History Research
2023; 12(2): 60-67
http://www.sciencepublishinggroup.com/j/history
doi: 10.11648/j.history.20231102.14
ISSN: 2376-6700 (Print); ISSN: 2376-6719 (Online)

Qian Xuesen's Role in Computer Development of China

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To cite this article:
Si Hongwei. Qian Xuesen's Role in Computer Development of China. *History Research*. Vol. 12, No. 2, 2023, pp. 60-67.
doi: 10.11648/j.history.20231102.14

Received: October 1, 2023; **Accepted**: October 20, 2023; **Published**: October 31, 2023

Abstract: Qian Xuesen is an important pioneer and founder of China's missile and aerospace technology. What is less well known is that Qian Xuesen also made an important contribution by actively supporting and promoting the establishment and early development of computer science and technology in China. Based on previous research, this paper further examines and reveals the important role played by Qian Xuesen in recommending the inclusion of computer technology in national scientific planning and emergency measures, supporting the training of computer professionals, guiding the development of domestic electronic computers, and promoting the application of computers in missile and space engineering during the nascent period of China's computer industry in the 1950s and 1960s. Qian Xuesen's thoughts and practices on the development of China's computer industry are characterized by the following features: planning the direction of computer industry development from the needs of the country's scientific and technological and industrial foundation and strategic development; training personnel of computer technology personnel from "integration of science and technology, implementation to industry, combination of teaching and scientific research", establishing departments and specialties according to disciplines, aiming at training talents who dare to break through the cutting-edge computer technology; developing computer business must be in line with the law of research and development, and progress in a gradual and orderly manner, firstly, carry out tracking and imitation of specific models of computers in order to solve the engineering problems, and then solve the various application problems.

Keywords: Qian Xuesen, China's Computer Development, Missile and Aerospace Technology

1. Introduction

Qian Xuesen, the father of China's missile and aerospace technology, had made an important contribution to the computer establishment and development of China. During the formulation of the “Twelve-year Scientific Plan” in 1956, he participated in or presided over several meetings of the Planning Commission. With a clear attitude and full discussion, he actively suggested that the country develop computer technology. With his attention and promotion, the development of electronic computers was listed as one of the important scientific tasks in “Twelve-year Scientific Plan” and “Four Emergency Measures”, which provided the institutional guarantee for building and developing computer science and technology. Qian also cared about the training of Chinese computer professionals, supported domestic computers to play a role in scientific research projects such as the development of missiles and aerospace technology models.

2. Insist on the Inclusion of Computing Technology in China Science Planning

The birth of computer science and technology in China is the result of the implementation of the Twelve-Year Scientific Plan, and is also the product of a combination of copying Soviet products, borrowing Western technology and building computer science and technology on its own. It was jointly completed by the patriotic scholars who were back after finishing their studies in Europe and the United States, the experts who visited and studied in the Soviet Union, and the young technical backbone they had cultivated by themselves. Although Qian Xuesen is not a computer specialty researcher, he has played a crucial role in the inclusion of computer science and technology in the national-level science and technology planning.

2.1. Introduce, Explain and Demonstrate the Development of Computer Business in the Process of Formulating the "Twelve-Year Scientific Plan"

From January 14th to 20th, 1956, the Central Committee of the Communist Party of China held a meeting in Beijing to discuss the issue of intellectuals. Premier Zhou Enlai made a report to the conference, emphasizing that science is a decisive factor related to national defense, economy and culture, and asked the State Planning Commission to coordinate relevant units to jointly formulate the first grand plan on science and technology of New China - "1956-1967 Long-Term Plan for the Development of Science and Technology" (referred to as the " Twelve-Year Scientific Plan"). [1] On January 31, the State Council established a scientific long-term planning group, and Zhou Enlai personally led and presided over this work. On March 14, the planning group was reorganized, and the Scientific Planning Committee of the State Council was established, consisting of the director, the Vice Premier Chen Yi of the State Council, the deputy directors including Li Fuchun, Guo Moruo, Bo Yibo and Li Siguang, and 35 members including Qian Xuesen.

