

Soft Technology **--The Essential of Innovation**

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Abstract

In this paper, the author proposes a new conceptual framework for technology and reclassifies technology into hard and soft. Soft-tech refers to technology derived from outside of natural science disciplines and from outside of conventional science. Through discussions on technological competitiveness, new institutional innovation, Chinese traditional medicine, and the gap between developed and developing countries, the author argues for the significance and need for soft technology. Based on this conceptual framework, the author offers her view on China's path towards innovation.

Key words: Soft technology, Intellectual service industry, Institutional innovation

1. The Evolution of Technology

Technology has made great advances in recent years. The dream of man being able to fly to the moon has become a reality. Now it is even possible to clone human beings. The influence of technology on economic development is outstanding everywhere, witnessing the information economy, the digital economy and the knowledge based economy. Apparently, technology is the engine of the society and its economic development.

In the meantime, unexpected consequences and unethical applications of technology have brought tragedies, some very significant and lasting. Therefore, criticism against the development of technology has been on the rise. However, it should be noted that when one talks about the advantages or disadvantages of technology, even technology that "threatens to make human beings an endangered species", the "technology" being referred to is "hard technology" in traditional sense, which is derived from natural sciences.

From Plato (427-347 BC) in ancient Greek (see Fig.2) to Diderot Denis (1713-1784) in 18 century, there were different definitions for technology. However, for a long time, people used the word "technology" to refer to the rules, methods and tools obtained from the utilization of natural science knowledge in solving problems in material production. For example, The

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Modern Chinese Dictionary defines the term “technology revolution” as “revolution on production technology”, and the term “technological innovation” as “improvements in production technology, process and machine components”.

This is because in the age of the industrial economy, material production plays an important role. The outstanding contributions of natural science and technology were those that dealt with nature and materials, for the sake of increasing material output. Therefore, understanding and knowledge naturally lean toward natural science, and the technologies based on natural science were fully developed.

So, traditionally, "technology" describes an operable knowledge system that is mainly derived from knowledge of natural science. In this paper, this is referred to as "hard technology", namely, the skills, tools and rules that are employed by people to alter, accommodate and manage nature for human survival and development.

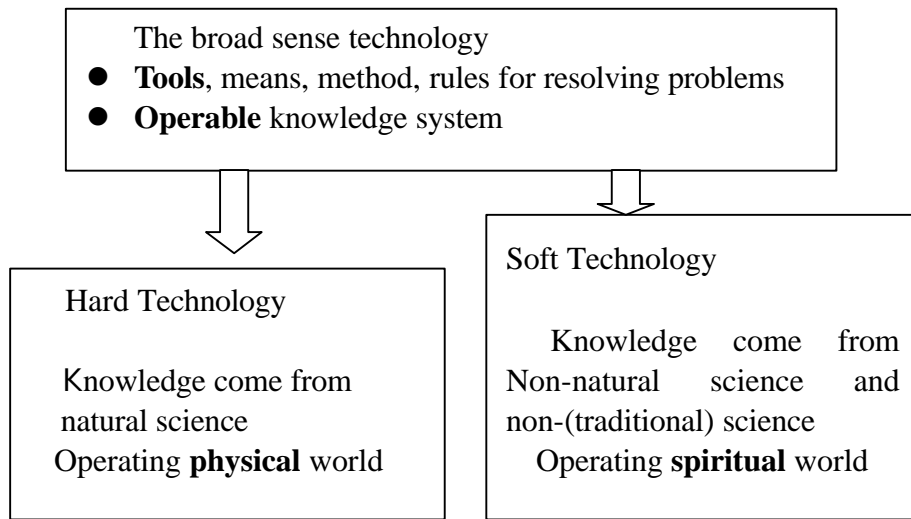
The knowledge derived from social science, non-natural science, and non-scientific (traditionally) knowledge to solve various practical problems also belongs to "the category of technology". This class of technology is referred to here as "soft technology". Soft technology comes into being through the conscious use of those common laws or experiences in economic, social and humanistic activities, and then shapes rules, mechanisms, means, institutions, methods and procedures which contribute to the improvement, adaptation or control of the subjective and the objective world.

So, we need go back to Plato's definition of technology. Technology is composed of hard and soft technology. Although as economy develops and technology changes, the boundary between hard and soft technology blurs, in general, we can say that hard technology takes material as its carrier, while soft technology takes human beings. Here, “hard” refers to the tangible entity upon which an operation is conducted. “Soft” refers to an entity without physical form.

Soft technology must meet two characteristics: it must be technology as well as “soft”. As a technology, 1) it should be an **operable** knowledge system of means, tools and rules for solution of problems; 2) it should aim at practice for providing the “**service**” to social change and economic development.

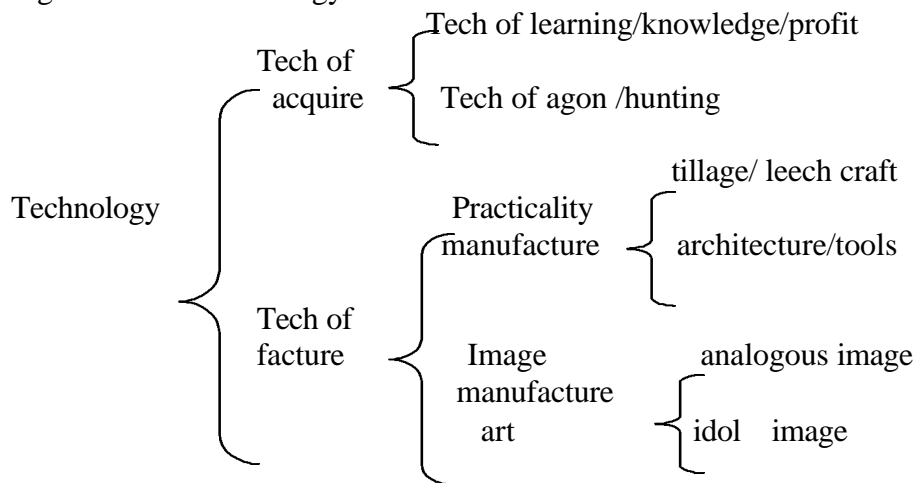
Having “soft” as an attribute, 1) the characteristic of the **operating** objective depends on the “mind's world” in which the human's immanent consciousness activity is conducted (details see below); 2) The **operating** fields include the process of immanent mind activities and the systems of human's social activity, and the latter is the dominated performance of the former. So, the main technical parameters are various human, social and cultural factors; 3) Except for products, the most common providing modes of **service** are those without physical forms such as services, processes, rules, institutions etc.; 4) It should be able to present, mold and affect changes through human cognition and actions in the subjective and objective world.

