded, as may have been the case in the recent dot-com craze, as well as under-shot).

There are a lot of difficulties in making entrepreneurship policy that we have only just begun to think about. It is difficult for political leaders to support a policy that has only distant payoffs and no existing constituency. It is difficult to identify the bottlenecks to entrepreneurship in a rapidly changing economic and technological environment that policy-makers ought to concentrate their attention on. It is difficult to evaluate the effects of entrepreneurship policy, since so many other factors besides governance affect entrepreneurship. At this time, we need to do a lot more work, both theoretically – thinking about what might be done -- and empirically – thinking about what has been done. We also need simply to build awareness and sell the general idea of "entrepreneurship policy," two words that sound strange together in the American context.

It's probably easiest to illustrate what I'm talking about by turning to specific sectors of the economy. As I said, different sectors have different needs; a "one-size-fits-all" entrepreneurship policy does not make a lot of sense.

I'm going to talk first about biotechnology, drawing on the work of Andrew Toole of Rutgers University. Biotechnology is a sector of high-tech entrepreneurship that is clearly attributable to public action, although it wasn't until this new industry had begun to blossom that policy-makers realized what they had done. Toole lays out four dimensions of governance of biotechnology entrepreneurship: research funding, intellectual property law, drug regulation, and the ethical climate. These four spheres of governance interact to produce an environment that may favor or suppress entrepreneurship. Toole identifies uncertainty and delay in the intellectual property area as the biggest bottleneck in this sector right now. He also notes that biotechnology and information technology entrepreneurship are increasingly linked together, so that regional and state policy-makers may want to focus on strengthening the environment for both sectors at the same time and facilitating the linkages between the two.

Telecommunications is also a sector in which public policy has played an enormous role, although it is quite a different role from the one it played in biotechnology. Here I am drawing on the work of Eli Noam of Columbia University. As I'm sure everyone here knows by now, there was an entrepreneurial boom in the wake of the break-up of AT&T in 1982, which was accelerated by the 1996 Telecommunications Act and the commercialization of the Internet, and has now been followed by a bust. Federal and state regulators made it relatively easy for new entrants to challenge incumbent

monopolists in telecommunications markets. However, the challenge stimulated the incumbents to fight back, which they have done, both in their business practices and in the political sphere, making the start-ups vulnerable in the recent downturn. Noam argues that unless policy-makers take active measures to foster entrepreneurship in the future, there will be very little of it. Economies of scale and the capacity of incumbents to subtly discriminate tip the scales in their favor.

The final area that I want to talk about is electronic commerce. This sector is different again from the other two; few ecommerce entrepreneurs see government having a legitimate role at all in their business. Yet, as my Kennedy School colleague Viktor Mayer-Schönberger shows, it does indeed play an important role. Ecommerce entrepreneurs are particularly dependent upon intellectual property and contract law. Without any controlling authority in these areas, the risks of entrepreneurship are extremely high. Competitors can copy innovations and customers can renege on agreements at relatively little cost. On the other hand, if the legal regime is too rigid, these markets can easily be dominated by the most aggressive or deep-pocketed participant, rather than the most meritorious. Entrepreneurship policy in this sector must balance the contending interests. Even though it isn't possible to be sure in advance what the right balance will be, Viktor argues provocatively that policy-makers should nonetheless move forward in an entrepreneurial fashion themselves and take a stab at defining a framework to create such markets, rather than waiting. Something, he thinks, is better than nothing. I'm not sure that I can defend this position as eloquently as he advances it, but I thought it worth putting out for your consideration.

Let me conclude by saying again that this is an emerging area of policy thinking. Policy-makers are out ahead of the academics, and they need us to help weed out and consolidate what they have done and to help identify new directions. It strikes me as an area that Chinese economic policy-makers should be quite interested in as well, although the challenges in China are very different from those here. The contributions of new and rapidly growing businesses to technological innovation and diffusion and to economic growth in general make them well worth attending to. But it must be done with a light hand; it's less like gardening than ecosystem management.

Relationship between the Innovation Behavior and Innovation Type: The Choice of Product Innovation and Process Innovation during the Transition Period in China ♦

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Abstract
Because of capability constraint and resource, SOEs have born feeble competence during the transition period in China. As a main way to enhance competence and increase return, product and process innovation were paid more attention, thus, it is need to study the relationship between innovation behavior and innovation type which related with the choice of product and process innovation. However, current models for innovations are fundamentally static, the analytical methods designed for pure market or pure planned economies are unlikely to provide much needed insight into these new issues. Previous researches have been criticized for focusing on market and capability but not capturing the changing of governance in transition, and they underestimate the government's role. In this paper, there are theoretical and empirical attempts to examine the relationship among market motivity, inner governance improving, government control, capability constraint and capital constraint, motivation on innovation and investment on innovation. The paper develops 11 hypotheses and presents a structural equation model, which original adds the inner governance and government control as factors that influence innovation in transition. We surveyed 550 SOEs for obtaining the data about product and process innovation from 1995 to 1999 in China. By the factors analyses and path analyses with AMOS, the results told that the model and 10 of hypotheses had been tested. The collusions can be used to explain how the factors of market and governance simultaneously influence product and process innovation under the capability and resource constraints during transition.

