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From the Era of Mao Zedong to Xi Jinping

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Bengaluru, India
October 2021

S. Chandrashekar

Preamble

The rise of China and its transformation into a major global power is one of the sagas of the twentieth century. After centuries of turmoil, humiliation, and a major civil war, the People's Republic of China (PRC) came into being in 1949. Since then, notwithstanding major domestic upheavals and a hostile international environment, it has achieved remarkable progress on all fronts. It is now one of the world's largest economies and is poised to overtake the US as the world's largest economy soon.

The Chinese model of development is a unique one that combines Marxist Leninist thought with the pragmatism of state supported capitalism and market forces. The organizational and institutional mechanism through which this blending has taken place for delivering results that no country has ever achieved, appears to be unique to China. This dynamic adaptation to the internal and external forces that aim to shape the national agenda by the political elite has created a country that is poised to become a major force in the geopolitical landscape of the twenty-first century.

The Chinese Space Programme easily stands out as one of the jewels in the Chinese crown. Its origins go back in time to the return of the well-known rocket and missile pioneer, Quian Xuesen from the US to China in 1955. This was also the time when after a period of consolidation, China's leaders were looking at an agenda for development with key roles to be played by science and technology. Since those early days China has gone from strength to strength and is now a major player in the global space arena.

A study of China's Space programme and how it has evolved and changed from its turbulent origins provide a lens through which one can understand the larger enigma that is China. This narrative about the origins and the evolution of the Chinese Space Programme attempts to provide an Indian perspective on the Chinese Space Programme. The study draws upon the vast literature on China and the Chinese Space Programme. However, its interpretation of the evidence on China's space capabilities and aspirations tries to integrate the various diverse and often contradictory strands into a coherent understanding of its strategy.

The book is divided into two parts. The first part provides an overview of how the space programme has evolved from its beginnings in the 1950s to the present. It uses the major political turmoils within China and the external forces that influenced

Chinese decision making, as the basis for dividing the period into four phases. The major achievements in each period, the internal and external forces acting on the programme as well as the major organizational and institutional changes that were affected during each phase are threaded together for providing an integrated picture. The last section of this first part provides an overall assessment on China's space strategy and how it has evolved in response to the internal and external forces shaping it. Recent developments in the military uses of space and how these are driving an increasingly hostile China-US dynamic are also covered.

The second part of the book addresses each major functional area of space in greater depth. This section covers Recoverable Satellites, Communications Satellites, Weather Satellites, Remote Sensing Satellites, Navigation Satellites, the Human Space Flight Space Programme, and Space Sciences. A separate section covers the launch vehicles that China has developed to place the various satellites it needs in their proper orbit. In each of these assessments Chinese capabilities are benchmarked against global standards to provide a flavor of China's competitive position in the different functional areas.

A special Section on Military Uses highlights how military uses have influenced the direction and thrust of the programme throughout this period. These space capabilities are also connected to China's War and War deterrence strategies.

The creation of the infrastructure that is required for the programme is covered in a separate chapter. This also includes the major organizations involved in the space effort and their relative standing in China's space hierarchy.

The final section of the second part of the book looks at China's International Cooperation efforts. The commercial, political, regional, and global dimensions of this cooperative effort are used to get an understanding of China's space strategy and its role in China's grand strategy.

Annexure 1 provided at the end of the first section of the book provides details of the satellites launched by China since the inception of the programme.

Other Annexures Tables and Charts in the second part of the book elaborate in greater detail the capabilities and achievements in each major functional area of space.

Contents

About the Author

S. Chandrashekar is the J R D Tata Visiting Professor at the National Institute of Advanced Studies. Before joining NIAS he was a Professor of Corporate Strategy at the Indian Institute of Management Bangalore (IIMB). His work at IIMB involved linking technology especially high technology with business, corporate and national strategy. Prior to his stint at IIMB he spent more than 20 years working at the Indian Space Research Organisation (ISRO) on satellites, rockets as well as the applications of space technology especially remote sensing. As Deputy Director of Earth Observation Systems he was also involved with all international matters related to space. He has been a member and leader of Indian delegations to the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS). He was the focal point at ISRO for all matters related to the militarisation of space. At NIAS his research is focused on missiles, nuclear weapons and space. Recent work includes the use of satellite imagery for identifying Uranium mills, the role of space in safeguarding India's National Security interests, a critical assessment of China's Space Programme and North Korea's recent missile and nuclear weapon tests. His current research critically reviews China's Anti-Access Area Denial military strategy directed against the US and its allies in the Asia Pacific Region.