Fig.1



In short, soft technology is the intellectual technology around individuals, human thinking, ideology, emotion, value view, world view, human and organizational behavior as well as human society for creation and innovation.

Fig.2 Plato's technology ^[1]



2. Re-thinking of technology

2-1 Hard technologies are being "softened"

Software technology is an example of a hard technology that is losing some of its rigidity. It is an important strategic technology for economic stability and national security. But this doesn't mean that it is the only result of "hard" technology. The successful design, implementation and application of software require the embodiment of different cultures, languages, institutions, arts, thinking styles, working styles and procedures. This gives software products the characteristic of localization. Software technology is thus no longer a pure "technology" in the traditional sense. The more successful the software is, the greater the "non-technology" factors it includes will be. One such factor could even be "the milk of human kindness" The Linux operating system can

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serve as one fit example.

2-2 Soft-tech is involved in the processes of technology acquisition, conversion, commercialization, and industrialization

Technology cannot turn out products or acquire market share by simply relying on "technology" itself. Many other functions are needed for technology to be "injected and infused" into products and services. For example, we have to develop correct strategies, raise the necessary funds, design products that embody technology and that will be adopted by society, as well as set up marketing procedures. For the sake of their continuous survival, enterprises not only need to adjust their products and technology structure continuously, but also need to address issues involving cooperation, purchasing, acquisition, and foreign investments to remain competitive. How all of these can be done efficiently is itself a soft technology. To consider all of these simply as "management" is a little far-fetched. In the author's point of view, standardization, processing and regularization of this process are examples of soft technology.

2-3 Various business technologies are mature examples of soft-tech -- The process of creative human economic activities and its management

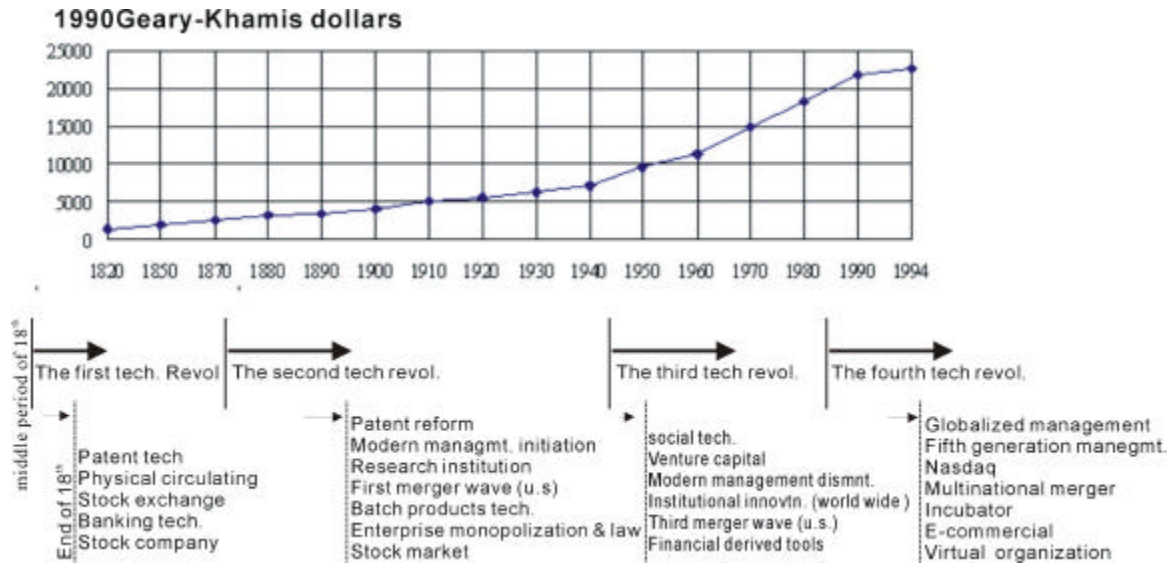
In its long history, human society has developed different kinds of business rules and financial tools that suit different cultures, social systems and technology levels. Those processes of applying creative thoughts and ideas in production, marketing and profit making have, over time, become standardized, regularized and formalized into mechanisms, rules or systems. This process of human creative activity is a soft technology. These technologies are similar to natural science technologies, but they are accumulated from experiences and formed after thousands of "tests" and experiments (in this experiment, the laboratory is the whole of human society). for example with commodities exchange, monetary exchange, value added to property and other production and social activities, formed after thousands of "tests" and experiments (in this experiment, the laboratory is the whole of society).

Economist Charles Jones^[2] at Stanford University pointed out in his research into people's living conditions in 19th and 20th century that the consuming level per capita in France in 1790 was not higher than that of ancient Rome. It was only during the late 19th and early 20th century that unprecedented rapid growth produced a much higher living standard than in the past several thousands years. One of the main reasons must be the creative mechanism by which various innovations were encouraged. For example, the patent system, the establishment of companies of limited liabilities, the development of stock markets and venture capital, and preferential policies towards research and development. Jones considered the creative mechanism is the driving force of human society.

Jones considers the encouragement of creative mechanisms is the driving force of the human society.

Our study on GDP per capita in U.S. shows^[3] that economic growth was more directly related with the wave of soft technology development despite four times technology revolutions occurred during the last 200 years,.

Fig.3 Per capita of U.S. GDP and Soft technology



For instance, there was unprecedented rapid growth in the 20th century especially during the 20s and 50s. During this phase, various technological inventions were widely utilized and man's average life expectancy grew from 35 years in the age of Revival of Letters and even in the 18th century to 55 years in 1920s.

The main reason is that creative soft technologies were widely utilized and new economic institutional innovation was adopted by countries in which various innovations were encouraged. For instance, the patent technology was first introduced in the 15th century, but, only by the end of the 19th century, patents were applied in all industrial countries (1883, Paris Common Divisor^[4]). The stock company first appeared in early 17th century, but the stock markets have had great development only since early 20th century. The research mechanisms came of middle 19th century, but most of industrial R&D laboratories were established in the late 19th and early 20th century. It was also in this phase, with Frederick Winslow Taylor as the representative, modern management technology has been developed. 1950s saw the development of social technology, venture capital, modern management, etc. and the occurrence of the third wave of corporate merger in U.S.

In fact, the patent system, the mechanism of corporate limited liabilities, the stock market institutions and stock techniques, and venture capital system etc. all belong to the field of soft technology. They encourage innovative activities and build the environment for protection and stimulation of innovation. Therefore, Industrial revolutions were more closely related with waves of soft technology development.