Keywords: Product innovation; Process innovation; Inner governance; Path analyses

1. Introduction

In China, the economies currently undertaking a historical transition, in which a diminishing centrally planned sector coexists and interacts with an emerging market. As main representative organizations, state-owned enterprises (SOEs) gradually transformed

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from plan producers to market entities, according to recent reports, which account for about 37% of China's economy yet employ a larger percentage of the urban workforce, and pay a much larger portion of taxes (Kynge, 2000)—attesting to the important of this sector, so they have to be paid more attention to cultivate their competitive advantage. But for capabilities and resources constraints, and long term of excessively depending on state, SOEs have born feeble competence, however, the only way for enterprises to sustain a competitive advantage is to constantly upgrade its facilities and activities through innovation (Porter, 1990; Drew, 1997). Bettis & Hitt emphasize the fact that China must depend on technology during rapid technological change and transition. Since the days of Schumpeter (1934), technology innovation had played an important role in the study enterprises (Dosi, 1988; Chandler, 1977; Fransman, 1982), and had been frequently trumpeted as crucial for organizational competitiveness and success in these dynamic, turbulent and transitional environments. Being a source of competitive advantage, technology innovation becomes part of the firm's strategy (Ettlie, Bridge & O'Keefe, 1984); it seems to parallel the two strategic choices (Miles & DroKge, 1986), new or improved products, and technological processes (Cooper, 1976; Meyer & Goes, 1988; Normann, 1971). Technology innovation pertain to products, services and production process technologies; that is, they are related to the primary work activity of the organization and can be either the product and the process innovation (Daft, 1978; Damanpour and Evan, 1984). Product and process innovations are distinguished based on the different areas and activities that each of them affect within enterprises (Gopalakrishnan & Damanpour, 1997; Ettlie & Reza, 1992; Utterback & Abernathy, 1975). Product innovations are new outputs or services that are introduced for the benefit of customers or clients (Utterback & Abernathy, 1975). The power of product innovation in helping companies retain and grow competitive position is indisputable (Hart, 1996). On the other hand, process innovations are new tools, devices, and knowledge in throughput technology that mediate between inputs and outputs (Utterback & Abernathy, 1975; Ettlie & Reza, 1992).

The success of China's economic reform in the past decades has generated some new theoretical issues, which resulted from the plan and market coexistence. Current study examines the issue of product and process innovation from several directions. Some researchers attempt to identify the "environmental" and "structural" correlations that facilitate the innovations (Zaltman, Duncan & Holbek, 1973; Aiken & Hage, 1971; Kimberly & Evanisko, 1981). There are theoretical and empirical attempts to examine the interaction between governance mechanisms and external market mechanisms (Hirshleifer and Thakor, 1994). Streeck and Schmitter (1985) identified three limiting and ideal cases to define the feasible set: "state," "community," and "market," but for transition; the "market" and the "state" can be considered equivalent to "market driven" and "state regulated," Bailey's (1995). Many researchers refer to that market driven is a

main factor for innovation motivity, and have some detailed studying about influence from market to innovation. On the other hand, the management literature has partially addressed the relationship of governance and innovation activity (e.g., Baysinger, Kosnik, & Turk, 1991; Graves, 1988; Hansen & Hitt, 1991; Hitt & Snell, 1988), but more research is required to precisely explain the relationships involved. Myung JanMoon (1997) thought that the administration of state was benefit for diffusion and speed of innovation, but it is not ulteriorly testify that the government how to influence the behavior and the selection between product and process innovation. However, there are several other governance problems unique to China's state-owned sector during the economy transition (Du & Yong, 1998; Steinfeld, 1998), such as the appointment & dismissal of CEO and changing on organization. The resource and capability of enterprises were affirmed as essential factors for researching product and process innovation. Bharadwaj (2000) refers to activities within an organization to enhance their capability for innovation, and provided resources to encourage innovation behaviors.

Current models for researching product and process innovation are fundamentally static which is not fit for the successive transition (Stark, 1996), and the analytical methods designed for pure market or pure planned economies are unlikely to provide much needed insight into these new issues. Corporate governance is one of the most heavily studied topics in strategic management, and its importance is beginning to be recognized in the Asian context (Young, Ahlstrom, Bruton, & Chan, 2001). Previous research has been criticized for focusing on market and capability and not capturing the governance in transition. Thus, in the reported research, we developed an integrated model which original adds the inner governance and government control as factors, and there is need for research that these factors how to influence simultaneously the innovation behavior and innovation type in transition. The purpose of this research is to test this systemic model of why the SOEs make decision between product innovation or process innovation under differ prompting or restriction, Figure 1 depicts the model developed.

Below, we explain the model and each of the expected relationships and present the hypotheses tested in this study. The paper is organized as follow. Section 2 is theoretical model and hypotheses; section 3 is methodology; section 4 is results, section 5 is discussion, section 6 is limitation and future research directions.

2. Theoretical model and Hypotheses

The model can be used as an analytical device to study the product and process innovation, and it depicts the relationship among motivation on innovation, investment on innovation, innovation type and the influence factors, which include market motivity, inner governance improving, government control, capability and capital constraint.

Improving and radically changing products are regarded as particularly important for long-term business growth. It is, however, not enough to avidly engage in product innovation for its own sake—what some managers refer to as "product innovation"—adding more and more product variants or changing product mix (Michael, 1996). Some researchers have argued that high quality products and low development costs are both gained through improvements in the development and manufacture process — e.g., reduced mistakes, and reduced waste of manpower and materials. Thus, product innovation consists in the creation of new goods and service, we think of it as an improvement in the quality of product and change in the product mix; the process innovation leads to a reduction in the cost of producing existing product (Giacomo Bonanno, Barry Haworth, 1998).

