Sun Yat-sen Management Review
Vol.2, No.4, December 1994

National Innovation in the Information Age

Jimming Lin
Department of Information Systems
National Central University
(Received March 1994, Revised June 1994, accepted October 1994)

Abstract

China has achieved numerous great feats in many fields of science and technology in history. Other than the well-known inventions of paper, campus and explosive materials, Chinese achievements in the study of astronomy and the development of delicate cratsmanship of dademaking are two impressive examples of scientific and technological accomplishments. However, one puzzle remains in the mind of historian: "if China can create so many inventions thousands years ago, why did the Europeans, instead of Chinese, initiate the scientific and Industrial Revolution which changed the structure of the societies we live today ?"

This paper explores some important factors based on the comparative discussion of the subject of astronomy and jade-craft, and discusses some important issues on innovation and national economic competitiveness. From the 1980s, China has successfully achieved some predetermined economic goals after the implementaiton of the Open Door Policy. To maintain the momentum of modernization, it is suggested that Chinese national decision makers institutionalize social mechanism and restructure educational systems in order to sustain continual generations of creative scientists and technicians and risk-taking entrepreneurs that can explore new way of thinking and methods beyond tradition ideology. Innovation is the only way to sustain the long term national econmic growth.

Keywords: Innovation, Information Age, Astronomy, Jade Craftsmanship, Comparative Management, Chinese Economic Development, National Wealth.

1. Introduction

Could Asian Pacific countries lead the way to the club of world's richest nations? Will those Asian NICs, including Taiwan, Singapore and South Korea be able to sustain the high growth rates through the first half of 21st century and become members of OECD? Will China be able to continue its national drive to reach the goal of modernization and become an economic superpower? These questions certainly have arouse international interest, but there is no easy answer.

In retrospect, China has achieved numerous great feats in many fields of science and technology which were far ahead of the comparable accomplishments of European's in history. For example, Vogel (1993) reported that Chinese could drill a well 100 meters underground to obtain brine one thousand years ago-400 hundred years ahead of European similar achievement. Mechanic clocks were first invented in China by *Su Sung* in 1084, who designed an extraordinary one ran by water power. Disassembled in 1127, it was never rebuilt again(Nova Show #1706, 1990). This marvelous astronomic

clock, framed in a five-story pagoda like structure, was intended to be built for the calendarf time-machine for the emperor, rather than for the publicconvenience. The clock was vandalized immediately after the successive emperor came to power in 1094. Thus, the general public did not have access to the knowledge of replicating this machine. Eventually the Chinese lost the techniques of rebuilding one. It was not until Matteo Riccii 利瑪竇 (1552-1610), for the purpose of converting Chinese into Christian, brought two elegant Italian clocks-one driven by weight and the other one driven by spring, that Chinese saw the wonder of mechanical clocks again(Boorstin, 1985, p.58-59)

This paper examines the factors that influence national innovation from comparative studies on scientific, technological and social-political development in the East and West in the 15th century. Other than the well-known inventions of paper, campus and explosive matters, Chinese achievements in the study of astronomy and the development of delicate craftsmanship of jade-making are two impressive examples of scientific and technological accomplishments. However, one puzzle remains in the mind of many historians: "If China can create so many inventions thousands year ago, why did the European, instead of the Chinese, initiate the scientific and Industrial Revolution which changed the structure of the societies we live today?" There is no reason why couldn't this nation regain the historical economic advantage with scientific and technological innovation again. However, if China is to reclaim the reputation of its technological civilization, it is imperative that China should investigate when and why it gradually lost its superiority in the world.

This paper explores some important factors based on the comparative discussion between the East and West historical development on the subjects of science, technology, cultural evolution, orthodox dogma, religious attitudes, marine exploration and academic freedom, and then bring up some important issues on innovation and national economic competitiveness. From 1980s, China has successfully achieved some predetermined economic goals after the implementation of the Open Door Policy. In order to maintain the momentum of modernization, this paper argues, China needs to create a cozy environment to foster a new generation of entrepreneurs who can explore new way of thinking and methods beyond tradition ideology. In brief, innovation is the only way to sustain the long term national economic growth.

2. The Craftsmanship of Jade-Making and Research Attitudes

2.1 The Craftsmanship of Jade-making and the Ways of Study

Traditionally, Chinese adore the beauty of jade. Archaeological data indicate that Chinese employed the durable nephrite in ornaments and weaponry from seven to eight thousand years ago. It is not easy to cut jade with any ordinary tool since the hardness of jade is pretty high, from 6 to 7. In order to process the jade stones into art pieces, Chinese used silicon crystal sands and water, as well as many different tools to cut, saw, drill, grind, and polish the jade stones in different stages(Wang ,1993, pp.5-7). With such experience, Chinese always use those verbs of refining jade pieces to indicate the degree of hard-working in academics. These verbs include cut-*chieh*(切), file-

tsoh(磋), chisel-*zhoh*(琢), and grind-*mo*(磨). In Chinese language, the phrase for research is *yien-jio*(研究). *yien*(研) means grinding while *jio*(究) implies drilling. Therefore, the general basic requirement of Chinese research is to concentrate one's study patiently like a jade artist making a beautiful jade piece. In other words, Chinese believes that truth hides in books, just as jade resides in rough stones. Only those who work diligently will be able to make it. This kind of assumption is also reflected in an old Chinese saying, "A jade piece will not be a useful one without drilling. Likewise a man will not be able to understand the meaning of truth without learning 玉不琢，不成器。人不學，不知義."

Compared to the English word of "research," "re-", a root for many other words, means that one does something again, while "search" implies that one explores around without even knowing the very existence of the truth. In Western culture, a researcher has to continuously observe the phenomenon, collect data, test the assumption and propose new aspects of the "truth." The Chinese concept of research tends to emphasize on hard-working without questioning too much of the traditional knowledge structure written by previous sages or wise men, while the Western counterpart stresses the exploration of unknown territories. Such discrepancy is also exhibited in the title "Ph.D," the highest academic degree. In both Western and Oriental societies, doctoral degrees are conferred to those scholars who have finished a highest degree in a specific discipline. Chinese phrase of Ph.D is "*Bo-Shi*"(博士). *Bo* means extensiveness while *Shi* means a scholar. Put together ,it denotes to a scholar whose knowledge covers widely many different subjects, while in English the word- Ph.D means Doctor of Philosophy: a scholar, a philosopher, a thinker, and an explorer.

2.2 Knowledge - The Way to Fame, Power and Wealth

Many students in Oriental nations study extra hours each evening preparing for the entrance examination into a decent high school, a university, and even a graduate school. Such pressure does not only exist in the minds of the students, it is also highly ingrained in the mentality of the Oriental society. Stevenson(1992) examined elementary education in Taiwan, China, Japan and USA. He found that while Asian kids performed generally better compared to American counterparts. However, Asian families generally were less satisfied while kids were less positive about their academic capabilities. He also found that while kids in Chicago wish for money and material objects, Beijing kids wished for educational goals. Although Stevnson found no proof that Asian experienced extraordinary stress from their more demanding study, he attributed this to family support and school's backing.

An Oriental student with a degree from a well-known university, usually sponsored by the Ministry of Education in the national level instead of provincial government or private foundation, is almost a sure thing to career success in the future. The Tokyo University in Japan, Jiaotong, Tsinghua, Beijing, Fudan and Xiamen Universities in China; Chiao Tung, Tsinghua, Taiwan, Central and Sun Yat-Sen Universities in Taiwan, and Singapore University are some of those top ones. Therefore, a success in the national examination is not only

a matter of family fame and humiliation, it is also a matter of individual life and death, so to speak. For example, in 1994, totally more than 300 university graduates participated a series of written examinations and oral examinations to compete for the 30s' vacancies into the graduate programs of information management in National Central University in Taiwan. The examination is so competitive that many students went to some private tutor classes in order to get in. In National Chiao-tung university, the author eye-witnessed that many examiners participating the graduate program's admittance examination even brought tents to sleep overnight besides the classroom. Many universities in Taiwan compete against each other not only based on the teaching quality or research activities of the faculty, but also based on the number of the applicants and the minimum admittance scores in the national examination.