For decades Hong Kong could not boast of any high technologies of its own, yet it registers a noticeably fast economic growth. The contributions of soft technology are undeniable.

2-4 Cultural technology ?

-- The innovative process of human's cultural and artistic activities

As spiritual consumption being enhanced, culture will play a more and more important role in technological and economic development, and sometimes, its function may even go beyond that of the government and markets. There are thousands upon thousands of cultural products that meet increasingly diversified spiritual needs, enrich social life, and drive forward the immateriality economy and cultural industry. Cultural technologies embody cultural values and culture industry takes cultural values as a consumptive object, taking the cultural contents or cultural conceptual value as the main attribute of products.

2-5 Soft-tech and Chinese medicine type of technology

-- A special thinking mode and problem solution approach

The traditional Chinese medicine technology of diagnostics and therapeutics is an example of another type of soft-tech, which is successfully used in the human body through concepts about the relationship of man and Nature, disease and health. This field is worthy of additional and deep research and development.

Ever since the earliest medical work, "Emperor Inner-Cycle Theory", which was produced about 2000 years ago (770B.C -222B.C.), traditional Chinese medicine and medical practices have formed a unique systematic theory and treatment methodology. It involves an ecological concept of man and Nature as a whole and the human body as an organic whole that takes the viscera and "Jingluo- the inner cycle-channel" as the core. There is "Yin" and "Yang" which obeys the law of unity of opposites and unifies in everything in man and in Nature. Disease is the process of maladjustment of the balance of "Yin" and "Yang" and of striving between evil and good ^[5]. Regarding the relationship between the whole and its parts, the whole is emphasized. It pays attention to holding the "Qi", "Spirit", "Zangxiang", "Jingluo", "Symptom", etc. that only exist in the whole level. Chinese medicine theory and methodology are examples of integrated system theory, dialectic in unity of opposites, "Yuan Qi" theory, as an example, forming a particular set of theories with which to treat human, nature, disease, and health. It has created practical and efficient tools for solving medical problems such as diagnostic technology, therapeutic technology, health care technology and longevity technology, based on Chinese medicine theory and medical practices of several thousand years.

The methodology of traditional Chinese medicine has given priority to the methodology of LPFE (Learning Through Personal Feeling and Experience) science. LPFE science ^[6] is a science system in which subjective experience is the object of research and manipulation. This is greatly different with experimental science system with objective experience as the object of research and manipulation. The so-called subjective experience is the reflection and reaction of man towards the objective world, and the objective experience just indicates the objective world itself. Generally, the achievement of LPFE science will be individualized and allows for difference as well as admitting individualized explanations for a sort of event. According to the definition of soft tech, the methodology of LPFE science is part of soft tech.

According to statistics in1993, there are 2457 Chinese medical hospitals, 129 ethnological hospitals, 222 thousand Chinese medical hospital berths, and 249 thousands of Chinese medical doctors. Moreover, there are 30 Chinese traditional medicine and medical colleges, 51 Chinese traditional medicine and medical middle schools, 77 independent academic institutions, and more than 10,000 professionals as well. However, Chinese medicine has not made the

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contribution it should have. For various reasons, in modern history, especially in the most recent 100 years, China's economy and technology have lagged far behind that of Western countries. China did not put emphases on the financial and human resources required for developing Chinese medicine and medical technology. Nor did regard China medicine theory as one of the advanced modern sciences.

China is a multi-ethnic country, with considerable Chinese national medicines including Mongolian medicine, Yi ethnic minority's medicine etc. Tibetan traditional medicine is a good example with a history of over 2000 years. It has its roots in the specific geographical climatic environment and culture. Tibetan medicine theory considers three factors, in which "Long", "Chiba" and "Peigen"(main breath, quantity of heat and body fluid) are the substance elements of holding the body. Health indicates the three factors being kept in balance and harmony. If the balance and harmony is broken, man will be ill. According to this kind theory, Tibetan medicine frames dialectic RX. People begin to realize that Tibetan medicine can be developed into a promising industry ^[7].

It has been very difficult for a long period of time for the Western world to accept and understand Chinese diagnostic and therapeutic technology due to different cultural backgrounds and ways of thinking. Chinese medical theories and technologies are very different from the traditional scientific technology. It is the main-flower of the Chinese traditional culture, the unique soft technology, which integrates science, Chinese culture, philosophy and traditions. It is the special soft-tech field in which China should boost R&D vigorously.

The exciting point of our discussion on traditional Chinese medical technology is the way of treating conflicts and the methods of their solution. For instance, the consideration of relationship between the whole and the part, the holistic and systematic approach can lead to understanding and resolving of non-medical problems. The comparative study of life systems and non-life systems will help human beings understand and treat the complex system of the entire society-economy-technology system ^[3] as well as the relation of its various elements well. Meanwhile, to a certain extent, the analogy of Chinese medicine may provide a more effective platform for the coordination, merging and balancing eastern and western nations, for the learning from each other and co-existence of the western and eastern cultures.

2-6 Technology around human's "heart"

Technology has started from the stage of liberation of the two hands and use of tools. However, along with industrial revolution, technological development has focused on Nature and materials, ignoring man himself. Even though in Modern Iatrology the human body regarded as a complex organic system that has composed by digestive system, circular system, metabolism system, generative system, nerve system and athletic i.e. High technology treat human body as a special material structure. In short, for a long time, human develops technology, which has foreclosed human "heart" ^[8].

Now, in the post-industrial society, we meet various austere social problems. For example, the human nerve becomes more flimsy and there are 4 hundred million multifarious mental patient in the world. Only high technology cannot do much about this. Now, people care more about the feeling (vision, hearing, gustation, olfaction, touch) of life and their mood, emotion, feeling, will, ethic and moral dignity are respected.

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Apparently, technology must turn from pursuing the “efficiency number one” and “profit number one” to pursuing the environment which enables an easier and more comfortable life with more concerns about human feelings and emotions, which shows more defer to ethic and moral standards, though immolated a little bit of efficiency and profits.

These factors are the driving force of softening hard technologies, main content of increasing soft technological add-values and important task/content of service innovation.

Hence, it is necessary to define a new concept of technology that covers the above-mentioned functions, with soft technology as the new paradigm of technology

In order to understand more about soft technology, the author will classify soft technology first, then continues with the discussion of the characteristics of soft tech comparing with hard tech.