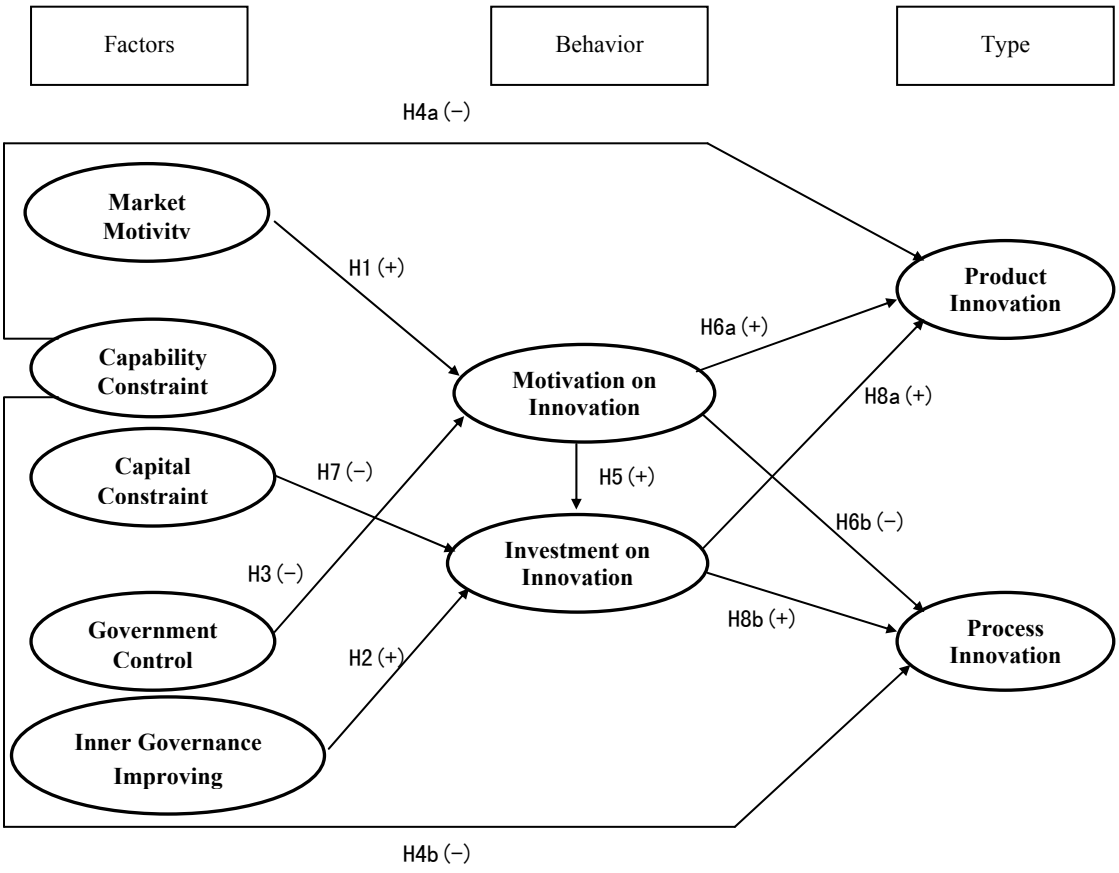

Fig. 1 Theoretical Model

Motivity mechanism is the foundation of technology innovation, it consists of inner drive and outer drive, inner include motivation, investment, benefit and capability of innovation; the outer includes pull of requirement and push of technology. The pull of requirement can be shown by industrial attraction and competitive pressure, industrial

attraction means the developing direction and foreground of industry; a nicer foreground will increase the product demand. When enterprises face to great competitive pressure and uneasily obtain profit, they have to innovation for enlarging share. The push of technology is a potential power that new technology changing to fortune, in a certain period, the new technology will create demand forwardly, and inspirit subject finish innovation with new production (Liyuan, 1994). Face to the emerging of market economic during transition, SOEs pays more attention to participating in competition. For immature market segmentation, leading with competitors becomes a key way to acquire share and benefit, thus innovation was regarded as a strategy for leading. It supposes that all the changing of inner governance is benefit for enhancing competence and innovating, so we named an improving. Therefore, we define "outer drive" as market motivity, which is an outer motivity for innovation; and define "inner drive" as inner governance improving, government control, capability constraint and capital constraint.

2.1 Market motivity and motivation on innovation

Market brings the outer motivity for product-process innovation, it include "requirement pull" and "technology push", which were considered the main driving forces, and many scholars have argued in favor of one or the other (Schmookler, 1976; Mowery and Rosenberg, 1979; Walsh, 1984). For economists, in particular, this concept accommodated the treatment of all economic parameters under "market demand" leaving "science technology" as an externality. Because of the complexity of the product-process innovation, this concept has a weak explanatory power regarding the interpretation of historical facts and is inadequate for the support of a theory of the dynamics of the innovation (Dosi et al., 1988; Mokyr, 1990; Porter, 1990). Marketing theorists have shown that leading with competitors and gaining in market share are generally associated with higher revenues and higher profitability.

Arrow (1962) demonstrates that the returns generated by technology innovation are greater when the innovation used in a competitive as opposed to a monopolized market, hence competitive markets implied greater incentives in innovation. In centrally planned economy, producing and marketing were controlled completely by state, SOEs had little of autonomy and enthusiasm on innovation, but in market economy, satisfy demand and acquire shares are main objects of competition. Market motivity indicate a degree of competing, demand and share constraint mean a not consecutive increasing on returns, thus enterprises should decide to leading with competitors, which is a motivation on innovation. Leading competitors imply greater incentives in innovation, and enterprises have enough enthusiasm on study new technology and follow the new tendency on science & technology. So we claim that the innovations depend on the enterprise's initial market share and on the subsequent effects of R&D on the post-innovation market

structure the size asymmetry triggers heterogeneous behavior in product-process innovation choice. We thus hypothesize:

Hypothesis 1: Market motivity will be positively related to the motivation on innovation.