Abbreviations

A2AD	Anti-Access Area Denial
AALPT	Academy of Space Propellant Technology
AASPT	Academy of Aerospace Solid Propulsion Technology
ABM	Apogee Boost Motor
APSCO	Asia Pacific Space Cooperation Organization
ASAT	Anti-Satellite
ASBM	Anti-Ship Ballistic Missile
ASEAN	Association of South-East Asian Nations
AVIC	Aviation Industry Corporation
BACCC	Beijing Aerospace Command and Control Centre
BLMIT	Beijing Landview Mapping Information Technology Company
BMD	Ballistic Missile Defence
C4	Command Control Communications Computers
CAAET	China Academy of Aerospace Electronics Technology
CAC	China Aerospace Corporation
CALT	China Academy for Launch Vehicle Technology
CAS	Chinese Academy of Sciences
CASC	China Aerospace Science and Technology Corporation
CASIC	China Aerospace Science and Industry Corporation
CAST	China Academy for Space Technology
CBERS	China Brazil Earth Resources Satellite
CD	Conference on Disarmament
CEODE	Centre for Earth Observation and Digital Earth
CETC	China Electronics Group Corporation
CFOSAT	China France Oceanography Satellite
CGWIC	China Great Wall Industry Corporation
CLEP	China Lunar Exploration Programme
CMA	China Meteorological Administration
CMC	Central Military Commission
CMI	Civil Military Integration
CMIPD	Civil Military Integration Promotion Department

CMSA	China Manned Space Agency
CNPGS	China North Polar Ground Station
CNSA	China National Space Agency
COPUOS	Committee on the Peaceful Uses of Outer Space
COSTIND	Commission on Science Technology and Industry for National Defence
COSTND	Committee on Science and Technology for National Defence
CPCC	Communist Party of China Congress
CRESDA	China Centre for Remote Sensing Data and Applications
CZ	Chang Zheng
DAMPE	Dark Matter Particle Explorer Satellite
DF	Dong Feng
DFH	Dong Fang Hong
DMC	Disaster Management Constellation
DSLWP	Discovering the Sky in Long Wavelengths Pathfinder
DSP	Defence Support Programme
ECT	Equatorial Crossing Time
ELINT	Electronic Intelligence
EO	Electro Optical
ESA	European Space Agency
FB	Feng Bao
FSW	Fanhui Shi Weixing
GAD	General Armaments Division
GLD	General Logistics Department
GLONASS	Global Navigation Satellite System
GOES	Geostationary Operational Environment Satellite
GPD	General Political Department
GPS	Global Positioning System
GSD	General Staff Department
GSO	Geostationary Orbit
GSSAP	Geosynchronous Space Situation Awareness Programme
GTO	Geostationary Transfer Orbit
HXMT	Hard X-ray Modulation Telescope
IAF	International Astronautical Federation
ICBM	Inter-Continental Ballistic Missile
IGSO	Inclined Geosynchronous Orbit
IRNSS	Indian Regional Navigation System
IRSA	Institute of Remote Sensing Applications
ISR	Intelligence Surveillance and Reconnaissance
ITAR	International Traffic Arms Regulation
ITU	International Telecommunications Union
LEO	Low Earth Orbit
MAI	Ministry of Astronautics Industry
MASI	Ministry of Aerospace Industry
MBB	Messerschmitt Bolkow Blohm