3. The classification of soft technology

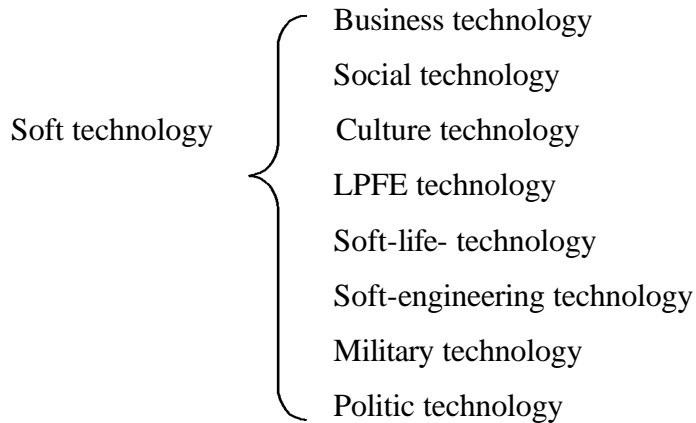
From the knowledge background of soft tech, soft tech can be classified in the following ways.

3-1 Soft tech can be classified in terms of its source

- 1) Technologies originated from knowledge of social sciences including technologies of business, consulting, education, organization, and tools derived from finance, incubator technology and system technology;
- 2) Technologies originated from knowledge of the natural sciences with the features of soft, such as software technology, network technology, artificial intelligence;
- 3) Technologies originated from knowledge of LPFE science; For instance, telepathy technology of human and environmental change such as Chinese traditional diagnostic technology, Chinese medicine therapeutic technology, Tibet medicine therapeutic technology as well as technology of regulation of breathing, heart and body in Qigong.
- 4) Technologies originated from knowledge of thinking science, psychology, life science such as Qi technique, psychological training technique, spiritual health technology, decision-making technology, thinking technology etc.;
- 5) Technologies originated from non- traditional scientific knowledge such as culture art, religion, language, law, history, philosophy, special environment, for instance, cultural technology, music technology, amusement technology and indigenous technologies etc.;

3-2 Soft tech can also be classified by its field of application

From the content of operation and the field of human’s activities, soft tech can be classified as follows:



1. Business technology

Soft technology flows from developments of society, the economy, science and technology. Soft technology existed even in the earliest time of human productive activity. The ancient Chinese military science of Sun Zi, traditional Chinese medical technology, and technologies of accounting, insurance, stock institution, public relations, advertising, bank mechanisms have long histories. However, most of the modern and regularized business technology and its application in economic development began in Western countries during their industrialization.

Business technology is the process technology and the efficiency technology in man’s creative economic activities, also is the embodiment technology to implement the economic value of hard/soft technology. Various exchange tech, accountant tech, stock tech, ad tech, management tech, alliance tech, venture capital, logistic tech, virtual tech, incubator, e-commercial, financial derived tools, etc. are examples in point. They are soft technologies with long histories and best maturity.

2) Social technology

In 1955, Misumi Jyuji, a Japanese scholar, proposed the concept of social technology in “Introduction of social technology”^[9]. He summed up the technology with which to control human relationships and psychic phenomena in society as social technology. Based on the concept of “Group Dynamics” which Lewin K. developed in 40s, Misumi Jyuji took group engineering as the social technology and focused his study on agora assembly exercise technology of various meetings and conferences.

In 1966, Olaf Helmer, an American scholar, published^[10] the book “Social Technology” with contributions from Bernice Brown and Theodore Gordon. The mission of social technology was explained as follows: “It has been remarked that many of the difficulties that beset our world today can be explained by the fact that progress in the social science domain has lagged far behind that in the physical science...” Olaf Helmer described social technology as a methodology of social science and tools of study for the future. They focused on studies based on operations research, the Delphi technique, the systematic use of expertise and so on.

By 1970, Japanese scholars have proposed the concept of “soft science” and “ soft series of science and technology”^[11]. It is a concept in opposition to the traditional concept of “hard series science and technology” based on natural science and engineering. In 1990, according to

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the report of “soft series of science and technology investigation committee”^[12], the definition of soft series of science and technology was revised as follows: “It is a new science and technology area, in which the aim (sciences) is to clarify the mechanism of human knowledge activities such as cognition, thinking, consequence, judgment, innovation as well as their behavior; to deal with and operate those tools that are supporting or partially substituting above activities and those information and knowledge that is generated by activities (technology).” This report also declared that technology could be classified as hard ware, and “human ware”.

Social technology is a method and system of development/application social resource and of resolving social problems. It is also the process of creation and embodiment of those values of social resources. Various social communities, associations, non-profit organizations, NGOs and human/social relationship are the external social resources, while those institutions, belief, religion, view point of value, ethics, social desirability, human’s emotion are internal social resources.

3) Culture technology—it is the technology of embodiment of cultural values and the abundance of spiritual life, for instance, music tech, entertainment tech, sports, Media tech, programming, beautify tech, fashionable dress tech, image design, publish tech, ad tech, game tech, amusement tech, various chess art, brushwork tech, performance art, cooking tech, etc.

4) LPFE technology —Technologies originated from knowledge of LPFE science, for instance, the diagnostic and therapeutic technology of traditional oriental medicine, Qigong that is operating human’s breathing, mind and body, diagnoses by Look – Hear – Ask- Feel in Chinese medicine, Tibet medicine therapeutic technology, etc.

5) Soft-life- technology – it is a concerted and harmonious technology between physiological health and spiritual health and also it is a technology of respecting man’s feeling, emotion and mentality, for instance, new concept of longevity tech, health care tech etc., which has developed and applied the concept of human body in the sense of soft technology see table 1 . It is quite different from hard- life technology such as gene tech or regenerative medicine tech.

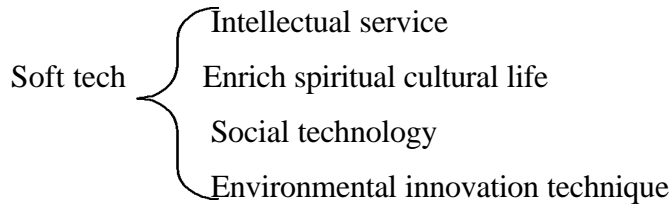
6) Soft-engineering technology—it is the natural systems and artificial systems in which the content of human being systems or social system will be simulated, e.g. software tech, network tech, ecology tech, social engineering, etc.

7) Military soft technology –military strategy, military tactics

8) Political technology

3-3 Soft tech can be classified in terms of function

From the classification of function, we will see how soft tech as a technology of innovation and creation is providing wisdom and intelligence to “resolve problems”.