The Science Planning Committee of the State Council has set up a number of discipline (professional) planning groups and Qian Xuesen, who has just returned to China, serves as the head of the comprehensive group attended by 12 top scientists, responsible for the evaluation and consideration of the whole planning project, etc., and summarizes the opinions and suggestions from all aspects to provide the final reference for the central high level decision. One of the groups, the Planning Group for Computing Technology and Mathematics, is made up of experts from the electronics industry, computer experts and mathematicians, with 26 members and Hua Luogeng as its leader. The planning group held a series of reports and seminars. Qian Xuesen, the director of the Institute of Mechanics of the Chinese Academy of Sciences then, made a keynote speech to the planning group, describing the necessity of developing electronic computers in China. [2]

At that time, China was still in an "agricultural society" and was in the process of building a modern industrial system. We had never even seen an electronic computer, let alone developed one. Therefore, when discussing the specific content of planning, the electronic computer has become a focus of contention. Although everyone admits that it has fast computing speed and powerful computing functions, is it enough to have only a few units and is it necessary to incorporate it into the national science and technology development strategy? As for whether computers can replace human mental work, there are doubts and problems not only in scientific and technological areas, but also in philosophical perspective. When the experts in the planning group discussed the start and development of computers in China, some agreed and advocated sending talents to the Soviet Union to be trained first and returning later with the Soviet computers. But this opinion was later rejected. [3] Some people hold an objection, believing that China has no conditions to develop computers, its economic strength is limited, and it lacks talents in this area. This is like looking for the moon in the middle of a river. In several discussions, the electronic computer "was once considered to have an uncertain future". [4]

At this time, Qian Xuesen, the leader of the comprehensive team, played a "pivotal role". [5] He gave many examples to illustrate the importance of developing electronic computers. For example, in the design of a water turbine, many simulation experiments must be firstly completed before, and only the computation in the minimalist state could be performed. If electronic computers are used, complex equations can be solved by numerical methods accurately, taking into account various factors affecting the water turbine, and making an optimal design in the shortest time and in the most economical way. Qian Xuesen also cited the example of a computer being able to play chess, illustrating that a computer can replace part of the human brain for thinking. Compared with labor, electronic computers compute much faster and cannot be fatigued, so the computers can outperform human in some aspects. He also introduced the logic, memory and even learning functions of electronic computers, thinking that this is a field with great development prospects. [6] Qian Xuesen's consistently firm and clear attitude and a series of well-founded speeches have extremely important influences on promoting the inclusion of the computing technology in the national scientific plan.

2.2. Contribute to the Inclusion of Computing Technology in "Four Emergency Measures"

The Scientific Planning Committee completed the first draft of the "Twelve-Year Scientific Plan" and sent it to the Central Government. Zhou Enlai said that the most urgent matters needed to be reported; otherwise the printed book would be too thick for the State Council to handle. As a result, the key projects in the plan were isolated as emergency measures, and the "plan" was quietly juxtaposed with "measures". [7] To this end, the Planning Commission set up a special group composed of Qian Xuesen, Qian Weichang, Huang Kun, Luo Peilin, Wang Daheng, Ma Dayou, etc. to jointly study and discuss "emergency measures". Qian Xuesen argued forcefully that China should focus on developing missiles rather than aircrafts. He advocated the development of electronic computers, radio communication technology, automation technology, atomic energy and semiconductor technology, and fully explained his reasons. [8] They finally identified six urgent measures for national priority development: atomic energy, missiles, electronic computers, radio, semiconductors, and automation (the atomic energy and missiles were arranged separately and were publicly referred to only as the "Four Emergency Measures"). On May 20, 1956, the "Emergency Measures Program" for the development of computers, semiconductors, radio-electronics, automatics, and long-range manipulation technologies was submitted to the State Council by the Scientific Planning Commission, and Zhou Enlai personally

deliberated and immediately approved it. On July 5, the Planning Committee officially printed out the scheme text. It can be seen that Qian Xuesen has made irreplaceable contributions in the process of determining the entry of electronic computers into the country's "emergency measures". Zhang Jinfu, then secretary general of the Planning Commission, later recalled, "After the completion of the plan, four urgent measures were proposed, including the implementation of these measures, and Comrade Xuesen also made great contributions." [9].