Chinese society created this type of national civil examination to select the best of the society into government bureaucrats from Sui 隋 Dynasty. Such a fair system increased social mobility for those talented and hard-working students. As the Chinese has an old sying, "Studying patiently beside a cold window for ten years without fame, but, once succeed in the examination, you are instantly a famous person 十年寒窗無人問，一舉成名天下知." The Oriental societies teach their younger generation with examples of those historical people who achieve great success out of poverty. Su Qin 蘇秦 is a famous case during the Chinese Warring Era 戰國時代 (402 BC to 221 BC). Coming from a low class of the society, Su Qin had an ambition to get political power by presenting a strategy of attacking six other major countries to the king of Qin, one major kingdom located in the isolated fertile plain near Xian. Failing to convince the Qin's king(Qin Huei-wang 秦惠王), he returned home and was humiliated by his wife, parents and other family members. Rather then been discouraged, he concentrated on his study so much that he sometimes even used a tool to inflict self-bleeding whenever he was tired and felt sleepy. To the end, he restarted his political career by persuading other six kingdoms to united agains Qin. He was so successful that he became the prime minister of the "mini united nations" in China. History said that later when he passed his home town, all his family members who previously looked down upon him, including his parents, were all knelt down besides road-pass to welcome him(Kuo,1994). Another successful scholar, Sun Jing 孫敬 in Han Dynasty, before he succeeded in his carreer he usually hanged his long hairs to a horizontal wooden column in a study room so he would not fall asleep comfortably after long hours of study. As a result,these two famous study were abbreviated into a famous Chinese idiom-ci4 gu3 xuan2 liang2 刺股懸梁 - which indicates a student's absolute dedication to study(Xiang, Lee and Liu, 1986,p.246). Such stories convince many poor Chinese that power and wealth can be reached by diligently and patiently studying. In fact, one Chinese saying reflects such belief, "There are jade-like beauty and golden houses in books 書中自有顏如玉，書中自有黃金屋." There are many similar versions of idioms taught in schools to encourage the young kids regardless the ethical, legal and moral implication, as well as effectiveness of the means utilized. The common factor of those idioms points to a picture which depicts those poor and despised people

finally became successful with persistent hard-working. Listed below are some of those well-known ones and their brief explanation is provided in Table 1. Taiwan's Post had issued a series of stamps depicting these stories to promote these "traditional virtues."

As such, hardship and poverty were deemed as a way to enrich personal extra-ordinary capabilities. Mencius, another respectable Confucianism scholar ranked next to Confucius, once said in his book:

> "Heaven, when it is about to place a great responsibility on a man, always first tests his resolution, wears out his sinews and bones with toil, exposes his body to starvation, subjects him to extreme poverty, frustrates his efforts so as to stimulate his mind, toughen his nature and make good his deficiencies. Men for the most part can mend their ways only after they made mistakes. Only when their intentions become visible on their ways only after they made mistakes. Only when they are frustrated in mind and in their deliberations can they stand up anew. Only when their intentions become visible on their countenances and audible in their voices can they be understood by others. As a rule, a state without law-abiding families and trustworthy gentlemen on the one hand, and on the other, without the threat of external aggression, will perish."

He even concluded that "anxiety and distress lead to life; ease and comfort end in death 生於憂患, 死於安樂." (Mencius, Book VI Kao Tzu, Part II.15., translation provided by Confucius Hall in Hong Kong and Confucius Publishing Singapore Pte. Ltd.)

Such value systems, promoted by the Confucianism's scholars and encouraged by the civil examination, was spread into other surrounding nations in East Asia. There are many similar Cinderella stories in China, Korea, and Japan. The Asian immigrants carry with them such value system into US. For example, In 1948 William and George Devos of the UC Berkeley found that Japanese-American students overcame prejudice in US after World Wat II immediately and thrived academically(Caplan, Choy and Whitmore, 1992,p.42). Caudill and Devos attributed their success to cultural values and parental involvement. The children of disruptive Southeast Asian refugees performed excellently in American school system after they adjusted into American society. Caplan, Choy and Whitmore(1992) gathered survey on 6,750 persons in five major American urban areas and obtained information about their economic, social and family life. From this large group, they chose a random sample of 200 nuclear families and their 536 school-age children. At the time of the survey, these young refugees had been in the US for an average of three and a half years. Even with the pressure, their math performed just above national average, while the language performances were just a little bit below national average. Yet, it is noteworthy that these kids' scores tended to cluster toward the middle ranges. Caplan, Choy and Whitmore suggested that family support to children's education at home is required for US schools to succeed.

TABLE 1
Chinese Idioms that depict the hard working attitude toward study

Chinese Idioms in Ping-Ying and Historical Sources	Literally English Translation
zho4 bi4 tou1 guang1 鑿壁偷光 To dig a small hole on the wall in order to let in light from a neighbor.	Kuang-Heng 匡衡 in Jing Dynasty. He dug a small hole on the wall to let in the candle light from his neighbor so that he could study at night.
mo3 ch3 cheng2 zhen1 磨杵成針 To grind an iron bar into a needle.	Li-Bai 李白 in Tang Dynasty. He once was discouraged in study, but was inspired by an old lady when he saw her grinding a piece of iron stick into a needle .
mo3 chuan1 tie3 yan4 磨穿鐵硯 To tear and wear an iron ink grinding stone.	San Wei-Su 桑維翰 in Five-Generation Dynasty. He was turned down several times in the civil examination not because of his capability, but due to the fact that his last name was pronounced the same as "death". When his friends advised him to give up and changed his career, he cast an ink grinding tablet made from iron and swore that he would not give up until all his ink sticks drilled through the iron ink tablet.
ying2 chuan1 xue3 an4 螢窗雪案 A window lighted up by fire flies and a reading table lighted up by the reflection of moon light from snowy ground.	Ji-Ying 車胤 and Sun Kang 孫康 in Jing Dynasty. Both were once very poor and could not afford to purchase candles in order to study during the night, so they have to utilize natural light sources. The former collected fire flies in the summer night in a paper bag while the later utilized reflecting moon light from the white snow.
duan4 zhi1 quan4 xue2 斷織勸學 To cut across a piece of unfinished weaving cloth in order to persuade someone to continue unfinished study.	Yue Yang Tze 樂羊子 in late Hang Dynasty. His wife cut the unfinished weaving cloth in order to persuade him that study half-done achieved nothing. Mencius's mother also did the same to him.
yu2 gong1 yi2 shan1 愚公移山 Old Mr. Stupidity is determined to remove the blocking mountains.	Yu Gong 愚公- Old Mr. Stupidity, a legendary old and stubborn person., who was determined to remove two big mountains that block his house to the city. Heavenly god was moved by his determination and assisted him to accomplish the goal.

Although different in origins, both traditional Indochinese and middle-class American values emphasize education, achievement, hard-work, autonomy, perseverance and pride. The difference between the two value systems is one of orientation to achievement. Americans more encourage independence and individual achievement, whereas Indochinese values forster interdependence and a family-based orientation to achievement(Caplan, Choy and Whitmore, 1992,p.41). In 1961, Judith **R.** Kramer and Seymour Leventman found that 13-year-old kids in 15 countries. Korea and Taiwan's students ranked at the top, while Canadian kids ranked 9th and American kids ranked 13th..

However, almost 90% of the third generation of Jewish immigrants attended college, while the first generaation has usually no education when they came to US. On the other hand, the American kids who study harder are usually considered by their peers to be nerds, brain, geek, grubber or brownnoser. Wevl(1989) surveyed the ethnic group in US that contributed to American scientific excellence and found that Jewish and Oriental people stand out. He collected the frequencies of a special ethnic last names in the specialized reference group over the frequencies of the same ethnic names in general population, and then multiply 100 to define a performance coefficient. While English and Northwest European people obtain perofrmance coefficient ration close to 100 in all fields, the Jews are over-achieved in all area with performance ratio between 287 to 684. Chinese is underscored in law with an average of 24, but excellent in science and technology with an average of 784. Those eminent individuals in the reference books(i.e. Who's Who in America, American man and Woman in Science, etc.) are usually middle aged or senior. Therefore, in order to find out the situation in the younger students, he analyzed 15,000 high schools' seniors who obtained the top scores as semifinalists in the national Merit Scholarship in 1987. With the same principle of calculating the performance ratio, he found that English and Northwest European groups obtained the value of around 50s; the Jewish 218; the Chinese 1,097; the Korean 1,411 and the Japanese 218. The academic success of Oriental and Jewish kids can not be attributed to heredity alone, family and culture were two major factors that contribute to this remarkable achievement(Caplan, Choy and Whitmore, 1992.p.42).

In the heart of Little Tokyo in Los Angeles there is a bronze statue postulating a poor boy. He bears a heavy bundle of chopped woods on his back while reading an important Confucianism's book. Obviously this poor boy had no time and money to enter school, so he had to study hard while walking towards market. This hard-working boy is the well-known Japanese scholarly politician, Ninomiya Sontoku 二宮尊徳(1787-1856). Before World War II, Japanese govenment usually set up this paragon of virtue in schools to encourage the younger generation. The message is loud and clear: with hard work, thrift, concentration on the serious, avoidance of romance and imagination, a poor nation like Japan could become a wealthy and powerful advanced country like Mr. Ninomiya(Jansen,p.67). During Meiji Era, despite Japan gradually distanced from Chinese cultural influence in order to modernize herself with Western technologies and values, Japanese national drives toward modernization were more highly motivated by such Confucianism spirit.