- 1) Technology of intellective development, e.g. education tech, learning tech, etc.
- 2) Technology of intelligence supply
- 3) Management technology
- 4) Organizational technology
- 5) Technology of property increment
- 6) Technology of corresponding and collaboration
- 7) Relation technology
- 8) Technology of propagandizing and inducement
- 9) Marketing technology
- 10) Special service technology
- 11) Design technology
- 12) Environmental innovation technology, e.g. institution, policy, law, mechanism, systems
- 13) Technology of value development
- 14) Technology of individual creative interspace
- 15) Culture technology
- 16) Social technology

3-4 The characteristics of soft-tech

What then is the essentials of soft technology?

Whether hard or soft technology, since they are both of technology, their attributes will be common:

Means/skill/ tools/ rules/mechanism/methodology/process for solution of problem.

The aim is to practice, to provide “service” for social change and economic development.

But, soft technology forms absolutely different paradigm from hard technology.

Table1 Differences between soft and hard technology

	Standard	Hard tech	Soft tech
1	Resource	Knowledge of natural science	Knowledge of Non- natural science and non-(traditional) science
2	Operational object	“substance”	“human” psychological action and social behavior
3	Operational	Physical world	Spiritual world*

	field		
4	Operational Aim	To change and control the nature and substance	To master, orchestrate and manage human's ideology, emotion, thinking mode, value view as well as behavior mode of individuals, groups and organizations
5	Carrier	visible substance	intangible human factors
6	Technological parameter	Physical factors	psychological, social and cultural factors
7	Meaning of human factors	influences of extrinsic behavior	1) influence of extrinsic behavior --the performance of psychological action 2) influence of intrinsic behavior viz. psychological action such as feeling, sensation, emotion, ideology, culture, value view, world view, tradition, individuality, etc.
8	Position of human body	An organism, in the final analysis, an substance and a cellular combination	A life in which have consciousness, sensation, spirit dimension side
9	Source of innovation	New invents and discovers	Result of human's notion, life style and view point of value
10	Characteristic of innovation	Not necessary to destroy and can coexist with old system	Need a creationary creation new system displace old broken system
11	Process of innovation	Materials-machining products; Design products manufacturing market	Dream up/originality forms systems/modes/methodology exercise/regularization; Design system and methodology run/implement: cultivate the process from which the new institution grow—displace the old system creation and building new system
12	The relation with institutions	the environment of hard tech innovation and creation	Innovation environment, on the contrary, soft tech innovation is the content and basis nature of new institutional innovation
13	Whole and part	From part to whole	From whole to part
14	The relation of subjective purpose	Independent of man's will	able to present, mold and affect to change by human's intellect, thinking mode and behaviors
15	Mode of resolving problems	Products and services	process, rules, institutions, products and services

16	Nature	Neutral	Dual nature
17	Standardization	Can standardization	Strong individuality and difficult to standardize
18	Regional feature	Cross culturally constant	Regionally specific

source CTISS/JZY/2000/12/9

* Soft technology rooted in Spiritual world. The so-called spiritual world includes the abstract world the object has conceptualized through those actions process in immanent consciousness , visual world (reappeared the image through memorize and mind's eye the events) and presentational world ^[13] reflection of sensory, emotion/mood and action e.g. ache, dread, enjoyment, etc. , where abstract thinking operates concept, visual thinking operates image and presentational thinking operates consciousness itself.

The Physical world in which hard technological operation is conducted includes natural field and artificial field. The mind world in which soft technological operation is conducted includes inner orchestration action system and outer behavior system. The former includes the abstract field (concepts, modes, systems) and consciousness field (sensation, emotion and mood, feeling), the latter includes social behavior field(the performances are dominated by inner orchestration action and value view, world view, ethic/moral, sentiment etc. .

4. Main functions of soft-tech

Table 2 Function of soft tech

Tool of innovation (technology innovation)	Key tech for independent industries (industrial innovation)	Contents & basis of new institutional innovation (institutional innovation)
process tech of tech transfer tools & contents of innovation	Intellect Service Industries cultural Industries Social Industries Soft Life Industries Chinese Medicine Industries	Institutions, systems, Policies, mechanism Laws, regulations * Nasdaq * Stock company law * Exclusive law *Institution of intellectual property right *Corporation law (to start-up business)

source CTISS/JZY/2000/4/9

4-1 Soft-tech and technological innovation

Soft technology contributes to technological innovation in two ways. First, it provides tools and the means of technological innovation. Every country and region should create and apply tools that fit its own reality. Secondly, awareness of soft-tech has expanded the space of technological innovation, so besides that there will be soft-tech innovation as well as innovation

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in the integration of hard and soft tech.

When we talk about technology applications, usually we say that we should not "copy mechanically and apply indiscriminately". This will be suitable for soft technology. Hard technology can be "copied", even standardized. In fact, soft-tech is a vehicle, to "move" the outside technology into enterprises or industry. Soft-tech is the means and tool for technology transfer. That is to say, most knowledge needs technology as a carrier to turn itself into products and services. Thus **soft tech is the tool for innovation, viz. technology of value development**. The development and the conscious use of soft technology will expand the space for technological innovation and knowledge innovation.

For a long time, there have been arguments about the past 10 years' development of Zhongguancun (High Technology Development Zone in Beijing) and whether or not it should develop its own technology, especially high technology. Their development is widely recognized as trade-manufacture-tech road. Some people even say that Zhongguancun's "electronic street" is a "cheats camp". But from the soft-tech perspective, trade is a process of utilizing commodity exchange technology to make wealth; manufacture is a process of utilizing manufacturing and management technologies to make products.

Before the introduction of the reform and opening up policy to in 1979, Zhongguancun had already been a well-known research center for education and national natural science. 68 universities, over 200 research institutes located and over 30% of academicians of Chinese Academy of Science and Chinese Academy of Engineering worked in this region of Beijing. However, after 1979, this region was no longer a pure research center. It became a center of the new economy, the incubator of high-tech industries, and a center for commercialization of knowledge and technology in China as well as a demonstration base for experiments. The unique advantage it enjoys helps it to attract many talented people from across the country and abroad. In 1990s, registered Zhongguancun residents increased by 37 percent annually. By the end of 1998, Zhongguancun (the experimental zone of Hai Dian) had a registered work force of 138,546, among which 8.27% were PhD's and MA's. 36.8% university graduates, 19.2% college graduates, and 12.9% technical secondary school graduates. The zone contains nearly 5,000 new tech enterprises of considerable business scale set up by Chinese entrepreneurs (over 900 of which were joint ventures). These enterprises grew at a speed much higher than that of the national average (from 1988 to 1998 the total technical, industrial and trade income of the zone recorded an annual growth rate of 42.58%, and the industrial output value 48.7%). For years the scientific enterprises in the zone have employees with the average age of 30, and many bosses of small companies are only in their twenties^[14]. The zone is full of change and vitality.