On August 21, 1956, the revised draft of the "Prospective Plan for Scientific and Technological Development for 1956-1967" and four annexes including "emergency measures" were issued, covering 57 important scientific and technological tasks. The 41st item is "computing technology", which mainly focuses on the design, manufacture and application of electronic computers. [10] Practice has proved that scientific planning and emergency measures have played a guiding role in the Chinese government's concentrated efforts on developing modern science and technology, have established and developed a large number of emerging disciplines such as computing technology, have filled the domestic gap and narrowed the gap with the world's advanced technology, and have provided scientific and technological support for China's industrialization construction. Therefore, the introduction of the national "Twelve-year scientific plan" and "Four Emergency Measures" in 1956 is considered as the beginning of China's computer industry. [11]

3. Care for and Guide the Cultivation of Chinese Computer Professionals

Qian Xuesen attached great importance to computing technology talent cultivation. Although he had undertook a lot of important works and had been extremely busy, he still cared about the talent cultivation; particularly, he spared no efforts to care for and guide young students. In the Sino-Soviet computer cooperating agreement, there are two key points in training cadres and talents in the computer field. One is to establish two majors in computer science and computational mathematics, and the other is to hold a computer training class. Qian Xuesen participated in both of them.

3.1. Training Class of Institute of Computing Technology, Chinese Academy of Sciences

According to the specific requirements of scientific planning and emergency measures, on August 25, 1956, the Preparatory Committee of the Institute of Computing Technology, was established by the Chinese Academy of Sciences, with Hua Luogeng as the chairman. Since then, China's first electronic computer science and technology research institution was born. [12] At that time, only a few of our scientists who had returned from abroad had mastered the emerging technology of electronic computers, so we had to concentrate our efforts in developing the computer business. According to the requirements put forward in the scientific plan, the preparatory committee mainly focuses on the Chinese Academy of Sciences, and focuses on the scientific and technological forces of the Second Ministry of Machinery Industry, the Ministry of Higher Education, and the General Staff Department of the Chinese People's Liberation Army. In the start-up stage, the primary task of the Institute of Computing Technology of the Chinese Academy of Sciences (in preparation) is to cultivate computer technology professionals.

From 1956 to 1960, the Preparatory Office of the Institute of Computing Technology of the Chinese Academy of Sciences, together with Tsinghua University, Peking University, University of Science and Technology of China and other units, organized four computer and computational mathematics training classes. The students included students at school, graduates of engineering universities assigned to the Preparatory Office of the Institute of Computing, trainees on contract and fellows. These four training classes had trained about 700 computer professionals, who later became the backbone and pillars of our country's computer industry. The first training course started in the autumn of 1956 with over 140 students. They were divided into two specialities and had lecturers such as Xia Peisu, Wu Qikang and Min Naida, all of whom were renowned scholars who had returned from Britain, the United States, Germany and the Soviet Union, representing the highest level in China at the time. Although Qian Xuesen was very busy with his work, the students of the first computational mathematics training class were honored to hear lectures given by him in person. [13]

At the same time, Qian Xuesen felt the necessity and urgency of training computer talents in China, and he was very concerned about the construction of the Institute of Computing Technology of the Chinese Academy of Sciences. On December 20, 1957, he wrote an article in the People's Daily, stating: "The preparatory work for the Institute of Computing Technology was an urgent task of the Chinese Academy of Sciences in 1957. It was originally planned to be formally established in 1957... But now 1957 is almost over. It's over. it hasn't been established yet, and there's no news about the candidate for the director. Is this the attitude we should have when dealing with urgent national tasks?" [14] Under the care and supervision of Qian Xuesen and others, the first large-scale general-purpose electronic computer of our country, the 104 machine, which was developed under the auspices of the Preparatory Office of the Institute of Computing Technology, successfully calculated the first problem in April 1959. On May 17 of the same year, the Academic Affairs Executive Meeting of the Chinese Academy of Sciences decided to cancel the Preparatory Office and officially named it the Institute of Computing Technology of the Chinese Academy of Sciences. In February 1960, Yan Peilin was appointed as the director of the institute.

3.2. Computer Specialty in Tsinghua University

In the initial stage of China's computer industry, Tsinghua University made outstanding contributions in cultivating computer talents. In January 1956, the National Conference of Intellectuals issued a call to "March into Science", which inspired the enthusiasm of the majority of scientific and technological workers. At this time, Jiang Nanxiang, President of Tsinghua University, made a decisive decision to establish China's first computer specialty and semiconductor specialty in Tsinghua. In February, it was reported to the Ministry of Higher Education and received an official reply on March 31: "electronic computer specialty: I agree with your school's opinion and set it up this year in advance." [15]