In comparison, there is an art museum specialized in the collection of the French artist "Rodin" in Philadelphia, A gigantic sculpture of "The Thinker" is established in the front yard of the museum to symbolize the enigma of mental exploration. Philadelphia's China Town is not far from this museum and Quality Inn sits right in the heart of the Chinese community. In the hotel, paintings that reflect Chinese culture are hanged along the passage of each floor. There is an oil painting which depicts Ming Dynasty's *Zu Mai-Cheng* 朱買臣, another typical example of "Ninomiya." In the painting, poorly dressed Zu is walking with a bundle of woods while reading a book in his hand. He

was not discouraged even he was being ridiculed by a group of naughty boys. Such interesting contrast of European and Chinese attitude towards study is so vividly demonstrated in the mulitifaceted American culture.

This hard-working attitude has been promoted by Confucianism for more than two thousand years, why didn't it work for China after 15th century until recently? Lately there are some educational studies from North America commented that Asian economic dynamics are derived from higher standard of Asian education and Confucianism. However, judging from the number of the highest award, the Noble Prize, given to those scientific achievers there is no proof that Asian educational model is superior to that of North America. In recent years the United States has won 206 Nobel prizes, including most for physiology or medicine(69), physics(55), and chemistry(36) (refer to The Guinness Book of Records, edited by Matthews, 1993,p.494). Canada, a medium country with population of 28 millions, has won three Nobel prizes in science and medicine (refer to The Canadian Global Almanac-1993, edited by Colombo,p.546). In comparison, Asian countries, including China and Japan, have only received no more than a dozen awards. This tilted achievement in the most advaced territories of science exploration does not seem to improve in recent years. Obviously, there are some additional ingredients other than just hard-working and patience in the recipe of making the best scientific explorers.

2.3 The Impact of National Civil Exam on the Development of Science and Technology

The unique civil examinations have a profound influence on Oriental societies and exert great impact on Oriental scientific and technological development. Chinese established the civil examination in the county, provincial and national level. Each level screened gifted students from the local area and only the best selected ones were allow to participate in the next level. Up to 30,000 scholars would attend the lowest levels of the examinations. An examiner usually had to start his arduous study from the age of seven and to spend at least another six or seven years just to prepare for the county examination. In order to maintain the fair system, cheating and briberies were seriously punished. For example, the candidate's paper was identified by a number and the original answer sheet might be copied by other calligraphers to prevent the paper be identified by the graders(Nova Show #1706, 1990).

Chinese culture traditionally takes a more rational and practical approach toward religion and religion seldom played a critical role in Chinese history as much as Catholics in Europe or Muslim in Mideast did. However, the national examination effectively established an ideology in a grand scale in China where the power of law and religion were not as strong as other civilized area. With the nationally institutionalized examination systems, the most intelligent groups were brain-washed and were made to feel indebted to the emperor. It became an obligation for them to rule over the hundred of millions of less intelligent loyally. Passing a seriev of local, regional and national examination, an examiner would be entitled to the title of *Chin-Shih* 進士, a "presented Scholar" (Smith,p.11). That is, once he successfully competed

against thousands of contenders in the three consecutive civil exams, he then was qualified be presented to the Emperor who then would bestow him the title of *Chin-Shih*. Each level of examination was progressively more difficult and the chance of success diminished.

Although the examination was gender biased towards male examiners, the examination system was fair and contributed to the social stability of Chinese history. A man was admitted into the ruling bureaucracy not based on his family, blood, or race. The system is one of the major factors that Northern Chinese gradually expand their civilization southward without major bloody conflict, because nobody was discriminated by his racial characteristics. In 847, An Arabian with a Chinese name of Li Yen-Shen 李彦升 passed the examination and was promoted into *Chin-Shih* (Gong, 1993,pp.160-161). Even the Jews in Kaifeng city were culturally and racially assimilated into the local society. The synagogue in Kaifeng shows strong evidence of harmonious mixing of Judaism and Confucianism. In history, many Kaifeng's Jews had succeeded in mastering the Confucianism, passed the examination and became governors(ibid., 136). As Smith(1990)pointed out that the 1,500 year's long of Chinese civil examination had ensured a dedicated, hard-working, and intellectual civil service. The system prelude nepotism and favoritism in the appointment of highest officials of the state,and assured that all officials even in the local level of government came from an intellectual class that had worked hard and competed for the position, and allowed the poor family to dream that their sons would be successful in their academic and political career. This might be contributing to the relative peaceful and stable history in China, while Europe, with much smaller in population and territory, has been constantly at war for the last 1,500 years.

Although the Chinese traditional civil examination is one of the its great inventions, it favored those intelligent people who are good at memory, written word's organization, artistic composition, and good hand coordination that can control the Chinese delicate writing tools, but failed to select those who are good at mathematics, spatial perception, innovation, and creativity. In 1930, American psychologist Louis Thurstone classified intelligence into seven primary mental abilities: memory, numerical ability, reasoning, word fluency, verbal comprehension, perceptual speed and spatial visualization. Later in 1960s, J.P. Guiford proposed the structure- of-intellect model, classifying the intelligence into 120 separate abilities. Furthermore, the discovery of dual brain raised concerns that traditional IQ test is not valid for measuring the holistic approach of the right brain(Fincher,1984, pp.67-70). The weakness of the civil examination, as Smith pointed out, was that it tended to create a reacionary point of view in that the examination system relied on memorization, recitation, and analyses of the ancient classics. Because the examination tested students over the same subject, the uniformity of thought was enforced into the mind set of not only the ruling classes, but also those millions of students who prepared for the examinations.

Furthermore, the civil examination acted as a major force of cultural evolution on Chinese society. Cultural evolution (Haviland, 1991, p.195) is created by human's intelligent activities and therefore is much more important than biological evolution to human survival. With the civil examination, those who

were good at words accessed more political power, married more wives and produced more offspring, than those who were good at other intellectual capabilities. Those who had more creativity usually had the tendency of unwilling to conform to tradition, and consequently might have a higher chance of failure in the examination. Even if they are successful to pass the system, their unnyielding thinking may make the conservative ruling class uncomfortable and thus may be jailed or beheaded. There are many times in Chinese history that quite a few progressive politicians who promoted radical social change failed in the end, their political career terminated, their fortunes confiscated and some of them were even persecuted. For example, Sang Yang 商鞅 in Qin during Warring Era, Wang An-Shi 王安石 in Sung Dynasty, Kang You-Wei 康有為 in Qing Dynasty are some famous cases.

Lin (1988) studied the intellectuals in Ming and Qing Dynasty and found that annually only averaged 50 plus Chin-Shih were selected at the very beginning era of Ming Dynasty. The number increased somewhat around 110 in mid Ming Dynasty, and continue to increase to 140 in mid Qing era. Considering the enormous size of the Chinese population which was estimated around 200 to 400 million during that period, the examination was very highly competitive. Since cheap compulsory education was not institutionalized, usually only very few rich families could afford to support their children to endure such long process of private tutorship. However, many gifted scientists in this period usually came from rich families so that they could afford to pursue the scientific explorations by giving up the civil examination. Lin found that the examination was a very effective method of selecting politicians, Lin found that the examination was a very effective method of selecting politicians, but there was a very low correlation between the group of *Chin-Shih* and the group of outstanding scientsts.

Compared to Western basic building blocks of written civilization, alphabets, Chinese writing is composed of many thousand of complex ideographic words which takes a long time to remember and practice. Smith indicated that while some 40,000 Chinese characters make up the basis of the Chinese written language, the people in Taiwan probably have a mastery of 4,000 to 5,000 words. Moreover, since the complex written calligraphy has been developed into art form, a scholar usually needs patient practice and delicate skill to master the Chinese thrush. However, a man with the capability of remembering those thousands of complex written words and with an artistic skill in calligraphy might not possess a scientific mind.