Why the fundamental change of Zhongguancun has not taken place before 1980? Under a planned economy, most enterprises did not have enough inner demand for technology progress. They were short of technology transferring abilities. In a sense, there were enterprises without entrepreneurs. Those scientists and technologists who are mastering natural science knowledge and technology, are not qualified experts in raising funds, managing capital, knowledge and market, namely, have no capability of transferring technology, imbuing knowledge and technology with market values, and accumulating money for further innovations.

So, during the reform and opening up era in China, the road of trade-manufacture-technology

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has been the common solution of people that have no market economic knowledge and experience. This gave them chances to experience market economy laws themselves. They practiced the process of trade, agent, assembling, copying and imitation to innovation. In this way they became familiar with markets, and step by step they carried out the design and production of their own products. In one word, they learned soft technology. If there were not a sound macro environment for exploring and doing business and, there were no mastery of soft technology, surely innovation would not have been improved. The achievements of science and technology would have been doomed to remain as samples and as display items in a showroom.

Thus we understand that the past 10 years of Zhongguancun witnessed the process of Chinese scientists and engineers mastering and making use of soft technology to foster innovation capability under the new environment presented by policy reform. This capability could not grow from textbooks. Who can say that in the past 10 years' Zhongguancun has no technology of its own?

4-2 Soft-tech and the service industry

It is known that the proportion of tertiary industry in developed countries and some developing countries is much higher than that of the traditional primary and secondary industries. This is the so-called economic softening phenomenon. From the technology perspective, continuous soft-tech innovation has played a significant role in the rapid advancement of intellectual content of the service industry and has become the core of new economy.

After entering the second half of the 20th century, with the material needs being mostly satisfied, spiritual demands become more important. R&D investments and innovation activities in the service industry have increased. For example, in 1980, the US R&D input took up 4.1 % of the total investment in service industry, while in 1996 the percentage increased to 19.5 %. In Britain the R&D investment in service industry has already accounted for 4.02 % of its sales in total, and the figure for manufacturing is 3.17 % ^[15].

At this point, some intelligent service industries that have been developed into considerable scale will be mentioned:

- 1) Intellectual service Industries such as Consultation industry, R & D industry, Reconstituted industry, Public relation industry, Brokerage industry, Advertising industry, E-commerce industry, Concept or Idea industry, Design industry, Venture capital industry, Incubator industry, the various specialized management industries.
- 2) Culture industries such as Education Industry, Sports industry, Experience industry, Beautification and cultural business, Media industry, Entertainment industry.
- 3) Social industries such as City management industry, conference industry, association and community industry, etc.

Now, most entrepreneurs are engaged in the intelligent service industries, such as "cultural entrepreneurs", "design entrepreneurs", "education entrepreneurs", "social entrepreneur" and "city management entrepreneur" etc.

4-3 Soft –tech industry and industrial structure

For a long period of time, economists studied industrial structure by classifying them into the primary, secondary and tertiary industry categories. Recently, most scholars have concluded that

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a fourth industry is emerging the knowledge industry, but the understanding of this fourth industry varies.

In 1962, Fritz Machlup brought forward the concept of knowledge industry ^[16]. In 1977, Mark Paratt and his partners in US proposed the method for dividing the industrial sphere into four industries in “*Information Economy*”. The article, “*The Main Resource for Social Economy*” was published in French newspaper *World* on March 2, 1999. It put forward the concept of social economy, in which the fourth industry was mainly based on human relationship and personal "production".

In 1978, Kusaka Kimindo, a Japanese scholar, proposed that the tertiary industry could be separated into three parts: the part that is physical power oriented, the part that is non-physical or intelligence oriented and the part that is psychology oriented. He proposed the second part (the so-called knowledge and information type) as the fourth industry and named the third part (the so-called emotional satisfaction type) as the fifth industry ^[17].

It is clear that, in the future besides information technology, there should be many technologies that penetrate into the primary, secondary and tertiary industries. For example, bio-tech, nanotech, robotics etc. So the suggestion is to take those high tech industries as the **fifth industry** or the modern high tech engineering industry and to separate the intellectual service industry from traditional service industry as the **fourth industry**. The kernel technology of fourth industry will be those soft technologies.

We could go further: a **sixth industry** or life industry centers on life and the human body. It would include the medical industry, health care industry, medical treatment industry, life prolonging industry, human gene industry, special manufacturing, etc.

Table 3 Soft-tech development and the change of industrial structure

Industry List	Name	Characteristic	Example
First Industry	agriculture industry	industries in terms of land is the object	agriculture, forestry, stock raising, fishery
Second Industry	engineering industry	equipment based material producing industry	mining and traditional manufacturing
Third Industry	traditional service industry (equipment service industry)	fixed assets based immaterial producing industries	transportation, shops, restaurants, real estate
Fourth Industry	New service industry (broad sense intellect service industry)	Immateriality producing industries in which the key tech is soft technology	i service industry cultural industry social industry
Fifth Industry	high-tech engineering industry	modern high tech is the high tech is relative, high-tech industry will continued change, polarizing	soft tech in software, network etc. -tech -electronics, photoelectricity,

		and flowing	spaceflight, bio-tech, nanometre, etc.
Industry		centered on human life and health	-tech Chinese medical treatment diagnoses life prolong hard- industry medicine, human gene, special manufacturing such as man-made organs industry

Soft technology serves as a tool for technology transfer and innovation in the primary, secondary, and tertiary industries. It also serves as the core technology in the fifth industry. And in the fourth and sixth industry, besides serving as a tool for technology transfer, it penetrates deeply into original technologies to add values.

4-4 Soft-tech and institutional innovation

Institutions are the aggregate of various social rules and tools for directing human interactive behavior. They have a large range, from the macro-sense institutions such as political systems to micro-sense institutions such as the enterprise, property rights, accounting, and so on. However, from the perspective of broad sense technology, the institutions, mechanisms or systems are just those behavioral and social rules that are legitimized and legalized by the society through regularization and formalization of those processes that create, apply, generalize and turn into profit using soft-tech. Hence, institutions also embody the values of their special environment

and diffusion process of many soft tech are different than those. Because human factors and cultural factors are most important parameters of soft-tech, it is obvious that their application will affirm or amend social active style as well as the positions, functions and profit both of individual and groups in order to regularize the rule of behavior both of enterprises and individuals, government departments, communities and industrial organizations regularize so as to form relevant policies, institutions, mechanisms, policies even rule of law to restrict human's interaction.