MCCC	Dongfeng Mission Control and Command Centre
MEO	Medium Earth Orbit
MIIT	Ministry of Industry and Information Technology
MIRV	Multiple Independent Reentry Vehicles
MMH	Mono Methyl Hydrazine
MOST	Ministry of Science and Technology
N2O4	Nitrogen Tetroxide
NASA	National Aeronautics and Space Administration
NDC	National Data Centre
NFIRE	Near Field Infrared Experiment
NOAA	National Oceanic and Atmospheric Administration
NOAC	National Astronomical Observatories of China
NORAD	North American Aerospace Defence Command
NOSS	Naval Ocean Surveillance System
NSSC	National Space Science Centre
OROS	Operationally Responsive Space Satellite
P&T	Posts and Telegraph
PAM	Payload Assist Module
PAROS	Prevention of an Arms Race in Space
PCC	Party Central Committee
PKM	Perigee Kick Motor
PLARF	Peoples Liberation Army Rocket Force
PRC	Peoples Republic of China
PSLV	Polar Satellite Launch Vehicle
QKD	Quantum Key Distribution
QSS	Quantum Science Satellite
QZSS	Quasi Zenith Satellite System
RA	Right Ascension of the Ascending Node
RADI	Remote Sensing Satellite Ground Stations
RFNA	Red Fuming Nitric Acid
RSGS	Remote Sensing Satellite Ground Station
SAAT	Sichuan Academy of Aerospace Technology
SAR	Synthetic Aperture Radar
SAST	Shanghai Academy of Space Flight Technology
SASTIND	State Administration for Science Technology and Industry for National Defence
SBIRS	Space Based Infra-Red System
SBSS	Space Based Surveillance Satellite
SLBM	Submarine Launch Ballistic Missile
SOA	State Ocean Administration
SSA	Space Situational Awareness
SSF	Strategic Support Force
SSN	Space Situation Network
SSO	Sun Synchronous Orbit
SSTL	Surrey Space Technologies Ltd.

STARE	Space Based Telescope for Actionable Refinement of Ephemeris
STSSATRR	Space Tracking and Surveillance System Advanced Tracking Risk Reduction Satellite
TDRS	Tracking and Data Relay Satellite
TLE	Two Line Element
TT&C	Tracking Telemetry and Command
UCS	Union of Concerned Scientists
UDMH	Unsymmetrical Di Methyl Hydrazine
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UNOOSA	United Nations Office for Outer Space Affairs
USSR	Union of Soviet Socialist Republics
XPNAV	X-ray Pulsar Navigation Satellite

Part I
Origins and Evolution

Chapter 1
The Origins of China's Space Programme (1956–1976)

1.1 The Early Years and the Focus on Missiles

The return of Quian Xuesen from the US to China in 1955 also coincided with Chinese efforts to modernize their programme of economic development in which science and technology inputs were seen as key ingredients. Quian made a major contribution to the formulation of a 12-year plan in the aviation, missile, and space domains[1] (Chang 1995).

In January 1956, the Chinese government established the Institute of Applied Mechanics in Beijing headed by Quian. The main aim of this Institute, which functioned under the Chinese Academy of Sciences (CAS), was to carry out research on Applied Mechanics and High-Speed Aerodynamics for defense purposes. The political leadership also recognized that missiles had a crucial role to play for ensuring national security and protecting its international interests. To take care of these needs, Chinese leaders created the Fifth Academy for taking the lead role in the development of missiles. Quian was the founding director of this institute though it was headed by a Peoples Liberation Army (PLA) veteran at the Ministry level. By the end of 1958, the Fifth Academy had established its first set of ten laboratories dealing with different aspects of missile development. Figure 1.1 provides an overview of the organization structure of the early Fifth Academy.

The missile programme enjoyed top level support from major political figures that included Mao Zedong, Zhou Enlai, and others. The main spearhead of the effort was Marshal Nie Rongshen, a veteran of the Long March. He headed an early Aviation Committee that formally became the Committee for Science & Technology for National Defence (COSTND) in 1958. Initial efforts involved a major cooperative programme with the Soviet Union who helped China by supplying them with

[1] Quian Xuesen was a Chinese student of Theodore Von Karman the US aerospace pioneer. He became a US citizen and made a major contribution to the early aerospace efforts in the US. During the McCarthy era, he was accused of being a spy and deported to China. He went on to become the "Father of China's Space Programme".