2.2 Inner governance improving and investment on innovation

The basic principle of corporate governance is that shareholders elect directorate who select CEO in turn. But in SOEs of China, as a main agent-shareholder, sponsoring ministry (because each of SOEs pertain to a certain ministry or industrial corporation, we named them the sponsoring ministry) has authority on appointing or dismissing CEO who appoints top manager, then the management personnel is fixed on. The effectiveness of the management personnel may be affected not only by its composition and size but also by its internal administrative structure. In the process, personnel policy provides a legal procedure on changing management personnel, and that the changing effected by the governance mechanism. One of the most often cited factors is management personnel support (Selnes, Fred, Jaworski, Bernard J., and Kohli, Ajay K, 1997); it influences technology innovation through their motivational role, as well as through explicit support of the project. Innovation must depend on a group, which including entrepreneur, managers, engineers and others. Appropriate personnel policy wills incentive staffs for innovating; on the other hand, it ensures that the objects are same between members and the group. Top manager is also regarded as a group for decision-making, which was named "BanZi" in SOEs. If a particular manager enthusiastically endorses a new product of being customer focused or continually discusses the importance of information generation and sharing within the organization, others are likely to adopt similar attitudes (Jaworski, B.J., and Kohli, Ajay K; 1993). A new "BanZi" manages enterprises with its strategy policy and procedure; all of these must be supported by a suitable organization structure, which influence the efficiency of governance. Organization structure influences product and process innovation from various aspects. Its size and centralization has been the subject of more inquiries than perhaps any other aspect of structure (Damanpour, Fariborz, 1987, Grover and Varun.1993; Levin.1987; Maddala, G. S., 1967). An organization's willingness to adapt or change its structure to institute the innovation (i.e., flexibility) appears to impact implementation (Majchrzak, 1986).

During transition, many of SOEs undergoing the reconstruct from 1997, one of the characters is inner governance changing, and we assume the change benefits to product and process innovation. Governance is a foundation for organization's decision-making, thus, innovation strategy influenced by inner governance. As a basic activity, acquirement of innovation expenditure implies that enterprises already have motivation on innovation derive from market drive. We thus hypothesize:

Hypothesis 2: Inner governance improving will be positively related to the investment on innovation.

2.3 Government control and motivation on innovation

In transition, majority of SOEs have turned to corporation in the policy of restructure tendency, but their financial commission and personnel decision still controlled by state. However, state has little enthusiasm and insufficient information to supervise CEO, so the risk on finance and management will not be taken on by state but enterprises. Although state continually emphasize that separate the function of administration on SOEs from government, an indirectly control still existing, it is by the appointment & dismissment of CEO. CEO often appointed for political or other reasons rather than their performance for duty, and he is may not the best persons to manage the company effectively. As an important actor, CEO usually establishes and implement strategy and pays more attention to innovation, so the frequent change of CEO is not benefit for the implement of innovation. Government control makes CEO prefer to reduce blame than enhance performance; it causes a backward-looking decision-making that not prefers to lead with competitors, it is to say has a feeble motivation on innovation. We thus hypothesize:

Hypothesis 3: Government control will be negatively related to the motivation on innovation.

2.4 Capability constraints and the product and process innovation

As Hitt & Hoskisson (1996) argue, capability of enterprises to innovation is at the heart of strategic competitiveness. Therefore, as a factor of inner control, organization capability is an integrative item that includes several elements. Larry E. Westphal (1981) defined capability an integration of management ability, compliableness ability and acquirement of information. Seven Muller (1986) expressed the capability with R&D ability, manufacture ability, reserve ability and management ability. Xu Qingrui (1995) regarded it as a community that include innovation decision ability, R&D ability, manufacture ability, marketing ability and management ability.

Management ability reflects not only the efficiency of management, but also the adaptability to environment; R&D is one of the key processes of innovation, and it is the headspring of innovation; manufacture is a middle linking between R&D and marketing, which changes the outcomes (new design, new machines and new process, etc.) of products or service accepted on market. As an essential final stage of innovation, strong marketing ability makes enterprises have excellent share, and ensure successfully implemented the next new innovation with financial capital. Requirement on market is the driver for innovation, so the capability must guarantee satisfaction on the requirement

in enterprises. This is consistent with a recent survey of over 700 managers, which revealed that improving their enterprise's capability to innovation was the top concern (Dougherty and Bowman, 1995). But for long term of administrate by state, SOEs has not autonomy and enthusiasm on improving capability, so it seems that capability constraint is one of the main aspect in restricting product and process innovation. We thus hypothesize:

Hypothesis 4a: Capability constraint will be negatively related to the product innovation.
Hypothesis 4b: Capability constraint will be negatively related to the process innovation.

2.5 Motivation on innovation, investment on innovation and product-process innovation

Economists studying product and process innovation have viewed the theory of the enterprise as actually a theory of markets (Mowery, 1990), in this view, enterprises strive to use their capability to deliver output which accepted by market. Product innovation is one of the most important competitive challenges facing enterprises today (Jelenik and Schoonhoven, 1993; Leonard-Barton, 1995), it is concerned with the identification of new products and how these are best developed, and it provides the most obvious means for generating revenues. It is important to delineate just what product features are to be improved or radically changed, which are regarded as particularly important for long-term business growth. For historical planning policy, each of SOEs has a certain product scope, the process of stocking, producing, and marketing according to planning or administrate by state, so the product mix of SOEs is also partly unsatisfied requirement on consumer and client. Products have to be updated and completely renewed for the purpose of retaining market presence, and the introduction of new products and product differentiation accomplished by innovation is key to business success and customer satisfaction. On the other hand, process innovation is not easy, but its purpose is now well understood. Process innovation is concerned with the identification of new internal operations and how these are best performed, it embraces quality function deployment and business process reengineering (Cumming, 1998). An efficient supplier who keeps working on productivity gains can expect, over time, to develop products that offer the same performance at a lower cost. Such cost reductions may, or may not, be passed on to customers in the form of lower prices.