Furthermore, the examination usually required that the examiner to write essays commenting on phrases quoted from predetermined fundamental Confucianism books. In order to complete the essay, a participant had to present his idea in a very organized fashion, quoted voluminous Confucianism book, and argued his points of view within the domain of Confucianism. Confucianism was chosen as the main target of national ideology mainly because it emphasized on the virtue of maintaining respectable interpersonal relationships and maintaining social order of ruling hierarchy. For example, Confucius once said:"Let the king treat his ministers with honor, and the ministers serve the king with loyalty." Although Chinese civilization boasts of "Hundred School of Thoughts" which flourished in the Warring Era, only Confu-

cianism was officially adopted as the exam's subject. Other important philosopher's writings, i.e., The Art of War from military strategist–*Sun Tzu* 孫子 or The Way of Nature from Daoism–*Lao Tzu* 老子, were not incorporated in the examinations. This biased selection is still prevailing in Taiwan's textbooks today. Taiwan's Post has issued stamps of Confucius and Mencius portraits, but when Lao Tzu's portrait appeared, the stamp was classified as a classical painting instead of a portrait of cultural sages of philosophers. Ironically, while some American and Canadian management schools have listed The Art of War as the basic reference reading list in the course of management, most of the management students both in China and Taiwan never thoroughly glance over it because it is not a subject in the admittance examination. Franke (1960) has the following comments about this issue:

> "But after neo-Confucian interpretation of the Confucian classics was adopted as state dogma, there remained almost no opportunity for the development of original ideas, for any deviation from the orthodox interpretation led certainly to failure. In this way, particularly from the Ming Dynasty on, an unparalleled uniformity of thought was enforced not only nmong the officials but throughout the whole leading class. The examination system served simultaneously to recruit loyal civil servants of a standard type and to guarantee a through indoctrination in the Confucian ideology among the whole education class, which on its part was the model for the whole population. For over 500 years the traditional Chinese system achieved harmoniously and smoothly, with almost no resort to force, a degree of intellectual homogeneity eagerly sought, but so far scarcely attained, by the modern authoritarina systems(p.13)."

In conclusion, the Chinese civil examination system has tuned the Chinese mind sets to follow the role models of hard-working intellectuals, not those Western fancy folk tales of princes. However, in order to maintain the social stability, China ignore the enormous changes brought up by the Industrial revolution and paid a huge social-economic price for such stability from 15th century.

3. Astronomy and Research Methods

3.1 Chinese interest in Astronomy

According to some archeological evidences in Yin Ruin 殷墟, Chinese are the earliest people formally recorded solar eclipse, solar flare, in October 18th, 1328 BC (He and He, p.241). Earliest human formal record about nova (1339 BC to 1281 BC) was recorded in Chinese oracle bones 甲古文 (ibid., p.149). In fact, Chinese long lasting interest in astronomy has offered both archaeologists and astronomers exciting records of study. New evidences of Chinese star observations are found from various archaeological sites frequently. A few years ago, Xian Jiaotong University unearthed a West Han's 西漢 (around 100 BC) tomb in the campus while preparing a site for a new kindergarten. Inside the arch of the top part of the tomb, they found a simple, yet complete

pictorial painting of the 28 star constellations which coincide to the daily position 宿 of the moon. Furthermore, China's Hubei Provincial Museum 湖北博物館 near Huaxhong University of Science and Technology and Wuhan University, has a collection of major important relices from several excavation which were unearthed in 1987. An exhibition room presents various scientiffic and technological wonders that belong to a noble man during Warring Era 戰國時代 (433 BC). For example, a set of Chinese bronze chime bells large enough to occupy the entire stage of a modern recital hall which dates from the fifth century BC., consists of 65 delicate bells encompassing five octaves, a range greater than that of the most contemporary instrument(Shen, 1987) which revealed sophisticated acoustical design. Another one of the treasures is a lacquer box on which cover was depicted with the names of same 28 sections of constellation(Wu, Vol. 1., p.156)

For thousands years, the Chinese government, despite the change of dynasties, formally established an observatory to watch every day's nightly sky. Chinese believed that each emperor (the heavenly son, 天子) had the mandate to rule the nation according to the will of heavenly God. Every strange phenomenon might be a harbinger to the ruling class. Those who planned to revolt might also take advantages of the abnormal star phenomena to stir up political turmoil(He and He, 1983, p.149). Even the Confucianism scholars had the same attitude twoward the relationship between the art of ruling and the movement of stars(observed from earth). For example, Confucius once said, "A ruler who rules the people with virtue is like the Polestar, which keeps its place while all the other stars revolve round it" (Confucius, Analects). In Chinese astrology, the stars in the area of Little Bear are representations of the emperor's family. Surrounding this region are stars that repesent high-rank officers in the centralized government (He and He., p.168)

Since the observation of star was related to politics in China and the knowledge of astronomy was linked to political power struggle, little knowledge of astronomy was diffused into the hands of populace through printing (ibid., p.149). Therefore, the astronomers sometimes were politicians, rather than scientists. There are many fallacies of solar eclipse's records depends on the political situation (ibid., 184). For example, according to Chinese superstition, the astronomical phenomena when five major planets in the solar systems lined up as a series of pearls was deemed as the blessing from heaven to the emperor. This phenomena, according to historical record, appeared once when the first Han Dynasty's emperor, Liu Bang 劉邦，held the absolute power. However, according to computer's calculation, the timing is not correct. Later, such phenomenon appeared again during Liu' Bang's wife seized the supreme power and killed many Liu's family members, but the astronomical officers ignored it purposely and did not put in record. Also, the phenomenon that Mars approach the position of the Scorpion's constellation was interpreted as an omen that a very high-rank officer-either the emperor or the prime minister would die. Sometimes, the political enemy of the prime minister may bribe the astronomers to bring about such natural incidents to the emperor and forced the prime minister to die(Sun,1994). In the year of 340, the secretary of the state and attorney general was informed that Mars would come near the star

that represents the attorney general, Zazi Java. This was deemed as an omen to him, therefore he asked the emperor to relocate him to other offical post in order to avert the calamity(Nova Show #1706, 1990).

Other than visible planets and stars, Chinese has recorded a fairly complete description of comets. In the Chinese classics, Spring and Autumn 春秋, Chinese record the earliest human record of Halley Comet (He and He, p.153). Besides Halley's comet, Chinese also formally recorded the occurrences of regularly reappearance of the most comets and drew the patterns of the various shapes of comets in the very early stage of history(Wu, Vol. 2, p.279). Nevertheless, the Chinese astronomers never analyzed the time intervals between appearance of comets, never proposed a sound hypothesis to explain those repeated phenomena, and never discovered that some of those comets were exactly the same. Although hundreds of Chinese astronomers saw Halley comet with their naked eyes, it was Halley himself, who just observed the comet once at his 20s, completed the process of scientific exploration and made a precise predictlion with the help of physics from Isaac Newton's paradigm. In comparion, Chinese scholars made no attempt to test their theories. For example, *Zhu Xi*朱熹 (1130-1200), a well-known Confucianism scholar, explained the origin of the universe by two opposite factors: *Yin* 陰 and *Yang* 陽. The power of the universe, *Qi* 氣, was bubbing like turbulent current. The sediments of *Qi* crystallized and became static earth, while the lighter part of *Qi* condensed into Sun, Moon, stars and rotated around earth(ibid., p.327). Nevertheless, he never defined *Yin, Yang* and *Q* in a quantifiable, measurable and observable matter, and he never proposed any hypothesis to prove their existence.

Such missing chains of scientific exploration were commonly seen in many areas of scientific studies in China other than astronomy. Record keeping is a formal bureaucratic task not only in the federal level, but also in the provincial and municipal levels. Each dynasty, governors who are responsible for history loyally maintained the records of historical documents and events, leave the task of compiling the merits and faults of historical figures to the next dynasty. When Boorstin(1985) commented the paradox of Chinese faithful record-keeping, he said: "Of all modern cultures, the Chinese offer the longest continuous past and the most compious written record of their past. It is more remarkable, then ,that a modern historical consciousness did not develop in China. The Chinese way of filtering the past, although different from the Hindu, was hardly better designed to awaken people of social change or the power of mankind to transform institution(p.560)." As such, the Chinese history records of the past, including the scientific development, were "majority part of the apparatus of the government. The Western way of critical judgement about historical materials were not developed indigenously (ibid., p.562)."