Therefore soft technology innovation is the content and basis of new institutional innovation as well as innovation of systems, regulations and policies. Conversely, the soft-tech innovation will be restricted by institutions. Because, once soft technology has come into being as the relational institutions, further innovation and transformation of the soft technology are likely to meet strong resistance and counteraction since those changes will affect the benefits flowing to some groups and individuals. In any event, innovations of institutions must be kept in-phase with technological innovations and social progress. Otherwise, they will become the obstacle for socioeconomic development.

5. Technology competitiveness

Every developing country wants to catch up with and surpass the developed countries as soon as possible. But the fact is that the gap between developing and developed countries has become bigger and bigger, so has the gap between the poor and the rich with the economic globalization and the arrival of the information age. Why?

For the sake of challenge of world economic competition with high technology at its core, China had put large amount of human resources, materials and funds to push forward the development of high technology and its industry in the past 50 years. The very target is to have a position and change the backward situation in this area, and to catch up with developed countries. Chinese government has started a series of programs aiming at the development of high-tech, and more than 50 High-tech Development Zones were established. It is true that great achievements were accomplished in some technology fields. But on the whole, the technology level of China lags far behind the world, and in most of the fields there are still a 10~15 year gap with the advanced countries.

In 1998 and 1999, the topic of knowledge economy was widely discussed in Chinese governmental and academic circles as well as in the media. Is it another "opportunity" for China? If so, what is the key point in narrowing the gap to achieve the leap forward in developing countries? What separates developed and developing countries? Is it technology, or something else?

5-1 Knowledge and technology is merely the potential competitive capacity

It has been said that high technology is the key element in determining the competitiveness of a nation, and also knowledge is the kernel of international competitive capacity. But there are many examples that indicate knowledge or "hard" technology itself does not always lead to success.

The United States of America has the most advanced technology and knowledge. But in the 80s, it lagged behind Japan in many industries. The US government then stipulated a series of policies to intervene in high-tech areas. By 1990s, its semi-conductor and other important industries were restored to leading positions.

The former Soviet Union had a strong high-tech system that could compete with the US. Its education level and the quality of its citizens were high. Their basic industry was also strong. But what led them to crash? Although political causes are important, economic backwardness was the main cause. They were defeated in transformation of advanced technology, which could send people to the moon but was not converted to products and market value. In short, their science & technology did not contribute to increasing economic competitiveness.

Japan created the so-called Japanese miracle on the ruins of World War II through 30 years of hard work and went ahead of many western countries that owned more advanced technologies. The reason is not that Japan had grasped advanced technology. According to many investigations, Japan today still retains first class technologies. But since the late 80's, it fell into of a bubble economy and could not stop its decline. Has Japan or the world changed?

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The Haier Company in China is a successful enterprise both in domestic and foreign markets, but in the beginning, it was not advanced technology that led to its success.

Here, a point is made by the author that technologies mentioned in the paragraphs above are "hard technologies" as defined in this paper.

5-2 How to obtain technology competitiveness?

It is clear that technological competitiveness will be represented by the number of technologies that have predominated and have been commercialized. The essence of competitiveness is R&D capacity, plus the efficiency of technology transfer. Therefore, *competitive capacity comes from R&D capacity, soft-tech competitiveness and the environment for innovation.*

Most of the developed countries experienced soft technology by which various innovations are far better developed than in . Gradually appropriate macro environment is formed by soft ies and is also than in developing countries technologies such as modern management technique, venture capital, virtual technology, incubator, new money, Nasdaq stock, etc. developed by U.S. and U.K. ed of absorbing and applying advanced technologies is far high than in developing countries. eveloped countries have absorbed most of the the less developed inland and west areas tried to attract foreign capital by priorit policy all the time, however up to June 2001 number of absorbent foreign direct investment used foreign direct investment in west area only account for 7.3%, 6% and 5.3% of the national total . Come to light, investors are purs

it seems important for those developed countries own high- brought the high tech competition in positions. However, the situation i obviously backwards in R&D capability the frontiers of technology, but the main low efficiency of absorbing advanced technologies. These failures lie in the defects of macro innovational environment and soft technology. This is particularly true for China where the main and re innovation. echnology transfer is the key in the coming 20 years.

For they are profitable or not, hard- not associated with high- ent and benefits allocations E- The bottleneck is not E- , the problems management, laws, ideology, institutions and organizations.

A favorable environment is the for creating competitiveness

With economic globalization and the high speed development of information technology, the -environment and macro management within that environment determine competitiveness.

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The macro-environment provides the setting for technological competitiveness and can be classified as hard and soft one. The hard environment contains the infrastructure, industrial base, industrial structure and economic capacity; the soft environment, on the other hand, contains the institutional and international environment, policies and laws, rules and regulations (especially personnel policy), culture and customs, market condition, customers' demands and technology infrastructure. These conditions at macro level are not possibly controlled by any single enterprise. Rather they are determined by the actions of government and the social environment. However, soft environment can be improved through continued re-design and innovation of soft technology (see below). Among the soft environment factors, institutional and cultural factors must be emphasized.

1) Institutional environment

In the past 20 years, China has maintained a high economic growth rate. If there had not been economic reform and opening up policy, this progress would not have been possible. Japan serves as another example showing the importance of the institutional environment. A survey carried out by IMD in Lausanne showed that Japanese national competitiveness ranked the 4th in the world in 1996, but in 2000 it declined to the 17th, though Japanese science and technology competitive ability still ranks the 2nd from 1996 to 2000 in the world. IMD attributed this decline to faults that existed in the Japanese financial and management system^[18]. This decline indicated the institutional environment that supported Japan in achieving its economic miracles met new challenges.

In China, even though there are grand talks about the knowledge economy, the protection of the property right remains a tough problem. And further more, only the tangible property and value created by capital can be accepted in an enterprise property system. In addition, the necessary institutional reforms are costing time, because most people are worried about the political issues associated with these reforms. Therefore, the problem of property rights has become an obstruction for enterprises like Legend and Founder in Zhongguancun. Under this kind of situation, how can we encourage the spirit of innovation?