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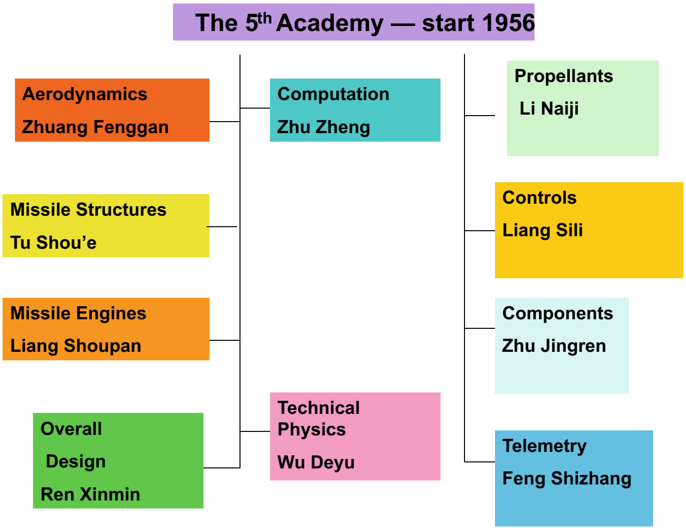

Fig. 1.1 Organization structure of early fifth academy

missiles, consultancy as well as with the training of Chinese engineers in the Soviet Union. They also provided them with the required blueprints for manufacturing the missiles and helped them with the establishment of production facilities.

In April 1958, construction activity for the Jiuquan Missile Test facility also began. This would become the launch center for the first Chinese satellite in 1970.

The early focus on missiles did not deter Quian from proposing a parallel project for launching a Chinese satellite in January 1958. This thrust towards satellites may have also been triggered by the launch of Sputnik in October 1957. The proposal put forward through the CAS, received support at the highest level. Mao himself wanted this programme to go ahead as a part of China's Great Leap Forward effort. A programme for the development and launching of sounding rockets as a part of the satellite development project was also cleared by a Committee in June 1958.

However, given the resource constraints of that time, China's capabilities to carry out both missile and satellite development simultaneously appeared to be unrealistic. Deng Xiaoping, as Party General Secretary, decided that China's focus should be directed towards the development of missiles and informed the CAS that the satellite programme had to be deferred[2] (Chandrashekar et al. 2007).

[2] The reference provides a technological and organizational perspective on missile developments in China.

Case Study 1

The Early Satellite Efforts and the Shanghai Connection[3] (Kulacki and Lewis 2009)

Immediately after the launch of Sputnik in 1957, five scientists, Qian Xuesen, Zhao Jiuzhang, Qian Sanqiang, Chen Fangyun, and Cai Xiang, tried to sell the idea of China building and launching its own satellite. As mentioned, the Soviet Union was actively supporting the PRC in its efforts to build a nuclear and missile arsenal. These ongoing collaborations could have also played a part in Chinese decision-making[4] (Lewis and Xue 1989, 1994). If needed, development problems in modifying the missiles to become space launch vehicles could be resolved with help from Soviet engineers and technologists.

Qian Xuesen was a well-known rocket scientist of international repute, Zhao Jiuzhang was a meteorologist and geophysicist trained in Germany, and Qian Sanqiang was a nuclear physicist trained in France. Chen Fangyun was educated in England and had carried out research on ground survey systems for Space applications. He later became an Academician of the International Academy of Astronautics.

The proposal went to the Chinese Academy of Sciences (CAS). Zhang Jingfu was its Vice Director and the Party Secretary. It was then sent to Mao who approved the programme in May 1958.

CAS then formed Group 581. The objectives of founding this group were:

- Development of Sounding rockets,
- Launch of a 200 kg satellite, and
- Launch a satellite with a mass of several thousand Kg.

This also led to the setting up of three design academies under the CAS.

The First Design Academy headed by Guo Yanghuai and Yang Nansheg would be responsible for the overall design of the rocket and satellite.

The Second Design Academy headed by Lu Quiang and Chen Yuanjiu would be responsible for the control systems. The Third Design Academy headed by Zhao Jiuzhang and Quian Ji would be responsible for environment testing of the various packages and subsystems developed for the satellite.

To consolidate all its satellite related work, the CAS created the Shanghai Mechanical and Electronics Institute with Wang Xiji as its Director in 1958. The scientists and engineers for this Institute came from the CAS in Beijing, CAS

[3] pp. 4–14.