3.2 Western Scientific Development in Astronomy

In the West, early astronomy was associated with the activities of the priesthood until the modern times. Gradually, astronomy was developed based on the needs of navigational purpose to determine the latitude and longitude

at sea (Mason, 1962, p.148). The mathematics and physics in the 17th century Western world became part of logical methods in astronomy. Isaac Newton synthesized the diverse ideas about the movements of objects and created a theory of the solar system based on a general theory of motion. The publication of his Mathematical Principles of Natural Philosophy in 1687 completed the revolution in thought begun by Copernicus(Gier, 1979, p.74) Around 1695, Edmond Halley, began applying Newtons's idea to the motions of Comets. Comets, no matter how mysterious, will exhibit certain regularity of movement based on Newton's theory,(ibid., pp.97-98). The problems of observing comets are that(a) only a small portion of their trails within a very short period of time when they approach the sun can be observed; and(b) most of the comets may complete one cycle in a very long time span. It is impossible to decide with that small portion of observation to determine whether a comet's orbit was an ellipse, or a parabola as Newton suggested. If the orbit of a comet is elliptical, the comet should havr traveled many times before and will come back again many times in the future with certain interval. With the hypothesis in mind, Halley explored the records of Western observations for previous comets and found 24 cases in the previous 150 years .Of those records, he found that two specific recorded comet orbits, one in 1606-1607 and another on in 1530-1531, were very close to the one of the 1682. He argued that it is very highly unlikely that three different comets should have such similar patterns of orbit. Besides, the time intervals among these three consecutive events are the same-76 years. Supported by Newton's theory and his own hypothesis, he predicted that the comet should be seen again in December, 1758. He published his work in 1705. but died in 1743, fifteen years before the predicted return. Halley's successful prediction provides substantial justification for Newton's theory. This case explicitly presented a complete process of scientific research. Observation, model building, hypothesis testing and prediction form a complete cycle of the scientific exploration.

In 1985, two centuries after Halley's prediction, scientists could precisely forecast the reappearance of comet Halley with the aid of computers. They had already calculated the daily position of the comet Halley and the Sun in the background constellations long before they came closer to each other after Halley's 76 years of long journey(Muirden, p.51).

Scientists usually build up the scientific theory on the conceptual framework, yet the hypothesis has to be supported by evidences. Modern precise technical observatory apparatus, such as computers and observation telescope are of great help in astronomic observation. For example, William Herschel's skill in making advanced telescope has expanded the study of astronomy from solar systems to celestial bodies outside the solar systems and even outside our galaxy in mid-18th century(Hoskin, 1986). The conventional type of optical telescopes can not detect celestial radiation emitting radio wavelength which usually passes through the celestial clouds. Superconduting tunnel detectors allows astronomers to pick up such radio wavelengths to study the formation of new stars lying deep in the clouds of interstellar gas as if they were virtually transparent(Phillips and Rutledge, 1986). Technical craftsmanship will promote further scientific exploration and continuously contribute to the new paradigm shift. In other words, scientific theoretical development may come

to a dead-end without the assistance of new technological devices. Scientific and technological progresses are closely linked together.

3.3Religious Belief, Ideological Dogma and Scientific Exploration

In terms of the love for knowledge and humane teaching about the value of life, Chinese Confucian scholars and Catholic scholarly fathers are very much alike. Confucian's teachings, such as "It is not worthwhile discussing with a gentleman who desires for the Way of universe, yet who is ashamed of poor food and bad clothes," sounds very similar to the teaching of Jesus in the New Testament. When Confucius once remarked of a very Pro testants-like disciple who died young, *Yen Hui* 顏回, saying " How worthy he is ! Living on one single meal and one ladleful of water a day, dwelling in the lowest havels of the city-no man could havve endured such hardship, yet he did not lose his good cheer. How worthy this gentleman is!" He praised such human virtue of pursuing spiritual self-actualization while ignoring the basic physical needs, regardless the family problems and social cost of such a tragic incidence. Without proposing a practical way to solve the problem of poverty, Confucius himself pursued the spiritual satisfaction by saying "Living upon the poorest fare, with cold water for drink, and with my bent arms for a pillow- I could yet find pleasure in such life." He even explicitly expressed " A gentleman should be in search for the Way, not just for food. Farming sometimes leads to starvation but education sometimes leads to official preferment. A gentleman should solicitous about the Way, not anxious about poverty." Confucius once described himself as a man who devoted his life to study while often neglects his food. When Confucius once encountered poverty and ran out food and many of his disciples were sick, one of his disciple complained to him, saying "How come a gentleman will encounter such distress?" Confucius replied that "A gentleman may indeed have to hold his integrity and endure the hardship, while a mean person will be reckless in distress."

However, there is one major difference between Christianity and Confucianism in the attitude toward super spiritual beings. Christianity, Muslim and Judaism believe that there is only one God and people should not worship all other idols. In comparison, Confucianism traditionally avoids such a firm stand. Confucius frankly expressed his unemotional attitude toward religion by saying "To know the essential duties of man living in the society of men, and to hold in awe and fear the spiritual beings of the Universe while keeping aloof from irreverent familiarity with them. Such behavior could be considered as understanding." Confucius always refused to discuss supernatural phenomena, extraordinary feats of strength, unnatural depravity of men, or of spiritual beings. When one of his disciple inquired that how one should behave towards the spirits of the dead and gods, Confucius answered, "We cannot as yet do our duties to living person, how can we hope to serve the spirits of the super beings?

Although Confucius was a great educator who would like to encourage students of every kind as he once said: "In teaching there should be no class distinction", he himself would like to stick to the tradition while rejecting the innovative way of solving problems. As few quotes from his comments may

reflect his conservative attitudes:

- I like to transmit the old truth and do not originate anything new and I believe in and love the study of Antiquity.

- I am not one born with understanding. I am only one who has given himself to the study of Antiquity and is diligent in seeking for understanding in such studies.

- To store up knowledge in silence and to learn without being surfeited.

On the other hand, Confucius is strongly intolerant of heretical doctrine. The following quotes may reveal his intolerance.

- To study heretical doctrines is very injurious indeed.

- I dislike purple for taking away from Vermilion. (Purple is not the color of righteousness).

- Man who follow different Ways can never discuss together.

Furthermore, Confucius's attitude toward science is not encouraging. Once a disciple inquired the studies of farming and gardening techniques, yet Confucius negatively advised his disciple to place his mind in the learning of virtue, rather than the trivial techniques of farming and gardening.

Although Confucianism encourage students to study the truth of the world, it emphasized on the existing framework of paradigm, rather than exploration into the immensely unknown natural phenomena to challenge the tradition. As one of the important selected standard book for civil examination explicitly express this point of view clearly: "In order to learn to be one's true self, it is necessary to obtain a wide and extensive knowledge of what has been said and done in the world; critically to inquire into it; and earnestly to carry it out.*Chungyung* (中庸)–The Book of Central Harmony, Chapter 20)." Confucius believed an effective way to manage a harmonious society is to give the power to the elites. He once remarked the unequal emphasis of "what and why" in the educational process for the ordinary populace, he said that "The common people should be educated in what they ought to do, not necessary told why they should do it." Although Confucius encouraged students to think while studying. He once said: "To study without thinking is labor lost; to think without study leads to frustrating confusion of mind.," the Confucianism encouraged inward personal-reflective thinking process rather than outwardly thinking and observing the nature's phenomenon. As another important Confucianism book, *Tahsueh*(大學)– The Book of Great Learning, said that "When things are investigated, then the true knowledge is achieved; when true knowledge is achieved, then the will becomes sincere; when the will becomes sincere, the heart is set right; when the heart is set right, the personal life is cultivated(Chapter 5)"

In the time of social chaos and declining human value, Confucianism, as well as most religions, are of great value to the stability of a society However,

when it comes to "innovation," they should give more room for daring scientific exploration. From the brief discussion above, we can see major differences lie in (1) Confucianism supports a religious attitude toward deceased ancestors while Christianity admits no other gods except Jehovah, and (2) Confucianism takes a very practical attitude toward religion.

In 1581, Italian Jesuit, Ricci Matteo came to China with a mission to transform Chinese into Christian. He brought Calendar, mathematics, European delicate mechanic clock, world map and advanced astronomic devices 渾儀. He made friends with Chinese scholastic governor, such as the Chinese prime minister, *Xu Guan-Qi* 徐光啓 and *Lee Zi-Zhao* 李之藻, Following Ricci, there are many other well-known Jesuits form various countries of Europe came to China with the same purpose, i.e., Jean Adam Schall Von Bell(1591-1666) 湯若望 from Germa, Ferdinard Verbiest (1623-1688) 南懷仁 from Belgian, J.F. Gerbillon(1654- 1707) 張誠 from France and J.Bouvet(1656-1730) 白晉 (Wu, 1993, pp.146-152).

Ricci's attempt to convince the emperor by presenting the western gimmicks was not fully successful. Among many reasons, the Chinese scholastic bureaucracy opposed the influence of religion into politics. For example, *Han Yu* 韓愈 in Song Dynasty opposed the influence of Buddhism into the Palace and was expelled by the emperor from the center of political stage.