2) The Factor of Culture

Culture and habit set the stage and are at the root of innovation, and sometimes even exceed the function of market and government. Ancient countries like Egypt, India, and China did have their historical times of leadership, but they are all developing countries today. It is obvious that culture and economy have a close relationship. There have been discussions on why modern Chinese lags behind in science. Academic scholars in China have been discussing this since the New Culture Movement and Anti-Japanese War. The focus lies on culture.

Silicon Valley is a technological innovation center in America as well as in the world. Every country tries to create innovation bases in their homeland like Silicon Valley, but there is only one Silicon Valley in the world. In general, people have cited the visible factors of Silicon Valley e.g. high-tech industries, venture capital funding mechanisms, excellent universities, research institutes, and infrastructure, etc. But it is easy to ignore the most fundamental factors that have supported Silicon Valley. Namely, it is the culture of Silicon Valley that forms the social supporting system, encouraging innovation, encouraging cooperation, allowing defeat and investing in talented people.

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Guangdong Province in southern China enjoys the advantage of technological innovation that derived from conceptual innovation. For five consecutive years, Guangdong has ranked the first in the number of patent applications examined and certified. It owes this achievement to the preferential policies granted to the earlier economic zones in China. The opening and flexible commercial environment is a "king card" used to attract talented people, new technology and investment. The name of Guangdong and Shenzhen is equal to the meaning of "open" in China now. Even the government officials are more open-minded than their counterparts in Beijing and Shanghai. Guangdong no longer allows the establishment of new state owned enterprises, and the local government encourages private companies to get together to compete with foreign companies.

It is obvious that, from competitive perspective, the key issue is to keep harmony between innovation and maintaining of the excellent cultural traditions that each nation, region and minority possesses.

Talented people are the key to improving soft tech.

In conclusion, soft-tech has been ignored for a long time in many developing countries. Obviously, just having knowledge and hard tech is not enough. Soft-tech is the tool of activation for latent competitiveness. The principle factor involved in the gap between developed countries and developing countries is backward soft technology. The shortage of soft-tech talented people is the essential component of this gap, at the national level, industrial level or enterprise level.

6 Soft-tech talents and educational revolution

Since China has pursued reform and opening up policies, many intellectuals have been promoted to leading positions for the sake of making cadres younger, more knowledgeable and more professional. For example in China, some excellent engineers have been promoted to executive directors of enterprises, some outstanding scientists have been chosen to be administrative leaders in academic institutes, some excellent teachers or professors have been promoted to leaders of schools or universities, some qualified physicians or surgeries have been promoted to president of hospital, and some technicians with no financial knowledge could be dispatched as president of bank, etc. Intellectuals have been placed in very important positions, but this policy fails and both sides suffer. After many painful experiences, people begin to understand that, "Excellent engineers may not necessarily be capable executive presidents, and excellent scientists may not necessarily be good entrepreneurs". Why is this so? It is because of the lack of awareness of soft technology and personal capability.

People who manage talented people should have the following three qualifications:

- 1) moral standing and character;
- 2) interdisciplinary knowledge background and
- 3) practical ability.

About interdisciplinary knowledge and technology background, training and education in soft science and soft technology is absolutely necessary. But because of the bias toward hard technology and natural science, soft-tech has not been regarded as a special field. Thus, people without enough education in humanities and social science, neither any soft technology training

Forthcoming in "Futures Research Quarterly" 2002 U.S.

have been pushed forward to management positions, even to important administrative positions. It seems to be assuming that management ability can be easily gained by experience or "compelled" into practice.

When management training comes through on job training, the costs are too high. Decision failures are the cost. The seriousness of the failures depends on the levels of the management position. The higher the position is, the heavier the losses will be. Eighty five percent of bankruptcies in the world have been caused by decision failures of entrepreneurs. This could be tolerated only in a planned economy that seeks no benefits and encourages no competition. So if we say China lags behind in high tech area by 10 to 15 years, it lags behind even further in management.

Clearly, the old education system, the setup of professions and departments as well as the training of human resources are out of date. It only produces talents with partial knowledge, and is divorced from the need to training entrepreneurial talents for high tech venture corporations. What the educational system needs is not merely reforms but revolutions.

7. Conclusion

The following conclusions result from the above discussion:

- 1) The main functions of soft-tech are: (1) innovational tools; (2) a key technology to form the new industries; and (3) Soft technology innovation is the content and basis of new institutional innovation as well as innovation of systems, regulations and policies.
- 2) A more profound understanding of soft technology and its practices will be a short cut to narrow the policy and strategic of technology development, should not just follow what developed countries do.
- 3) Awareness of soft-tech will expand the space of technological innovation and change the structure of innovation.
- 4) The new business mode is the integration of those relevant new institutions that supported by soft tech innovation.
- 5) Systematic soft tech education will be a road of fostering startups, entrepreneurs as well as interdisciplinary talent.
- 6) Harmony, balance, equality and co-existence are the basic principles for human society in the future.

As we are entering the 21st century, with the rapid development of science and technology, the quickening pace of technological and economic globalization, human beings are facing bigger and bigger challenges. For instance, the conflict of economic benefits with environment; the conflicts of nations and religions; the great gap between the rich and the poor; the conflict of the development of science & technology with that of the society, for example, the relationship of research freedom and the sustainable development of human society, especially the ethic and moral problems caused by the research on human gene and the breakthrough of mammal cloning technology, the unreasonable use of nuclear technology and computer virus, as well as family violence, internationally organized crime and violence etc.. Human beings are destroying the civilization created by themselves in a more and more dreadful way, with the help of high-tech developed by themselves.

These problems are of a very wide range, concerning individual and social interests, from national to global strategy, from domestic social relationship to international relationship, about economy, politics and national defense. Obviously, human beings are facing sustainable development problem of themselves, which could not possibly be solved by certain technologies, or some politicians and some governments.

To achieve sustainable development, to build a world of prosper and peace, which is civilized both materially and spiritually, those well-educated elite including political leaders of all countries need to change their world views thoroughly to advocate and build new culture and new value of view worldwide. That is to stick to one common principle, when dealing with problems concerning economic development modes, the pursued social civilization, the development of science and technology, and how to treat the relationship of different nations and religions, the relationship between the West and the East, the relationship of man-nature-society, namely the principle of coexistence, equality, harmony and balance.

Here, the essentials of Chinese traditional culture, the idea of peace is stressed, focused on the unity of man and heaven, together with ancient Chinese philosophy and culture Yin and Yang, are of significant theoretical and practical value with their contribution to the forming of sustainable development view and future development principles for human beings in the whole world.

Fig. 4



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