[4] Together the two references provide a fascinating account of the development of the missile and nuclear development programmes from their start to the late 1980s.

branch institutes in Hebei, Hunan, Sichuan and Shanghai, Jiao Tong University, Harbin Polytechnic University, Jiangnan Shipyards, the Radio Electronics factory, and the Textile machinery factory.

Though Mao had supported the early launching of a satellite, the economic problems created by the Great Leap Forward resulted in the deferring of the satellite programme. The missile programme was accorded the immediate priority.

However, the CAS Institutes did not completely give up their efforts. By 1959, their goal was to focus on starting a programme of building and launching sounding rockets. This was independent of the missile program that China was already pursuing.

The first two stage rocket system had no control system and combined liquid and solid fuels; it weighed 190 Kgs, was 5.3 m tall and could reach an altitude of 8–10 Kms. The launch took place on February 19, 1960. The second launch of the T-7 M sounding rocket took place on September 13, 1960.

Following this the cooperation between the three CAS institutes, (Geophysical Institute, Bio physical institute and the Shanghai Mechanical and Electronics Institute) became stronger. The focus was on R & D programmes in Space Medicine, Aerodynamics, Orbital Mechanics, Rocket Engines, Propellants, Attitude Control Technology, and environmental sensing missions in the upper atmosphere. Zhao Jiuzhang who was then the Director of the CAS Geophysical Sciences Institute led this effort.

In anticipation of future successes in the missile area, Quian once again started the push for the launching of a Chinese satellite. In 1962, he recruited four engineers from the Shanghai Mechanical and Electronics Institute to serve as the torchbearers for the satellite effort. These scientists went back to their Institutes and in turn trained others creating a core cadre of trained personnel. R & D efforts to build a satellite continued in the CAS institutes but there was no significant push from the CPC.

All this changed when China successfully tested the Dong Feng-2 (DF-2) missile on June 29, 1964. This was witnessed by Zhao Jiuzhang and a small delegation of CAS scientists who then decided that it would be appropriate for China to take the next step of launching a satellite. In December of that year, Zhao had the opportunity to put across the idea of satellite launch to Zhou-Enlai. Since the ballistic missile technology was reasonably well developed in China, Zhao felt that a missile could be modified to launch a satellite. The question then was to build the satellite.

1.2 The New Push for a Satellite

The missile development programme got reformulated after the withdrawal of support from the Soviet Union. After several setbacks, the DF-2, the DF-3, the DF-4 missiles as well as the sounding rocket programme achieved successes. The DF-5 ICBM programme also showed significant progress. Towards the end of 1964, the Fifth Academy became the Seventh Ministry of Machine Building responsible for all missile and space projects. Its various sub-academies all became full-fledged Academies. Figure 1.2 provides a snapshot of the structure of the Seventh Ministry of Machine Building in 1965–66.

In January 1965, after the missile efforts had shown significant successes, the plan for the satellite was once again revived. Two separate parallel requests for a satellite made their way into the higher levels of decision-making within the Chinese political establishment.

Two of the original scientists who spearheaded the satellite effort within the CAS, Zhao Jiuzhang and Lu Quiang, made one proposal. This was routed through Zhang Jingfu, the Party General Secretary, to the CAS Interplanetary Science Committee. The proposal was approved and passed on to the Party Central Committee for a final decision.

Simultaneously another proposal prepared by Quian Xuesen was discussed in a CSTND meeting. The participants at this meeting consisted of Gen. Zhang Aiping (Deputy Director of CSTND and member of General Staff Department), Zhao Jiuzhang and his team as well as 30 technical experts from CAS. The meeting ended with no decision being taken.

To break the impasse, Zhao Jiuzhang then approached yet another Deputy Director of COSTND, Gen. Luo Wuchu, CAS party Secretary Zhang Jingfu and Qian Xuesen to resolve the various issues.