It is interesting to know the comment from Ricci, when he encountered the resistance of Chinese intellectuals to the new knowledge he brought from the West:

> Because of their ignorance of the size of the earth and exaggerated opinion they have of themselves, the Chinese are of the opinion that only China among the nations is deserving of admiration. Relative to the grandeur of empire, of public administration and of reputation for learning, they look upon all other people not only as barbarous but as unreasoning animals. To them there is no place on earth that can boast of a king, of a dynasty, or of culture. The more their pride is inflated by this ignorance, the more humilated they become when the truth is revealed."(p.57, Boorstin, 1983.)

Ricci's comments were quite frank and true. Nevertheless, Ricci intentionally did not bring the new revolutionary findings of Corpenicus and Galelie's findings to China for fear of the political problem from his own side. Freedom of scientific debates among different disciplines is an utmost important element of scientific exploration– especially if the debates have to go beyond traditional boundary of ideology. However, western scientists once were suppressed by Church just as Chinese scholars were limited by Confucianism, especially when the scientists' findings contradicted to the religious belief. Two well known examples are Galilei's findings that the earth is not the center of the universe and Darwin's findings that man, as well as all other living organism, are evolving through natural selection.

In 1633, Galileo Galilei (1564-1642) was brought before the Roman Inquisition and charged with teaching that earth revolves around the sun. The ensuing trial was engaged by the authority of the Roman Catholic Church in a scientific and theological dispute. Galilei was forced to recant his scien-

tific conventions publicly on the grounds that he had defended the Copernican paradigm of the solar system, a position condemned as "false and opposed to Holy Scripture" in 1616. In 1600, Giordano Bruno, a celebrated Copernican was burned at the stake by the Roman Inquisition. Lerner and Gosselin(1986) argued that Bruno's real objective was to extend Copernican ideas allegorically to theological and political speculation. In brief, astronomy was merely a means for political and theological revolution and Galileo was tried partly because his aims were mistakenly identified with those of Bruno. In 19th century, Charles Darwin(1809-82) was provoking church by claiming the theory of evolution and he was ridiculed by the angry general public too: A Cartoon depicting a gorilla pointing to Darwin and saying: "That man wants to claim my pedigree. He says he is one of my descendants(Merriman, 1989,p.23)."

These two cases showed that medieval Western scientist whoever were pioneers in a new area of studies conflicting with biblical teaching may face a lot of oppression from Church. In comparison, Chinese people traditionally take a more tolerant attitude toward religion. Looking back into history, while European Christian and Arabian Muslim fought wars for thousand years and the religious conflicts continued into modern time, Chinese history is free from such grand scale religious conflict. However, in terms of national ideology, not only the Chinese intellectuals support the conservative attitude of Confucianism, but also the emperors themselves usually ruthless clamped down those intellectuals who would reveal their disobedience in writing, no matter how subtle that intentions were. Such punishment was much more cruel than the punishment imposed by the medieval Catholic church on those disobedient scientists. In many cases, not olny one person, but the whole group of family whovere had close blood kinship were executed. Such genocide practice certainly did not only effectively deter populace's innovative attempts, but also might exert degrading selection of Chinese innovative genes' stock since the whole line of family tree of those rebellious groups was eradicated. Such pessimistic mood can be observed in the main character, Monkey King, of the well-know known novel– A Tour to the West 西遊記. The Monkdy King was witful, intelligent, self-aspired and powerful. Despite his amazing capability to challenge the authority of the gods in the heaven, he was finally confined by Buddha and forced to assist a monk to accomplish his adventurous mission. Despite his ambition to be the "Heavenly Sage," he was always ridiculed as a "naughty monkey" by foes. Did the author try to subtly bring up the pessimistic mood of those who try to challenge the traditional ideology? It is interesting to note that in 1992 the author observed that a plant near Wuhan erected a stature of the fictitious Monkey King in the front entrance of the plant in stead of Mao's stature commonly seen in other Chinese public buildings. Obviously the plant's senior managers were convinced that change can only be achieved by brave innovation.

4. The Scientific Revolution - Why Didn't China Make It?

4.1 Why Did Not China Initiate the Scientific Revolution?

On the basis of previous discussions, this paper argued that the major strength behind 15th century's Chinese economic superiority – hard-working,

was gradually lost its determining power in guiding the cultural progress after Europe initiate the Scientific Revolution which consequently led to Industrial Revolution, and now the Information Revolution. Production and distribution of goods are largely more efficient with science and technology and machines are more hard-working than human, both manually and mentally.

Lester Thurow, the well-known management strategist in MIT, warned USA not to repeat the same declining path of Middle Kingdom in 15th century. He commented that China possessed unmatched potential during that time.

> "China was the first to invent gunpowder, printing, and the campus. China had an efficient unified national government while Europe was still a group of quarreling principalities. A Chinese armada with more than one hundred soldiers had already set foot on the east coast of Africa. In comparison, Europe's explorations were very small-scale. No nation could match the power of China. If there was a country about to conquer the world, it would be China. Of course, our observer would have been wrong, because China was about to retreat behind its Great Wall and slowly sink into poverty and powerlessness(1992, pp.153-154)."

The adventures of what Thurow referred to was led by *Cheng Ho*鄭和 (1371-1433). In 1399, there was a power struggle between the powerful uncle, *Cheng-Tsu* 成祖, and the designated heir apparent. *Cheng-Tsu* fought the war against his nephew for three years and became an emperor in 1402 and died in 1424. Supported by *Cheng-Tsu, Cheng Ho* led seven great navel expeditions between 1405 and 1433. His journey reached Java, Sumatra, Ceylon, southern India. Arabia, and east coast of Africa(Hucker, 1975, p.134). The total number of crews were estimated between 20,000 to 30,000 and members are composed of carpenter, doctors, interpreters, negotiators, soldiers (refer to Taiwan's junior high school's history textbook, Vol.2, pp.76-77). According to most of the historians, the main purposes of his long expedition were diplomatic and business. However, it is reasonable to suspect that the real motive of the unparalleled exploration was to search for the ex-emperor whose body was not found when Beijing was captured by *Cheng-Tsu.*

After Cheng Ho's expedition, Chinese were forbidden to have contacts with foreigner except on state business or under close state supervision and international trade that fostered in the southern China was severely curtailed (Hucker, 1975, pp.138-139). The mood of the 15th century Chinese intellectuals are unadventuresome.

Besides dispatching *Cheng Ho's* adventurous expedition, *Cheng-Tsu* rebuilt the city of Beijing and moved the capital from south to north – a strategic move both militarily and politically to fence off the threat of the Northern Nomads. Although *Cheng-Tsu* was one of the most arduous emperor in Chinese history, in general the atmosphere of Ming Dynasty was despotic and capricious and it could be judged as one of the most repressive regime The intellectuals in the Ming Dynasty might express their grievances with the four well-known rebellious novels: i.e., A Journey to the West 西遊記–part of the story described how the fictitious figure, Monkey King, struggled for his esteem and recognition; Water Margin 水滸傳 – a story about how those oppressed

people form a group of Robin-Hood attitude toward corruptive government officials; Romance of the Three Kingdoms 三國演義 – a military and political strategic fiction about the chaotic years in the declining late-Han period; and Golden Lotus 金瓶梅 – a masterpiece of pornographic satire about a group of slavery-like women and their master. On the surface, these novels were written with a moral judgment of Confucianism, an in-depth read-between-the -line may sssist a reader to wonder the real motives of the authors. Ming Dynasty was a horrible time that the palace eunuch holds political power and organized secret police to purge the officials and staffed the government with sycophants(ibid. 143). Furthermore, the Chinese population swelled from less than sixth millions in early Ming to a range between 100 millions to 200 millions(ibid. p.140). However, the technological progress did not keep pace with population growth(ibid. p.143).

In comparison, almost a decade later Christopher Columbus made three voyages across the Atlantic Ocean from 1492 to 1504. Columbus went to king of Portugal in 1484, but his exploration plan was turned down because the king's advisors believed the distance was too great to be successful and again Columbus solicited to the queen of Spain but was turned down again for the same reason (Britanica Junior Encyclopedia, Vol.4, pp.404-406). Finally the queen of Spain agreed that Columbus started his expedition in 1492 with three ships. In comparison, Columbus sailed to the unknown while *Cheng Ho* can sail one stop after the other. Columbus started with an hypothese that if the earth is round, he could reach China by sailing the opposite route. Rather than finding Japan and China, Columbus found Cuba instead. And he mistakenly identified the aboriginal people as Indian. The second trip were equipped with 17 ships and 1500 persons in 1493. The main purpose of Columbus was to hunt for gold. He died believing that Cuba was part of Asia. However, Columbus brought back knowledge about New World back to European which greatly reverted the possible trend of world history. *Cheng Ho's* adventures, as compared to those of Columbus, were supported by far more superior technological navigational vehicles, numerous personnel and abundant resources; while faced less risks. Yet *Cheng Ho* achieved comparatively so little: he brought back from Africa an animal unseen by most of the Chinese, giraffe, not because of *Cheng Ho's* curiosity, but because he believed that animal was one of the legendary animals representing emperor's power. Although *Cheng Ho's* main motivation was not to seek fortunes or to exploit other areas, Columbus expeditions were much worthwhile in terms of historical impact. Obviously, there are some other ingredients other than technological and resource superioriyt in making a great adventure.