Several researchers have noted that innovation investment is a real option. The current investment is viewed as a link in a chain of future projects opening up growth opportunities (Grenadier and Weiss, 1997). Trigeorgis (1996) has shown that competition in the market may force the firm to invest early so that the flexibility value of

the deferred investment strategy is eroded. The firm, thus, has a call option on the value generated from the innovation plus future growth options with a strike price equivalent to the investment cost. During restructure, the proper changing product group and management scope is supported by state policy. Therefore, face to an immature market system, enterprises should enter and occupy new market depend on new product and mix before oligarch monopolize. Majority of SOEs absence of the motivity of innovation because of existing of innovation risk and restriction on investment, thus, the target of innovation may fix on reducing cost and saving consumes that is low risk, they will not prefer to implement a leading-innovation strategy. In a recent study, 75% of the CEOs of large manufacturing organizations reported that faster and more effective new product development would most improve their enterprises' competitiveness, compared to improving their manufacturing processes or making new plant and equipment purchases (Dickson, 1995). We thus hypothesize:

Hypothesis 5: Motivation on innovation will be positively related to the investment on innovation.
Hypothesis 6a: Motivation on innovation will be positively related to the product innovation.
Hypothesis 6b: Motivation on innovation will be negatively related to the process innovation.

2.6 Capital constraint, investment on innovation and the product-process innovation

Besides the capability, resource constraint is another disadvantageous factors for innovation. During transition, financial capital may be the most important resource for SOEs, because of absence of self-reserve capital and feeble financing ability. Jensen (1993) argued that the failure of the market for corporate control regarding innovation is partly due to legal restriction on the capital market (e.g., Roe, 1990). Compare with stock companies, the main financing method of conventional SOEs is acquiring loans from banks. However, in fact, the state-owned sector now threatens the stability of the Chinese banking system, as many banks are state-owned and are forced to carry nonperforming SOEs loans on their books (Du & Yong, 1998), then they are thus prevented from providing capital to other needy enterprises. Therefore, it is very difficult to implement product and process innovation in SOEs.

It is now widely acknowledged that financial and real decision of firms interacts. Due to asymmetry of information between shareholders, creditors and firm managers, together with limited liability, financial structure impacts on the decisions of firms on investment, innovation or output (Boris Maurer, 1999). Kovenock and Phillips (1995) point out that financial capital has a significant impact on investment decisions not only for the restructured enterprise, but also for competitors in the same industry. We may, therefore, conclude that despite of their shortcomings, the data provide some evidence

that investment are related to financial status, and that the average cost of an innovation is of the same order of magnitude among large pharmaceutical companies. (Basil Achilladelis, Nicholas Antonakis, 2001). Cash flow created by an RI/MS leads to further investments in innovation, manufacturing capability and marketing-sales, which create scope of innovation. The selection of subsequent innovation projects whose cost can be cut by sharing accumulated knowledge, research facilities and marketing networks (Henderson and Cockburn, 1996). We thus hypothesize:

Hypothesis 7: Capital constraint will be negatively related to the investment on innovation.
Hypothesis 8a: Investment on innovation will be positively related to the product innovation.
Hypothesis 8b: Investment on innovation will be positively related to the process innovation.

3. Methodology

3.1 Sample

The sample was drawn from the SOEs of Shaanxi, Henna and Shanxi provinces in China. The three provinces were industrial-cities from 1960's; their enterprises were established in every period of Chinese economic development. We wanted to obtain the data about product and process innovation from 1995 to 1999, which period chosen because significant restructuring activity occurred during it. Therefore, while this study focuses on the three provinces, the conclusions and implications apply to a wider extent in China of our sample.

The sampling official list provided by Economy Commerce Committee (ECC) of the three provinces, 460 SOEs in Shaanxi, 430 in Henna and 400 in Shanxi. In order to random survey, each enterprise on the official list was be assigned a number from a discrete sequence of number. Random numbers then generated, modulated by the total number of enterprises and incremented by one until unique vectors have been generated (duplicates will be discarded). SOEs as the drawing of their vector identified them will be allocated sequential identifiers according to their order of drawing. A final list is formed which include 200 enterprises that involve l2 industries in each of three provinces. The survey began with the first enterprise in the final list and continues until about 100 questionnaires have been received or the list was exhausted.

3.2 Survey

Before the formal survey, we selected the 5 enterprises as the experimental objects from every province. One purpose of the experiment was to modify the questionnaires in

the particularity, and farthest reflected characters of different industries and different scales, which is in order to make the content of the structure and questions more capacious. Another was to prepare to solve the potential problems before formal survey in advanced. Questionnaires were distributed to employees in three departments (every department in a certain province), within these organizations that preserved the proportions. A reminder notice was sent to employees 2 weeks after they received the questionnaire. Managers of every department directed the main investigators and interviewed with CEO, who filled in each parts of the questionnaire by himself, and questioned some proposals about items and questionnaire. After the process, we modified and perfected questionnaire, and formed the final one that used in formal survey.