According to the "Twelve-Year Scientific Plan", in the first half of 1957, Qian Xuesen, Qian Weichang and others established engineering mechanics research class and automation training class at Tsinghua University, and gave lectures to students in person. [16] At the beginning of 1957, Qian Xuesen, the dean of the Fifth Research Institute of the Ministry of National Defense, entrusted Lin Shuang, the vice dean, to make a special trip to Tsinghua University to meet Jiang Nanxiang to discuss the cooperation between the two parties. Shortly after the meeting, Qian Xuesen and Jiang Nanxiang jointly signed a cooperation agreement, confirming that Tsinghua University's automatic control major and computer specialty will cooperate with The Fifth Research Institute of the Ministry of Defence to cultivate talents for the Fifth Academy. [17] Zhong Shimo, Head of Electrical Machine Department of Tsinghua University then led teachers Jin Lan, Zhang Yanshen etc. to visit Qian Xuesen in the Fifth Academy. Qian Xuesen recommended American academic monographs to them, and suggested that the Department of Automatic Control of Tsinghua University should set up three majors: automatic control, computer and operations research.

In May 1958, Jiang Nanxiang wrote to the Ministry of Higher Education to report the cooperation between Tsinghua University and the Fifth Research Institute of the Ministry of National Defense under the responsibility of Qian Xuesen, hoping to further strengthen the cooperation between both sides and get more guidance and help from the No. 5 institute. Meanwhile, the Fifth Research Institute of the Ministry of National Defense submitted a request to Vice Premier Nie Rongzhen to recommend that the Ministry of Higher Education transfer students to Department of Automatic Control of Tsinghua University for study. The General Office of the Central Committee of the Communist Party of China, the Fifth Research Institute of the Ministry of National Defense, the Second Ministry of Machinery Industry, and the Tsinghua University discussed how to ensure the needs of cadres for the development of national jet technology and Atomic Bomb, determining that during the years of 1959 and 1960, the number of graduates who graduated from Automatically Controlled Specialists and Computer Science Specialists should reach the number of 250. On September 15, 1958, the Central Committee of the Communist Party of China issued a notice to transfer the Report of the Party Group of the Ministry of Education on the Transfer of Students to the Automatic Control Department of Tsinghua University. A total of 287 students were transferred from 10 key universities to the newly formed Automatic Control Department of Tsinghua University to learn as Computer Science Specialists and Automatic Control Specialists, and cultivated as talents for nuclear and missile industry. [18] Deng Xiaoping, Zhou Enlai, Chen Yun, Peng Zhen, Peng Dehuai, Nie Rongzhen, Yang Shangkun, Beijing Municipal Party Committee and relevant provincial party committees, Ministry of Education, and military units reviewed this document. At that time, the number of college graduate was very small, and it was not a trivial matter to transfer students from across the country. This move provided an important talents guarantee for the smooth development of atomic bomb and hydrogen bomb.

3.3. Department of Computer Science of Harbin Military Engineering

In September 1953, the PLA Military Institute of Engineering, was established in Harbin. The first dean was Chen Geng. Qian Xuesen had a close relationship with this prestigious university engaged in the research of sophisticated national defense weapons and the training of military high-tech talents. In November 1955 and January 1959, Qian Xuesen visited the PLA Military Institute of Engineering twice and repeatedly put forward pertinent opinions and suggestions on its disciplines, education, teaching and talent training, including Computer Science Specialists.

On April 11, 1960, Qian Xuesen wrote to An Dong, Secretary-General of the National Defense Science and Technology Commission. In the letter, it said: "A few days ago, I talked to you about setting up operations research after the Harbin Military Engineering Institute has been adjusted. I think about it again now, and holds that it is recommended to set a Technical Mathematics (or Engineering Mathematics) department with two majors in addition to the five originally planned departments: (1) Major for Mathematics of Computation which helps to train program designers using electronic computers and tactical computing mechanics for national defense science and technology; (2) Major for Operations Research which helps to cultivate personnel in weapons usage theory, tactical calculation theory, and logistics scheduling theory for national defense science and technology. Teachers of these two majors can be upgraded and transferred among existing math teachers, and is it possible to enroll 60 students for each major in the fall semester of 1960".[19] Then An Dong forwarded the letter to Chen Geng. On April 21, Chen Geng wrote an instruction: "Such a major is indispensable to military science. My opinion is to set up a Department of Engineering Mathematics in addition to the five departments. Please ask Liu and Xie (Liu Juying and Xie Youfa, both are vice-presidents of the Military Engineering Institute) to

proceed with the preparation work for it, because you already have the foundation for this major. Please reply with your comments."[20]

Qian Xuesen's advice to PLA Military Institute of Engineering is of great significance to our country's Computer Science Specialists talent training and the talent pool required for the "Two Bombs and One Satellite" cause. PLA Military Institute of Engineering first set up Missile Conductor majors in the Department of Naval Engineering and then set up Electronic Computers majors in the Department of Electronic Engineering; when the time is right, the two majors will be merged, approved by the Commission of Science and Technology for National Defense and reported to the Central Military Commission, and on April 1, 1966, the first Department of Computer Science of China's higher education institutions was established and trained a number of leading talents for my country's computer industry.