Bodde (1991) pointed out the following factors that hindered scientific and technological progress in China: language, cosmology, religion, government, society, morals and values, and approaches to nature. There are many arguments, such as (a) Chinese technologies are limited in the practical application instead of abstract reasoning, or (b) Confucianism tend to inhibit individual crreativity in order to maintain social order, or (c) centralized governmental system's standard stifles innovation, or (d) the low social esteem of craftsman in the traditional society discourages new inventions. Although

this paper tries to discuss these issues, an in-depth discussion of the validity of each issue would run out of the scope of this paper. However, it is noteworthy that a comparative study (Wang, pp.232-245) indicated that while Galio, Newton, and Boyel develop the foundation of scientific exploration in Europe ,the Chinese scholars, such as *Gu Yen-Wu* 顧炎武 (1613-1682), *Yen Rou-Zu* 閻若壕 (1636-1704), *Yen Yuan* 顏元 (1635-1704) and *Dai Zhen* 戴震 (1723-1777) developed methods to deal with large volume of historical information. With the methods, they checked the authenticity of the Chinese classics. While the western scholars faced the universe, the Chinese dug their heads in the piles of historical records. As Boorstin commented(1985,p.562) "Chinese civilization suffered from its antiquity, and the early effectiveness of the central government all reinforced reverence for ancestors and stifled efforts to look at unauthorized vistas of the past or to speculate on what might have been."

The purpose of Chinese great collective effort to maintain a complete record of historical events is to incorporate all the cultural experiences that the following generation can learn from it. In comparison, as Boorstin (1985) pointed out, the word "history" derives through the Latin historical from the word history, which the Greeks used to mean "inquiry," or "knowing by inquiry." The modern Western scientists and historian inherited this sprit of inquiry into the nature of truth. Knowledge is not only explicated exhibited in the written words, it is also revealed by our continuously critical inquiry into the unfamiliar territory, and sometimes may even uncomfortable conflict with oru conventional belief.

4.2 Scientific Breakthrough, Innovation and Sustainable Economic Growth

If we view scientific and technological innovation as human most important elements of cultural evolution, as compared to the slow process of biological evolution, the institutionalized capability of a nation's innovation – the ability to quickly adapt to the changing environment, would be a prime concern of national decision makers.

On the other hand, no nation is an island in the Information Age. Today, most of the Canadian watch many US TV programs as Taiwanese cable TV conveys China's Central TV programs. Furthermore, nations around the world are integrating their economic base with other nations. Such movement will not only increase the geographical area of resource, but also will multiply their maket efficiency by freely exchange flow of information, technology and money across border. Mahajan and Muller (1994) point out that economic integration of the nations will lead to faster market penetration. Especially if the members of unified nations were not similar before integration, the integration will result in faster diffusion of ideas, technologies, and products. China has been isolated from developed nations for more than 30 years after World War II. However, after the Chinese leader established the Open Door Policy, fast diffusion of ideas, technologies and products from developed nations has promoted an amazing economic growth for more than a decade. will China be able to sustain this momentum of economic growth into 21 st centruy instead of repeating the same history after 15th century?

Thurow (1992, pp.203–214) examined the economic performance of the

world in the past two centuries and found that very few nations, except Japan, achieved the top-echelon of rich countries. Brazil has had a decade or two of economic progress but then stalled. Puerto Rico looks promising in 1960s but then faltered. Economic race into rich nations requires the power of compounded economic growth rate of 3 percent or more and low fertility rate over a centruy, Thurow argued. A century log of economic growth can not be sustained by agricultural developments alone. Thurow populated that:

> "Developing countries need efficient agricultural sectors to feed themselves and to reduce the need to use their scarce foreign-currency reserves to import food, but agriculture will not generate the resources necessary to pay for development (ibid., p.207). "

To revitalize America's economy, Thurow suggested that USA should search for strategic advantage revolving around investment on R&D (ibid., p.295). R&D and organizational learning are two important elements of innovation, a process to search for new and better ways to compete in the international market. Innovation, according Michael Porter–the management strategist in Harvard, is the fundamental source of national competitive advantage. It incorporates the activities of product changes, process changes, new approaches to marketing, new form of distribution, and new conceptions of scope (Porter, 1990, p.45). Porter observed, just as the Mencius postulated in the previous paragraph, that innovation often results from pressure, necessity or even adversity, rather than from the expectation of benefit (ibid., p.49). From the international competitiveness study, he concluded that most firms, especially, those who are successful, would rather not to change, There are powerful forces work against modifying strategy in most companies.

> "Past approaches become institutionalized in procedures and management controls. Specialized facilities are created. Personnel are trained in one mode of behavior. Self-selection attracts new employees who believe in the existing ways of doing things and are particularly suited to implementing them. ths strategy becomes almost like a religion, and questioning any aspect is regarded as bordering on heresy. Information that would challenge current approaches is screened out or dismissed. Individuals who challenge established wisdom are expelled or isolated (pp.580–590)."

As we have discussed extensively in this paper, hard-working and technical superiority alone would not guarantee a sustainable long-lasting economic growth. A nation has to institutionalize an infrastructure to promote continuous innovation, no matter how bizarre it might be. Unfortunately, it is not easy for us to tolerate off-the-track academic research Darwin's champion, thomas Henry Huxley, once pessimistically commented the human nature of resisting the unmost front of new discoveries by saying:

> "It *(the Origin of Species)* was badly received by the generation to which it was first addressed, and the outpouring of angry nonsense to which it gave rise is sad to think upon. But the present generation will probably behave just as badly if another Darwin should rise, and inflict upon them what the generality of mankind most hate-the necessity of revising their convictions (Boorstin, 1985, p.476)."

Based on his study of national competitiveness, Porter comments that strong pressures to counteract those anti-innovation forces, came from environmental forces, rarely came exclusively from within the company. This fact coincides with the point of view of Mencius: "A nation without the challenge of neighboring countries will surely be extinguished." In retrospect, it isnoteworthy that most of the fundamental schools of Chinese great philosophies were originated during the time of Warring Era, the troubling period before the first Emperor from Qin conquered the other nations and ruled the unified nation with brutal force. It seems that China lost its major momentum of innovation after it surged into a super power in East Asia after unification. Obviously, China pay a lot of cost for the purpose of maintaining social stability. The comment from Porter, "weather the role of outsider can be played by firms from within the nation instead of those from other nations will have much to do with whether a nation's industry will advance (p.581), " certainly has some great implications to national policy makers who has strong ambitions to explore the long journey into rich nations in 21st century.

5. Conclusion

In the time of Information Age, as we are facing information explosion and consequently feel the pressure of information anxiety, simply promoting the virtue of "hard-working" might not be the best approach to promote national economic growth. Criticizin the Confucianism's laborious effort of hard-working spirit in study, Zhuang Tzu 莊子, another well-known Daoism philosoper contemporary of Mencius, commented that "People's life is limited, yet the knowledge of the universe is unlimited. It is impossible and dangerous to pursuit the unlimited knowledge with limited life. Those who exert their mental capacity to do so will only cause anxiety(chang, 1971, pp.84)." In the time of information age, Zhuang Tzu's comment seems to be even more meaningful today. Million's bits of information can be stored in a single pocket-size of diskette; hundred of books can be condensed into a palm-size CD-ROM; world-wide news on social, economic, and political activities of billions' people can be tracked in any second and transmitted instantly through computer networks. With the help of computer and telecommunication, a scholar now can search and examine a large amount of data within a very short period of time. Obviously in the Information Age, a nation's survival and growth relies not merely on it's people's capabilities on remembering facts, but also the creative capabilities to organize voluminous old facts and to explore new meaning.

In the coming Information Revolution, we will eye-witness the coming dramatic impact of Information Technologies on our cultural evolution. As Orstein put it: "Our progress depends more on consciously directing adaptability than on improving rationality (1991, p.253)." In the time of information Age we have to restructure the out-of-dated educational systems and institutionalize sustainable national innovation. Multi-media virtual reality, wide area networks, these new technologies will bring in-depth knowledge and timely information to individual users. The equation of national economic competition is changing drastically. Many top scientists has storongly advised that modern educational system should not just encourage students who are

hard-working ad clever, it should also give more opportunities to those who are innovative and creative (West, 1979).