The data collection procedures were designed to ensure the response rate. Because response rates can be significantly increased when verbal commitment is obtained prior to sending a survey instrument (O' Keefe & Homer, 1987). So survey was made by visited to every enterprise, investigator appointed with CEO by telephone or fax in advance, which insure his or her cooperation in completing the interview, but in some enterprises, no telephone contact was possible. Each enterprise also was provided a covering letter outlining the purpose of survey and stating that the participation in it was voluntary. In several cases, if CEO could not be reached, the investigators (2 or 3 in every visit) interviewed with CEO designee who is enterprise's chief financial officer or top officer in charge of strategic planning. The investigators answered duly the question and noted some important information. Visiting need about one or two hours, investigators took the questionnaire back after visit.

Survey and responses were largely completed in the summer of 2000. A total of 550 questionnaires were distributed. In total, 313 responses were returned, 39 of which were unusable because of missing necessary data (what they provided was half-backed data, or the data was partly false, for consistency with the hypotheses, we delete them from the analyses). Hence, 274 responses were usable, and the final regular rate is 49.8%. Additionally, our response rate exceeds that the achieved by Michael (1996; 36.9%), whom sought survey responses from top executives. Thus, our response rate can be considered better. Non-response bias was minimized through the data collection procedures, and assessed through an examination of profile of respondents. The respondents were found to closely represent the proportions of personnel within the organization and no evidence of non-response bias was observed.

3.3 Primary Variables

In questionnaire, the majority of measures were on a 5 points scale from either (1) "not important" to (5) "extremely important" or (1) "no change" to (5) "very much has changed."

Market motivity *(Alpha a=0.70).* Market motivity was composed of two parts, the pull of requirement and the push of technology. We define the pull of requirement by using two variables in questionnaires *"share constraint"* and *"demand constraint,"* and define the push of technology by using *"competition of technical performance on product for custom,"* which were 5 groups of data each year from 1995 to 1999. Longer period from 1995, the influence from competition would stronger, so weight the five groups 0.30, 0.25, 0.20, 0.15 and 0.10 from 1995 to 1999, and formed a synthetical item.

Inner governance improving *(Alpha a=0.67).* We measured it by four indicators: *(1) changes in organization; (2) change of sponsoring ministry; (3) changes in management personnel* and *(4) change in personnel policy.* It means a drive for product and process innovation in inner.

Government control. We use the item *"frequency of CEO changing"* explain the influence in appointment/dismissal of CEO by government power.

Capability constraint *(Alpha a=0.63).* Four items defined it: *(1) management ability constraint, (2) R&D ability constraint, (3) manufacture ability constraint* and *(4) marketing ability constraint*.

Capital constraint. It is a variable in questionnaire named *capital constraint* during technology innovation.

Motivation on innovation. It depicted by the *leading with competitors*, which is a synthetical variable with *(1) following with competitor* and *(2) leading with competitor*. The question could told us why they want to innovation, but its measure was on 3 points, from (1) "general" to (3) "strongly important". We added one to another, and formed a new variable that was on 6 points, the new measure was nearly to the majority of 5 points, so the analyses was more credible.

Investment on innovation. It was composed of *new investments or change in technology.*

Product innovation *(Alpha a=0.62).* Product innovation was composed of two items: *(1) improvement in product quality* and *(2) change in product mix.*

Process innovation *(Alpha a=0.77). Process innovation* was composed of *(1) reduction material inputs* and *(2) saving on energy inputs.*

The reliability of the scales for the multi-item measures were found to meet Nunnally's (1978) recommendation, as the Cronbach α exceeded 0.6 is credible for all of the constructs.

3.4 Data analysis

The hypotheses were tested using structural equation modeling. By definition, structural equation analysis is a combination of factor analysis and path analysis. Our approach to estimating the structural equations model follows the two-stage procedure recommended by Anderson and Gerbing (1998). The first stage involves estimation of the measurement model using confirmatory factor analysis. This stage tests whether or not the variables selected to measure each construct exhibit sufficient convergent and discriminate validity. Once a good measurement model is established, the final stage tests the theoretical model (Anderson and Gerbing, 1998 and Bollen, 1989). An AMOS path analysis was used to identify the relationship between the innovation behavior and innovation type, which has been used by previous researcher about corporate control in innovation (Michael A. & Robert, 1996).