3.4. Training of Combined Talents in Mechanics and Computer Science

After the establishment of the Institute of Mechanics of the Chinese Academy of Sciences, where Qian Xuesen serves as the director, academic seminars were held regularly every Wednesday afternoon, allowing researchers to participate freely. In February 1956, Qian Xuesen taught Engineering Cybernetics in the small auditorium of the Institute of Chemistry. Not only the staff of the Institute of Mechanics, but also the teachers and students of the "Eight Colleges" in Beijing.

On September 20, 1958, the University of Science and Technology of China was established with Qian Xuesen as the head of the Department of Modern Mechanics. He and Guo Yonghuai taught courses such as Interstellar Navigation and New Boundary Layer Theory. On May 2, 1961, Qian Xuesen went to USTC to deliver a report on manned spacecraft for students.

The development of modern mechanics surged forward vigorously in an instant, but the role of a "hero" in mechanics has gradually diminished after Electronic Computers became popular. The widespread use of computers has led to structural changes in traditional disciplines, with some units declining. Faced with this scenario, Qian Xuesen raised the issue of new directions for the development of mechanics. He said that in order to solve engineering and technical problems with mechanical method, it shall first solve the problem of "calculation": One is to form a model, and the other is to have a calculation method. Where a computer reached the speed of tens thousands of times per second, Disembodied Excitation of a round ball still couldn't be calculated using the method of difference equation, and then later the problem was solved by the method of problem flow field. Qian Xuesen requested mechanics workers to make good use of electronic computers, get close to computer and participate in calculation work. The laboratory shall also be computerized, automatically recording and processing all kinds of data. He proposed to prepare for Electronic Computers mechanics. The future development of hydraulics and aerodynamics in the specific application of fluid mechanics depends on computers. For example, for turbulence theory, material properties, structural theory etc. We have to make breakthroughs through experimental work and combine the empirical laws of computer and mechanics, so as to make new breakthroughs in theoretical research. In addition, Qian Xuesen considered scientific issues in the overall picture of national economic development. He said that the software population in the United States accounted for 2.5% of the population, twice as many as the agricultural population. In the field of computer, we are far behind developed countries. He asked mechanics to go out of the research room and apply electronic computers technique in our country's engineering design and modernize mechanics work. [21]

It was Qian Xuesen's attention and participation that made our country ask for higher demands for the cultivation of combined talents in mechanics and computer science, and it did get better results.

4. Support Domestic Computer Development and Application

In December 1944, Qian Xuesen was invited by his mentor, Theodore von Kármán, to join a scientific advisory group of United States Army Air Corps consisting of 36 outstanding scientists, engineers, and military experts. At that time, its members have conducted research in United States, Europe, and Japan to witness the latest inventions in aviation, rockets, radar, and electronics, including the military applications of mechanical and electromechanical computing devices. In December 1945, the Advisory Group completed its famous consulting report, Towards a New Vision, which analyzed and summarized the latest developments in aviation, missiles, electronics, etc. in the world at that time, and basically covered the most cutting-edge technologies in global military technology at the end of World War II, and had made a profound impact on the development of the United States Air Force after the war.[22] In this report written by Qian Xuesen himself, there are many parts involving computer technology, including seven in the first volume Science-Key to Air Advantage, stating: "... With the development of Automatic guidance technology, the design of (electronic) automated computers is emerged as an important field of application in military engineering."[23]

In February 1946, the world's first electron tube digital computer ENIAC was born at the University of Pennsylvania in United States and was immediately used by the United States military for the development of sophisticated weapons such as atomic bomb and hydrogen bomb. At that time, Qian Xuesen, as an advisor to the Scientific Advisory Committee of the United States Army Air Force, visited several U. S. military bases, including Aberdeen Weapons Test Site, Maryland with ENIAC installed. [24] From 1945 to 1955, Science magazine published 14 papers on the development of electronic computers, and New York Times published 87

reports on the application of computers, indicating the rapid development of computers and their importance. It can be said that Qian Xuesen fully realized the development of electronic computers and the potential implications of confidentiality and disclosure before returning to China in September 1955. [25, 26]