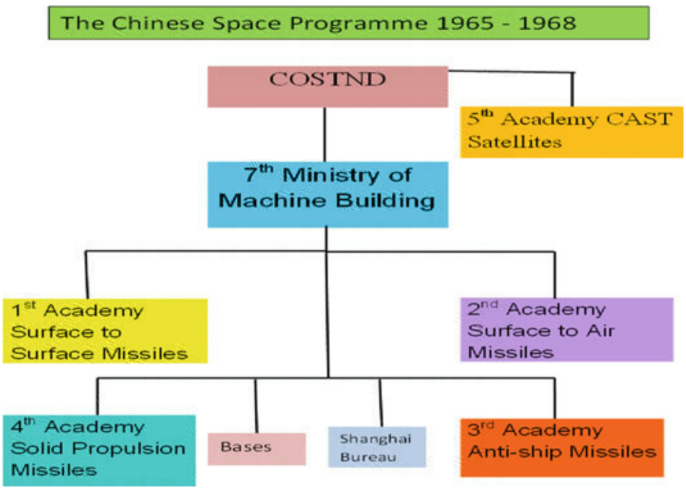

Fig. 1.2 The Chinese space programme 1965–1968

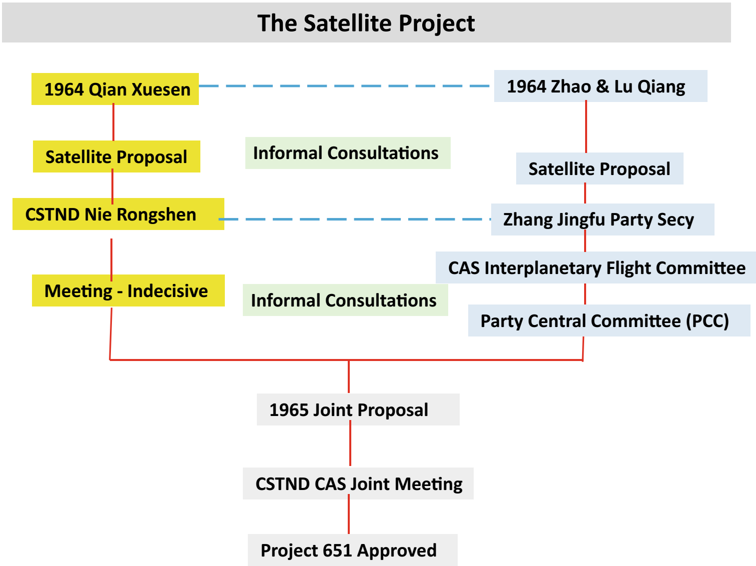

Fig. 1.3 The satellite project

Following these consultations on April 29, 1965, the Party Central Committee (PCC) adopted a proposal to put a 100 kg satellite in orbit by 1971. The Party Central Committee then sent the proposal to the Special Committee which guided national S & T Policy. This Committee included this proposal in the National Plan during its 12th Meeting in Beijing on May 4–5, 1965. It also directed the CAS to submit a plan for implementation of the proposal by July 1965. On receiving this plan, the Special Committee approved the proposal in its 13th meeting held on August 1965. The comprehensive National Satellite Program was called Project 651.

Figure 1.3 illustrates how the two separate proposals got merged to create the first satellite project—Project 651.

The first meeting of Project 651 was held in NW suburbs of Beijing and chaired by the CAS Vice-Director, Pei Leishen. Almost all institutes and organizations with an interest in space took part in this meeting. These included representatives from CSTND, the Committee on Industry for National Defense, National Committee for S & T, General Staff of the PLA, the Air Force, The Navy, the Second Artillery, the PLA Signal Corps, the First, Fourth, and Seventh Machinery Bureaus, Ministry of Post & Communications, Academy of Military Sciences as well as 13 research institutes under CAS.

In early 1966, a Satellite Academy was also established within the CAS. Work on a recoverable satellite also began in the Seventh Ministry. In May 1966, just as the Cultural Revolution was beginning, a committee that included Quian, finalized the requirements and the names for the first Chinese satellite. The satellite would be named Dong Fang Hong (DFH) translating simply into "the East is Red". The launcher would be called Chang Zheng (CZ) which means "Long March".

The original aim of Project 651 was to build a satellite with experimental instrument packages that would help design satellites for earth observation, weather monitoring, and communications. The CAS was given the responsibility for the satellite and the associated packages. The CAS initiated several mission-oriented research projects across China for the realization of the satellite. The Satellite Academy with Zhao Jiuzhang as the head, was responsible for the satellite design. A separate project, the 701 Project Bureau, was set up for managing the Tracking stations for the satellite mission. Within the Seventh Ministry, a design Institute (the Eighth Design Institute) was created for developing the CZ 1 launcher. The CAS Academy for Military Science and the CAS Academy for Medical Science were also set up for research on the space environment and space medicine.