Asian economic growth has been empowered by the hard-working morale of high-skilled labor. However, once Asian countries reach the level of industrialized nations by fast pace of technology infusion from advanced nations, they have to create an encouraging environemnt to vitalize the innovation atmosphere within their countries. This is no easy task. The innovation process is an endless process that requires risk-taking attitude for new exploration. "To boldly go where no one has gone before." –long lives the spirit of Star Trek.

References

1. Boas, Marie (1962), The Scientific Renaissance: 14500-1630, New York: Harper & Row, Publishers.
2. Bodde, Derk (1991), Chinese Thought, Society, and Science: The Intellectual and Social Background of Science and Technology in Pre-modern China, Honolulu: University of Hawaii Press.
3. Boorstin, Daniel J. (1985), The Discoverers: A History of Man's Search to Know His World and Himself, New York: Vintage Books.
4. Caplan, Nathan; Choy, Marcella; and Whitmore, John K. (1992), "Indochinese Refugee Families and Academic Achievement," Scientific American, Feb., Vol.266, No.2, .-45.
5. Chang, Me-Sheng (1971), A New Explanation of Zhuang Tzu, Taipei, Taiwan: Le-Tien Pub.
6. Colombo, John Robert (1992), The Canadian Global Almanac-1993, Toronto: Macmillan Canada.
7. Coppen, Yves (1994), "East Side Story: The Origin of Humankind," Scientific American, May, pp.62–69.
8. Confucius (551-479 B.C.), The Analects, in Chinese, Japanese and English, Taipei, Taiwan: Tatung Co.
9. Doren, Charles Van (1991), A History of Knowledge: Past, Present, and Future, New York: Ballantine Books.
10. Encyclopedia Britannica (1984), The World Around US: Science and Technology Illustrated, Chicago.
11. Fincher, Jack (1984), The Brain: Mystery of Matter and Mind, The Human Body Series, New York: Torstar Book.
12. Franke, Wolfgang (1960), The Reform and Abolition of the Traditional Chinese Examination System, Harvard press, 1960.
13. Giere, Ronald (1984), Understanding Scientific Reasoning, 2nd. ed. New York: Holt, Rinehart and Winston.
14. Gong Fang-Zhen (1993), The Wisdom to Merge Various Culture, Taipei, Taiwan: International Village. The book is one of the series Chinese Wisdom, edited by Professor Gu Xiao-Ming in Fudan University, China and is also published by Zhe Jiang People Pub. in zhe Jiang, china.
15. Haviland, William A. (1991), Anthropology, Sixth Ed., Toronto: Holt, Rinehart and Winston, Inc.
16. He, Bing-Yu and He, Guang-Biao (1983), A General Introduction to Chin-

ese Science and Technology History, in Chinese, Taipei, Taiwan: Mu-Touh Pub. Co.
17. Hoskin, Michael (1986), "William Herschel and the Making of Modern Astronomy," Scientific American, Vol.254, No.2, pp.90–96.
18. Hucker, Charles O. (1975), China to 1850: A Short History, Stanford University Press.
19. Jansen, Marius B. (1965), Changing Japanese Attitudes Toward Modernization, Tokyo, Japan: Charles E. Tutter Co. Pub.
20. Kaye, David (1994), "Managing the Information Revolution: Lessons for Business from the French Revolution," Future, May, Vol.26, No.4, pp.416–429.
21. Kuo, Fong Wei (1994), The Stories in Zho-Zhunag and Strategies in Warring Era, in Chinese, Taipei, Taiwan: Tien-Yi Cultural Business Ltd.
22. Lee Qiu-Lien and Chang Fu-Hou (1991), Thomas Aquinas and Nicholaus Corpernicus, Taipei, Taiwan: Shu-Quein Pub. Co. Original version published by An-Huei people Pub. Co., An-Huei, China.
23. Lerner, Lawrence and Gosselin, Edward (1986), "Galileo and the Specter of Bruno," Scientific American, Nov. Vol.255, No.5, pp.116–123.
24. Lin, Qi-Xian (1988), "The Ming and Tsing's Intellectuals in Civil Exam's System-A Data-Base Analysis Approach," The Journal of Graduate Program in Education, Vol. 32, pp. 237–260, a digest from unpublished master thesis, National Taiwan Normal University.
25. Mahajan, Vijay and Muller, Eitan (1994), "Innovation Diffusion in a Boarderless Global market: Will the 1992 unification of the European community Accelerate Diffusion of New Ideas, products, and technologies?" Technological Forecasting and Social Change, Vol, 45, pp.221-235.
26. Mason, Stephen F. (1962), A History of Sciences, New York: The Macmillan Company.
27. Mathews, Peter, Ed. (1993), The Guinness Book of Records-1993, New York: Batam Books.
28. Merriman, Nick (1989), Early Humans, New York: Alfred A. Knopf Inc.
29. Muirden, James (1985), Observer's Guide to Halley's Comet, New York: Arco Pub., Inc.Porter, Michael E. (1990), The Competitive Advantage of Nations, New York: The Free Press.
30. Needham, J. (from 1954), Science and Civilization in China, 7 volumes: all published by Cambridge, from 1954. In 1975, Vol. 3 Chapter 20, Astronomy was translated into Chinese by Tsao Mo and became Vol.5 in Chinese series while Vol.3 Chapter 21–25
31. Nova Show #1706, 1707, 1708, and 1709 (1990), "The Genius that Was China," Boston: WGBH Education Foundation.
32. Ornstein, Robert (1991), The Evolution of Consciousness: The Origins of the Way We Think, New York: Simon and Schuster.
33. Phillips, Thomas and Rutledge, David (1986), "Superconducting Tunnel Dectors in Radio Astronomy," Scientific American, Vol.254, No.5, pp.78–85.
34. Porter, Michael E. (1990), The Competitive Advantage of Nations, New

York: The Free Press.
35. Ronan, Colin A. (1987), The Short Science and Civilization in China: An Abridgment of Joseph Needham's Original Text, Vol. 2 (Vol. III and a Section of Vol. IV, Part I of the Major Series, Taipei, Taiwan: Caves Books, Ltd..
36. Science and Technology Illustrated (1984), Brain, in Vol. 4, pp.472–477, Encyclopaedia Britannica, Inc.
37. Shen, Sinyan (1987), "Acoustic of Ancient Chinese Bells," Scientific American, Vol.256, No.4, April, pp.94–103.
38. Smith, Douglas (1990), "Theoretical Foundations of Chinese Educational and Intellectual Thought: An Occidental Interpretation," Asian Culture, Vol.XVIII, No.1 Spring, pp.1–15.
39. Stevenson, Harold W. (1992) , "Learning from Asian Schools," Scientific American, Dec. Vol.267, No.6, pp.70–78.
40. Temple, Robert (1986), The Genius of China: 3,000 Years of Science, Discovery, and Invention, New York: Simon and Schuster.
41. Thurow, Lester (1992), Head to Head: The Coming Economic Battle Among Japan, Europe, and America, New York: Warner Books.
42. Vogel, Hans Ulrich (1993), "The Great Well of China," Scientific American, June, Vol.268, No.6, pp.116–122.
43. Wang, Zheng-Tuoh (1993), The Volume of Dexter Craftsmanship (Qiao-Gong Bian), in Chinese, Taipei, Taiwan, Shu-Quang Pub. The book is originally published by Chinese Youth Pub. Co. in PRC, in 1992.
44. West, Susan (1979), "The Fading Joys of Research," Science News, Vol. 115, March 31st, pp.218–220.
45. Weyl, Nathaniel (1989), The Geography of American Achievement, Washington, D.C.: Scott-Townsend Publishers.
46. White, Michael (1991), Galileo Galilei, Watford, UK:Exley Pub. Ltd. Chinese version translated by Lee, Yuan Qi, Published by Newton Pub. Co., Taipei, Taiwan in 1992.
47. Wu, Zhe Fu, Chief Editor (1988), The Volume of Astronomy, A Collection of Chinese Five Thousands Cultural Relics, Taipei, Taiwan: National Palace Museum Pub.
48. Xiang, Guang-Zhong, Lee, Xing-Jiang and Liu, Song-June (1986), Zhonghua Chengyu Da Cidian-A Great Chinese Dictionary of Chinese Idioms, Chang-Chun, China: Ji-Lin Literature and Histiry Pub. Co.