4.1. Support the Development of China's First Electronic Computer

In April 1957, Qian Xuesen, as a member of the Department of Mathematics, Physics and Chemistry of the Chinese Academy of Sciences, presided over the drafting of the Research Outline (Draft) of the Department of Mathematics, Physics and Chemistry, the section 5 of which clearly stated: "Vigorously carry out research on computer technology. Based on computers designed by the Soviet Union, we have organized departments to develop semiconductor tubes, ultra-mini electronic devices, and so on that are urgently needed by Electronic Computers, so that in the Second Five-Year Plan, we can design our own ultra-high-speed universal digital Electronic Computers with Chinese raw materials."

In November 1957, the development work of domestic Electronic Computers, hosted by the Preparatory Office of Institute of Computing, Chinese Academy of Sciences, was initiated with the earliest task of copying Soviet M-3 computer. According to the requirements of the "Four Emergency Measures", the method of "centralizing first, then dispersing" was adopted for the development work. Firstly, a group of experts from the Second Ministry of Machinery Industry and the relevant units of the National Defense Army was selected and gathered to the Institute of Computing Technology of the Chinese Academy of Sciences so as to strive to develop China's first electronic tube general computer as soon as possible. After that, researchers return to their own organization to set up and develop computer in their own units. In that month, Qian Xuesen's the Fifth Research Institute of the Ministry of National Defense established the second branch, and computer technologist Zhang Zichang, originally from the Electronic Research Institute of the Ministry of Communications and War, joined the Academy. In order to support the development of China's first computer, the Fifth Research Institute of the Ministry of National Defense sent eight computer technicians, including Zhang Zichang, Li Zuxi, and Qu Lihui to support the Institute of Computer Science, Chinese Academy of Sciences, and appointed Zhang Zichang as the deputy leader of the engineering group to take part in the task M-3 machine imitation.[27] The leader of the engineering team is Mo Gensheng, and the members are basically computer training students and college students who graduated that year. On August 1, 1958, China's first electronic tube computer, the 103 Model Computer was successfully developed. The 103 machine uses more than 700 electronic tubes and performs 1800 operations per second, completing 82 application topics in a year, including meteorology, dams, transportation, bridges, metallurgy, machinery, oil, aviation, atomic energy, construction etc. After the successful development of the 103 Model Computer, Qian Xuesen transferred Zhang Zichang and others back to the Second Branch of the Fifth Research Institute of the Ministry of National Defense to continue researching computer, and later established the 706 Research Institute to make important contributions to computer applications in serving the missile and aerospace industry.

4.2. Focus on Chinese Computer Applications

Qian Xuesen began to focus on Electronic Computers engineering applications after the development of domestic computers achieved a groundbreaking success. On June 3, 1959, Institute of Mechanics, Chinese Academy of Sciences invited a Soviet expert to deliver a speech. Qian Xuesen concluded, "Soviet expert places great emphasis on the role of Electronic Computers. In the past the experiments were used but now they can be replaced by computers. It's a new beginning… I also learned gradually. I agreed with the way from quantitative change to qualitative change. The Soviet Union developed computers, which led to creative and influential insights." In late August of the same year, Qian Xuesen personally inspected the eighth-order electronic analog computer made by the Department of Mathematics when he visited Anhui Normal University to guide the work. [28] On October 1 of this year, China announced the successful development of the first large general-purpose digital computer, the 104 Model machine, on which scientific computing of China's first Atomic Bomb development was carried out.[29] After the successful launch of China's first proximity missile in November 1960, Qian Xuesen suggested, "There are also small computers inside the rocket, called Microcomputers on Bullets, to control when that section of the rocket will be detached. To develop small size computers, the task is assigned to Huang Chang, a young scientist who has just returned to homeland... to build a computer research base, and the small computer inside the missile is developed by the Academy of Sciences".[30]

The 119, 109B, and 109 C Model Computers developed by the Chinese Academy of Sciences have played an important role in atomic bomb, hydrogen bomb development and other advanced defense projects, and are known as "meritorious computers". In September 1964, Yu Min made a major breakthrough in the "1100" task of hydrogen bomb principle research on a successful J-501 Model Computer which was developed by the East China Institute of Computing Technology. Three years later, China's first hydrogen bomb exploded successfully.