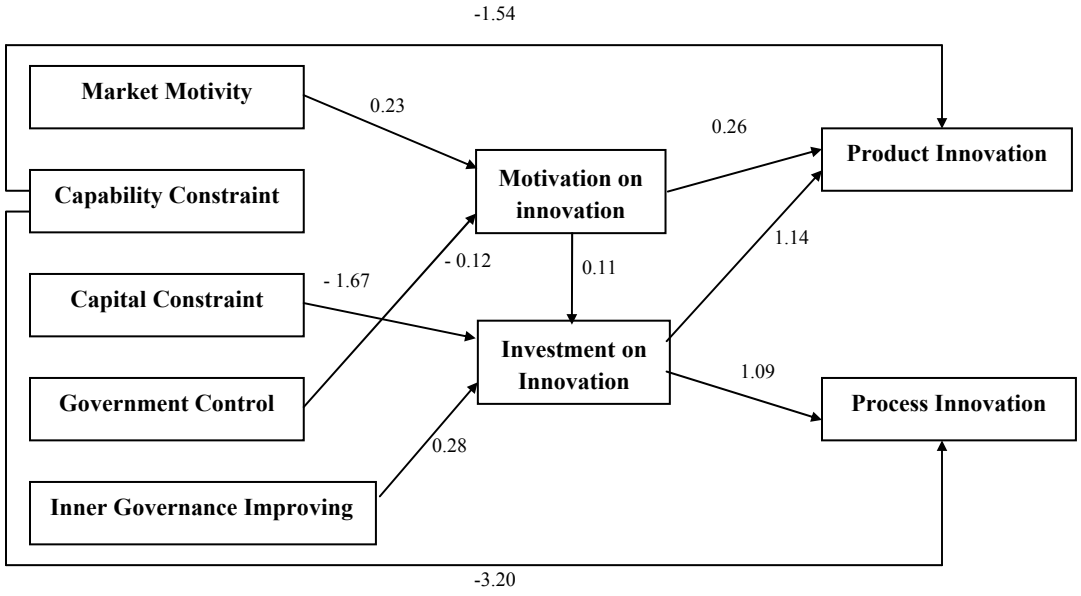

Fig. 2 Path analysis using AMOS

Table 1. Mean, standard deviations and correlations

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Demand constraint	3.17	1.52																		
2. Share constraint	3.11	1.41	.561***																	
3. Competition of technical performance on product for customers	1.57	1.15	.159*	.099																
4. Management ability constraint	2.64	1.29	.145*	.180**	-.097															
5. R&D ability constraint	3.25	1.34	.222***	.302***	.113	.150*														
6. manufacture ability constraint	2.42	1.37	.280***	.288***	.070	.234***	.327***													
7. marketing ability constraint	3.17	1.36	.292***	.379***	.028	.276***	.349***	.266***												
8. Capita constraint	3.70	1.29	.108	.187***	.086	.138*	.157**	.253***	.352***											
9. Frequency of CEO changing	1.93	1.00	.054	.023	-.062	.048	.011	.047	.059	.056										
10. Changes in organization	2.63	1.24	.087	.102	.124*	.059	-.036	.065	.085	.098	.036									
11. Change of sponsoring ministry	1.85	1.37	.099	.088	-.022	.085	.047	.097	.091	.091	.064	.311***								
12. Changes in management personnel	2.74	1.12	.091	.028	-.003	.154*	-.071	-.071	.014	.018	.198***	.437***								
13. Change in personnel policy	2.26	1.09	.109	.017	.049	-.053	-.043	.006	.012	.035	-.015	.413***	.379***	.222***						
14. Leading with competitors	2.59	1.54	.127*	.183**	.217***	.150*	.101	.139*	.179**	.032	-.120*	.072	.032	-.043	.091					
15. New investments or change in technology	2.61	1.12	.128*	.085	.142*	-.038	.045	.143*	.025	-.109	-.144*	.216**	.146*	.068	.314***	.187***				
16. Improvement in product quality	2.83	1.08	.186**	.215***	.200***	.035	.054	.134*	.102	.012	-.131*	.178**	.167**	.043	.237***	.265***	.440***			
17. Change in product mix	2.44	1.15	.102	.180**	.237***	.008	.031	.204***	.045	.040	-.053	.256***	.185**	.106	.224***	.130*	.336***	.338***		
18. Reduction material inputs	2.17	1.12	.202***	.165**	.048	-.081	.035	.031	.013	-.009	.016	.136**	.096	.035	.204***	.129*	.257***	.303***	.179**	
19. Saving on energy inputs	2.42	1.02	.200***	.091	.059	-.106	.006	.073	-.091	-.007	.044	.164*	.137*	-.004	.263***	.082	.323***	.305***	.201***	.600***

Correlations greater than or equal to .19 are significant at ***$P < 0.001$; those greater than or equal to .15 are significant at **$P < 0 .01$; those greater than or equal to .12 are significant at *$P < 0 .05$; and those greater than or equal to .10 are significant at $P < 0 .10$.

Table 2 Measures of overall fit in AMOS

GFI test	Model estimate
Model fit	
X_2 value	106.65
Cmin / *df*	1.088
GFI	0.959
Adjust GFI (AGFI)	0.928
Root mean standard error of approximation (RMSEA)	0.018
CFI	0.991
NFI	0.903
Model comparison	
Tucker-Lewis index (TLI)	0.986
Normed fit index (NFI)	0.903
Model parsimony	
P for test of close fit (Pclose)	0.999
Akaike information criterion (AIC)	252.65

Table 3 Summary of support for hypotheses

Hypothesis		Estimate	*P* Value	Result
H1	Market motivity → Motivation on innovation	0.23	0.019*	Supported
H2	Inner governance improving → Investment on innovation	0.28	0.000***	Supported
H3	Government control → Motivation on innovation	-0.12	0.031*	Supported
H4a	Capability constraint → Product innovation	-1.54	0.016*	Supported
H4b	Capability constraint → Process innovation	-3.20	0.028*	Supported
H5	Motivation on innovation → Investment on innovation	0.11	0.043*	Supported
H6a	Motivation on innovation → Product innovation	0.26	0.016*	Supported
H6b	Motivation on innovation → Process innovation	-0.05	0.558	Not Supported
H7	Capital constraint → Investment on innovation	-1.67	0.018*	Supported
H8a	Investment on innovation → Product innovation	1.14	0.000***	Supported
H8b	Investment on innovation → Process innovation	1.09	0.000***	Supported

** P < 0.05, ** p < 0.01, *** p < 0.001*

4. Results

Fig. 2 is the final model that best fits the data collected. The correlations between variables are presented in Table 1, which reports means, standard deviations, and they were used in the study. Analysis of the correlation matrix shows initial evidence of good validity; the corresponding GFI indices for the final path model are presented in Table 2, which highlights the important of the relationship between innovation behavior and innovation type. A summary of the hypotheses supported appears in Table 3.