1.3 The Cultural Revolution and the Creation of CAST

The beginning of the satellite project also coincided with the launching of the Cultural Revolution by Mao. This led to serious divisions within the various work centres responsible for the space and missile effort. Rebel factions led by the Red Guards created an atmosphere that seriously threatened activities within workplaces. The authority of COSTND and the Politburo above it was seriously undermined. At one stage all the Deputy Directors of COSTND and many scientists including Quian became victims of Red Guard actions[5] (Chen 1999).

Urgent action was needed to negate the impact of the Cultural Revolution on various projects and programmes of strategic importance. Within 2 months of the warring factions taking control of various units within the Seventh Ministry, Zhou Enlai along with Nie Rongzhen, Ye Jianying, and Li Fuchun met with all the political factions. They firmly indicated that they would not be allowed to take control of the key ministries of the Central Government.[6] They also imposed martial law within all defence-related ministries. A PLA General became the Director of the Committee of Military Administration that was responsible for the running of these key Ministries. In addition to proclaiming martial law, Zhou also managed to put all the defence-related industries within the ambit of Commission of Science & Technology for National Defense. This effectively placed COSTND directly under the military with the powers to approve and oversee all defence projects within the various defence ministries. By December 1967, the immediate problems seemed to have been resolved.

These political actions effectively transferred all the responsibilities of the satellite project from the CAS to the Seventh Ministry. The Shanghai-based Mechanical and Electronics Institute as well as some other institutes and work centers where expertise had been created in earlier years also came directly under COSTND.

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[5] See p. 93 for details.

[6] Zhou's actions covered all the critical ministries including the second, third, fourth, fifth, and seventh ministries.

In early 1968, an Academy for satellites was also created under COSTIND that assumed direct responsibility for the satellite project. This is also sometimes referred to as the Fifth Academy or as the China Academy for Space Technology (CAST). Quian Xuesen became the first Director of CAST with Sun Jiadong as his second in command. Some institutes and personnel working on satellite-related projects within the CAS were also taken over by CAST[7] (Chen 1999). The original objectives of Project 651 were toned down to accommodate the political interests of the Cultural Revolution. Instead of the scientific packages, the satellite would broadcast the song "The East is Red" to the whole world. At 173 kg, China's first satellite was the heaviest first satellite put into orbit in accordance with Mao's wishes.

Immediately after its creation CAST put in place plans and proposals for the development of various kinds of satellites that included weather, telecommunication, and navigation satellites. The Plan also proposed the initiation of a human flight programme[8] (Chen 1999). A Space Flight Engineering Institute that dealt with the medical aspects of human space flight was also created as a part of CAST.

CAST continued to function directly under COSTND till July 1973 when it was transferred to the Seventh Ministry and became its Fifth Academy. However, because of the delays in the human space flight programme, the Space Flight Engineering Institute remained with COSTND.

1.4 The First Satellite and Its Aftermath

On April 24, 1970, the first "East is Red" Dong Fang Hong (DFH) 1 satellite was successfully placed in orbit through a Chang Zheng (CZ) 1 launcher. The success was repeated the following year when a CZ 1 launcher placed the Shijian 1 satellite in a low earth orbit.

The turmoil of the Cultural Revolution continued till the end of 1976 and officially ended only in 1977. During this time, China launched a total of 11 satellites on 11 rockets using three different kinds of launchers[9] (Chen 1999). Apart from the CZ 1 launcher used for the first two satellites, the CZ 2 launcher developed by the Beijing-based First Academy and the Feng Bao (FB) Launcher also derived from the DF-5 missile developed by the Shanghai-based space Group (the later Eighth Academy) were used for placing these satellites in low earth orbit. These satellites included recoverable satellites with film capsules, Electronic Intelligence (ELINT) satellites

[7] See p. 177.

[8] See p. 180.

[9] According to Chen Yanping, the Feng Bao (Storm) Launcher was launched by China in August 1972. This carried an ELINT package. Other open sources suggest that this launch was a partial failure. Since most publicly available data bases do not include this launch, it has not been included in this assessment. See p. 86.