In February 1968, the National Defense Science and Technology Commission took over Artificial Earth Satellite research work and established the Institute of Space Technology, with Qian Xuesen serving as the dean. A number of domestic Electronic Computers, such as the 441-B transistor computers developed by PLA Military Institute of Engineering, have undertaken important support and safeguard for satellite launch. Before each launching test mission, Qian Xuesen would go to the launch site and guide, and spent dozens of days and made many critical decisions.

The 108-B Model Computer developed by the 15th Institute of Electronics was used in the test mission for the first time, and the participants of the institute often saw Qian Xuesen on the launch site road. On the November 16, 1969, the missile tested that day suddenly disappeared after taking off. Qian Xuesen asked: "What have you found on computers?" The technical personnel of the 15th Electronic Institute responsible for the prediction of the missile drop points reported the latitude and longitude of the flying body landing point and the distance from the launch site according to the predictive trajectory of missile drop points drawn on the flat panel plotter based on the output data of the 108-B Model Computer. Qian Xuesen nodded and affirmed this opinion. According to the instruments from the command, the search force quickly found the target at the forecast location and successfully recovered the warhead. [31] With the increase of launch missions, various types of domestic computers have been equipped at the launch site, and their processing capacity has been continuously enhanced.

On April 24, 1970, China's first Artificial Earth Satellite "Dong Fang Hong No. 1" was successfully launched at the Jiuquan Satellite Launch Center, thus creating a new era in China's aerospace history. In which, Chinese Computers made their due contribution.

5. Conclusion

Qian Xuesen's thoughts and practices on the development of China's computer industry are characterized by the following features: planning the direction of computer industry development from the needs of the country's scientific and technological and industrial foundation and strategic development; training personnel of computer technology personnel from "integration of science and technology, implementation to industry, combination of teaching and scientific research", establishing departments and specialties according to disciplines, aiming at training talents who dare to break through the cutting-edge computer technology; developing computer business must be in line with the law of research and development, and progress in a gradual and orderly manner, firstly, carry out tracking and imitation of specific models of computers in order to solve the engineering problems, and then solve the various application problems.

These have very important practical reference significance for China's computer industry to achieve self-reliance in high-level science and technology and take the road of Chinese path to modernization.

Acknowledgments

This article is a phase study of a key project of the Fourteenth Five-Year Plan of the Institute for the History of Natural Sciences, Chinese Academy of Sciences: “A Comparative Study of the Sino-Foreign History of Scientific and Technological Innovation: The Road to Scientific and Technological Self-Reliance and Self-Improvement”. (E2291J01).

References

[1] Zhang Baichun, Zhang Jiuchun, Yao Fang. Technology Transfer in Sino-Soviet Science and Technology Cooperation [J]. Contemporary China History Studies, 2005, 12 (2): 80.

[2] Xu Zuzhe. Trace to the source of Chinese computer [M]. Beijing: Sanlian Bookstore, 2015, 69-70.

[3] Xia Peisu. Recall the first electronic computer research group in China [A], 30 years of Institute of Computing Technology, Chinese Academy of Sciences (1956-1986) [C], Beijing: Printed internally by Institute of Computing Technology, Chinese Academy of Sciences, 1986, 18-19.

[4] Zhang Jiuchun, Zhang Baichun. Planning for China's Computing Technology and Soviet Aid in the 1950s [J]. Chinese Science and Technology Historical Materials, 2003, 24 (3): 196.

[5] He Zuoxiu. Professor Qian Xuesen and the Twelve-Year Plan for the Development of Science and Technology [J]. College Historical Materials and Research, 1992 (3): 23.

[6] Tu Yuanji. Qian Xuesen and Defense Technology [N]. Science Daily, 2001-12-7, 1.

[7] Xu Zuzhe. "Emergency Measures": Zhou Enlai and the Foundation of China's Computer Industry [J]. Literature of Chinese Communist Party, 2016 (5): 71.

[8] Jiang Yuping. Technical Science Ideas and the Twelve-Year Scientific Plan [J], Contemporary China History Studies, 2017, 24 (3): 97-98.

[9] Zhang Jinfu. Let the spirit of science shine forever--thoughts on Qian Xuesen's Manuscripts [J]. Complex Systems and Complexity Science, 2006 (6): 77.

[10] Outline of A long-term Plan for the Development of Science and Technology between 1956 and 1967 (Revised Draft) [A], Selected Important Documents since the Founding of the Country (Volume 9) [M], Beijing: Central Literature Publishing House, 1994, 436.