The results indicate that all of the variables in hypotheses are correlated with each other. This suggests that these correlation can be consistent as part of an integrated model. Market motivity was found to have positive and significant direct relationship with motivation on innovation, and government control has negatively relationship with it. Although the other factors (inner governance improving and capital constraint) do not have direct influence on the motivation on innovation, they do have significant and negatively relationship with investment on innovation, which subsequently influences product and process innovation. In addition, capability constraint influences the product and process innovation negatively, in which, product innovation was positively influenced by motivation on innovation. As a key relationship of these direct effects, motivation on innovation has a positively relate to investment on innovation.

Ten of the eleven hypotheses positing a relationship between factors to either innovation behavior or innovation type were supported. Only one hypothesis, which explains the influence from motivation on innovation to process innovation, is not supported. These results demonstrate the power of path modeling, i.e. recognizing that dimensions (independent variables) can have direct and indirect effects on each other.

5. Discussion

The primary purpose of this study is to explore the relationship between innovation behavior and innovation type, which influenced by several other factors. The strength of the relationship found among these items indicates that market and governance influence the innovation simultaneous. The support found for the dynamic influence innovation behavior by governance gives credence to past literature that has assumed this influence, and hence, this study contributes to the academic literature in this domain. Importantly, the governance was depicted with two concepts that inner governance improving and government control, and they are found to be distinct and not isomorphic.

We have supposed that there were a non-important relationship among factors, which are market motivity, inner governance improving, government control, capability constraint and capital constraint, thus, the relationships are not be appeared in model

before developing. In correlation, it seems that market motivity remarkably relates to motivation on innovation but not investment on innovation, it is because market information and pressure directly influence intention or motivation on innovation, which is a strategic direction to makes organizations have a perfect activity. Face to a good foreground, SOEs will select on leading or not with competitors, then, it subsequently set down a project for investment.

Corporate governance refers to the top management process that manages and mediates value creation for, and value transference among, various corporate claimants (Sundaram, Bradley, Schipani, & Walsh, 2000). The effectiveness of management group may be affected not only by its composition but also by its internal administrative structure. Klein (1995) evaluates the effects of management group and CEOs' roles within committees on the effectiveness of the management group. But in SOEs, CEO is not effectively monitored because bureaucrats suppose that CEO would manage the enterprise efficiently. However, there is a little of incentive to bureaucrats for diligently monitoring enterprise performance, it is that bureaucrats are neither rewarded for good performance nor punish for bad. Until recently, the concept of the "iron rice bowl" ensured that bureaucrats would keep their job even if they failed to adequately fulfill their duties (Andrews & Dowling, 1998). Moreover, because bureaucrats for SOEs may be dispersed throughout the government, the state lacks a clear, accountable representative to enforce its will (Qian, 1996; Steinfeld, 1998), so they have little interest in innovation. As an indirect influence, from government control to enterprises' innovation behavior, personnel decision-making on appointment or dismissal of CEO causes a feeble motivation on innovation. A second governance problem concerns managerial behavior. CEO has relatively wide discretion in managing enterprises, yet there are few mechanisms to ensure that they are acting in the enterprise's or the state's best interests. The ineffective monitoring exacerbates this problem discussed above. It restrained by "rigid" mechanisms in some extent, the "rigid" mechanisms may cause disaccord between enterprises and state, such as selection on innovation behavior and innovation type.

Excellent capability of organization can redeem partly disadvantage derived from the process of innovation. In SOEs, financial capital controls the direction and scale of investment, and for final marketing, renewing or changing on technology must locate at an extension controlled by R&D ability and manufacture ability. During transition, machines and technology of SOEs are older than others, and which of them are lagged decades of years to new market demanded; as a key obstacle, investment constraint is the only direct cause in why they cannot enhance competence.

This raises many new theoretical as well as practical issues in relation to the functioning and possible responses of this transitional period. The results can be used to explain how market and governance influence the innovation behavior and innovation type simultaneous during transition.

6. Limitations and future research directions

We identify three weaknesses with this study. First, since the study based on the sample of Shaanxi, Shanxi, and Henan, three inland provinces in China; so the conclusions may reflect mainly relationships but not the whole. Caution should be exercised in generalizing the results to other provinces that have a different environment and competitive structure. Being the transition is going, some new characters and change will emerge, the conclusion of study will has a little limitation on future. Second, although there were a assumption in advance, which ignores the correlation among the five influence factors which drive or restrict innovation behavior, we have not much golden-mouthed evidences to explain the perfection of assumption, thus, the results did not adequately explore the impact of innovations. Finally, this study is also subject to some general weaknesses associated with all ex post-facto research including the inability to manipulate the independent variables, lack of power to randomize.

Because of the dramatic economic transition underway in this country, China represents an exciting research venue that demands further research. Despite of the limitations, there is a lot of research directions suggested by this study. First, in this context, it is important to recognize that there may exist other factors to influence innovation behavior in future research, which the model does not take into account, for example, the organizational climate and individual creative abilities and personality traits have been shown to impact innovation. Nevertheless, it is also important to under-score that the variables studied in our study are more actionable and within managerial control in contrast to other variables typically discussed in the traditional literature. Second, future research can also attempt to combine other measure for motivation on innovation; such as inner or outer innovation, and independent or associated innovation, etc. Third, the specific characteristics of the enterprises studied limit the generalize ability of the results, thus, it is also needed to compare the innovation in different features in the future research, which including the different industries or scale of SOEs. In addition, innovation behavior involving in Chinese culture, so how the culture influence the managers' strategy decision is a direction for future research.

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