Table 1.1 Creation of industrial infrastructure by the 7th Ministry

Industrial base	Academy affiliation	Location (province)	Start year	End year
061 base	2nd academy	Guizhou province	1965	1975
062 base	1st academy	Sichuan province	1965	1975
063 base	4th academy	Shaan'xi province	1965	1977
064 base	3rd academy	Shaan'xi province	1967	1978
065 base	2nd academy	Guizhou province	1968	1970 merged 061
066 base	3rd academy	Hubei province	1966	1978
067 base	1st academy	Shaan'xi province	1969	1976
068 base	2nd academy	Hunan province	1970	1977

as well as some other experimental satellites. The launch data indicates that both the Beijing-based and the Shanghai-based groups received approximately equal shares of the space activity.

In addition to the satellite effort highlighted above, the transition from the Fifth Academy to the Seventh Ministry also resulted in an organized effort to create an industrial base for producing missiles and satellites[10] (Chen 1999).

The two main industrial centres of China at Beijing and Shanghai were of course the main locations around which research and production activities were initially organized. However, even in those early days, based on security considerations, decisions were taken at the highest levels to create parallel facilities in China's interior.

To accelerate space- and missile-related efforts, many research Institutes and several factories producing defence products were transferred to the Seventh Ministry. These included factories producing electronics, semiconductors, optics, chemicals, and precision engineered products. Vocational training schools were also identified for training workers needed for the space and missile programmes. After training, these workers were transferred to the ministry. The labor force needed for the missile effort was also augmented by the addition of trained workers as well as retired soldiers with special skills. By the end of 1970, the Seventh Ministry had about 250,000 people working for it. That this happened during the height of the Cultural Revolution is indeed a remarkable achievement.

The various bases created in China's interior during this period and their affiliations to the academies are provided in the Table 1.1 [11] (Chen 1999).

During this turbulent period, the space programme withstood the buffeting it received from different political groups within China and came out relatively unscathed. That it was able to do this successfully was in no small measure due to the support that it received from the top political leadership that included Zhou Enlai and Nie Rongzhen. Lin Bao, the Defence Minister and at one time Mao's designated successor, was another powerful player whose alliance with Mao's wife

[10] See pp. 181–184.

[11] p. 184.

and the Shanghai-based Gang of Four could have also created problems. The Gang of Four and the Red Guards also exerted a powerful influence on the happenings inside China.

The emerging space and missile programme was able to respond and adapt to these challenges in a variety of ways.

Though the original satellite project was under the CAS, the Cultural Revolution forced the top leaders to intervene and place all the defence industries including the Seventh Ministry under military protection. This in a way strengthened the influence of the military over the space programme. Scientists and engineers, though influential, were now directly under the military. In organizational terms, this can be viewed as a diminution in the power of the CAS vis-a-vis the PLA.[12]

One major loss that the Seventh Ministry sustained during this period was the transfer of its Third Academy (tactical naval missiles) and all its related activities to the newly created Eighth Ministry. Though it would eventually come back to the Seventh Ministry after Deng's assumption of power, the missile and space programmes did suffer a setback from this decision taken during the Cultural Revolution.

The creation of two parallel launcher and satellite groups, one based in Beijing and the other in Shanghai, to accommodate the interests of the Shanghai-based power center appears to be a very creative response to the political challenges faced by the nascent space and missile programmes.

The eventual integration of the Shanghai space interests with the space programme by making it the Eighth Academy of the Seventh Ministry, reflect the political and strategic acumen of the top political leaders Zhou Enlai and Nie Rongzhen.

Though China could ill afford to create parallel capabilities in space due to resource constraints, this accommodation of different political interests was possibly the only way to insulate the emerging space programme from the trials and tribulations of the Cultural Revolution.

In retrospect, it created parallel competing groups and capabilities that China could leverage to foster change and innovation as its space and launcher programmes matured.

Case Study 2

Power Struggles, the Loss of the Third Academy, and the Emergence of Shanghai

At various stages during the Cultural Revolution, the nascent missile and space programme had to find various ways to cope with the problems posed by a wide spectrum of political interests.

[12] In more recent times as China allocates more resources for science, including space-based science, the CAS appears to have become more influential in the space ecosystem.