[11] Jiang Zemin. Revitalizing the computer industry and striving to serve the four modernizations (preface) [A], Overview of China's Computer Industry [M], Beijing: Electronic Industry Press, 1984, 1.

[12] Zeng Maochao. Thirty Years of Institute of Computing Technology (Generation)[A], Thirty Years of Institute of Computing Technology, Chinese Academy of Sciences (1956-1986)[C], Beijing: Internal Printing, Institute of Computing Technology, Chinese Academy of Sciences, 1986, 1-2.

[13] Xia Peisu. Training of Scientific and Technical Personnel at the Beginning of the Institute of Computing [A], Thirty Years of the Institute of Computing Technology (1956-1986) [C], Chinese Academy of Sciences, Beijing: Internal Printing, 1986, 60-61.

[14] Qian Xuesen. Big-character Poster for Scientists [N]. People's Daily, version 1957-12-20.4.

[15] Editorial Board of Computer Science and Technology Department, Tsinghua University. Know All Around and Act Straight-History of Computer Science and Technology Department, Tsinghua University (Book I, 1958-2008) [M]. Beijing: Tsinghua University Press, 2018, 28-29.

[16] Kong Xiangyan. Qian Xuesen's life in technology [M]. Beijing: China Aerospace Publishing House, 2011, 245.

[17] Wei Hongsen. Qian Xuesen's love with Tsinghua University [M]. Beijing: Tsinghua University Press, 2011, 103-104.

[18] School History Office of Tsinghua University. Selected Tsinghua University Historical Materials (Volume 6, Book 1) [M]. Beijing: Tsinghua University Press, 2007.

[19] Letter from Qian Xuesen to An Dong, Secretary-General of Commission of Science, Technology and Industry for National Defense [Z]. Archives of National University of Defense Technology. File: KW-37-Y-SS. W-1960-011-005.

[20] Chen Geng's Reply on Qian Xuesen's Proposal [Z]. Archives of National University of Defense Technology. File: KW-37-Y-SS. W-1960-011-006.

[21] Li Jiachun, Fan Jing. Qian Xuesen-in the Days When the Institute of Mechanics Was Being Founded [M]. Beijing: Science Press, 2011: 38-40.

[22] Gorn, M. H. 'Prophecy Fulfilled: Toward New Horizons and Its Legacy'[R]. Washington, D. C: Air Force History and Museums Program, 1994, 1-16.

[23] von Karman, Th. 'Toward New Horizons'[R]. United States Army Air Forces Scientific Advisory Group, 1946.

[24] Gorn, M. H. The Universal Man: Theodore von Karman's Life in Aeronautics [M]. Washington, D. C.: Smithsonian Institution Press, 1992, 101-102.

[25] Wang, Z. Y. 'The Cold War and the Reshaping of Transnational Science in China'[A], Oreskes, N., Krige, J. (Eds.) Science and Technology in the Global Cold War [C], Cambridge, MA: MIT Press, 2015, 343-369.

[26] Jiang Yuping. Qian Xuesen and Towards a New Vision [J]. Dialectics of Nature Communication, 2020, 42 (9): 71-78.

[27] Zhang Zichang. Recall 103 Model Computer [A], Institute of Computing Technology, Chinese Academy of Sciences 45 Years (1956-2001) [C], Beijing: Internal Printing, Institute of Computing Technology, Chinese Academy of Sciences, 2001, 48-49.

[28] Comrade Qian Xuesen, Director of Institute of Mechanics, Chinese Academy of Sciences, visits electronic computers made by our Department of Mathematics [N]. Anhui Normal News, 1959 (8).

[29] Zhang Xiaoxiang. China's First Mainframe Computer Was Born Here [A], 45 Years of Institute of Computing Technology, Chinese Academy of Sciences (1956-2001) [C], Beijing: Internal printing of the Institute of Computing Technology, Chinese Academy of Sciences, 2001, 54.

[30] Zhang Jinfu. Please Remember Them in History-Memories of the Chinese Academy of Sciences and "Two Bombs and One Satellite" [A], Qian Xuesen-an Outstanding Example of Chinese Patriotic Intellectuals [M], Beijing: Tsinghua University Press, 2011, 152-153.

[31] Tao Dengyi. 108B Model Computer Development and 154-I Project Recollection [A], 30th Anniversary of the 15th Institute of Electronics Industry [C], Beijing: Internal Printing of the 15th Institute of Electronics, 1988, 52-53.