China's Space Forces:

Undergraduate Space Training at the PLA's Space Engineering University

Summary

The People's Liberation Army (PLA) created the Space Engineering University (SEU) in 2017 as a component of the newly formed Space Systems Department. It is an undergraduate- and graduate-level institution with an undergraduate cadet population of perhaps 1,200 students. Maj Gen Zhou Zhixin, previously the Director of the PLA's Space Reconnaissance Bureau, has been the President of SEU since its creation.

This paper reviews the SEU undergraduate curriculum to identify the programs that make up the core training for the PLA's space operations officers. A total of 15 specialties were identified and are shown below.

Space Engineering University logo

Source: 81.cn

Undergraduate majors offered at Space Engineering University	
Combat Environment Engineering	**Operations and Mission Planning**
Command Information Systems	**Optoelectronic Information Science**
Communications Engineering	**Radar Engineering**
Early Warning Surveillance	**Reconnaissance Intelligence**
Flight Vehicle Propulsion	**Remote Sensing Science**
Information Countermeasures	**Space Equipment Engineering**
Measurement and Control	**Weapons Launch Engineering**
Navigation Engineering	

The courses required for each of these majors cover the full spectrum of space engineering disciplines like launch systems design, space vehicle systems, and gas jet fluid dynamics as well as space intelligence technologies such as remote sensing, imagery transmission, laser radar data processing, and photogrammetry. This appears to reflect the extensive effort China is now expending on its overall space effort.

Background

Western research (principally by Costello and McReynolds[1]) on the creation of the PLA Strategic Support Force (SSF) has shown that, as part of sweeping military reforms started in late 2015, space, cyber, electronic, and psychological warfare functions were moved into this new separate service. The SSF is subordinated directly to the Central Military Commission. Its two primary components are the the Network Systems Department, the PLA's cyber force for network attack and defense; and the Space Systems Department, the new force responsible for space operations. Elements of the Space Systems Department were mostly drawn from the former General Equipment Department and collected together to put all space missions—space launch, telemetry, tracking, control, satellite operations, and space warfare—into a single organization.

As part of this consolidation, the Space Engineering University (SEU) was established in 2017 jointly by the State Administration for Science, Technology and Industry for National Defense and the SSF Space Systems Department, to which it is subordinated. The SEU offers degree programs at the undergraduate, master's, and doctoral levels, as well as programs for non-commissioned officers at a separate facility. As a first step toward understanding China space officer development, this report focuses on the undergraduate curriculum as the basic training structure for missions under the control of the Space Systems Department.

SEU Formation and Location

The university was set up on the grounds of the former PLA Equipment Academy just outside of Beijing. This had been an Army-level military academy established in 1978 and subordinated to the General Equipment Department. SEU material states that the Equipment Academy had been primarily engaged in "training personnel in equipment control technology and space control technology." The new entity, SEU, now appears devoted entirely to training personnel for space operations.

Chinese image of the main entrance to Space Engineering University

Source: 81.cn

The main SEU campus is located near Huairou, about 35 miles northeast of Beijing's city center. The address is No. 1 Bayi Road, Huairou District, Beijing. ("Bayi" means "August 1st," which is PLA Army Day.) This is a short road that extends from Highway G111

[1] See ndupress.ndu.edu/Media/News/Article/1651760/chinas-strategic-support-force-a-force-for-a-new-era.

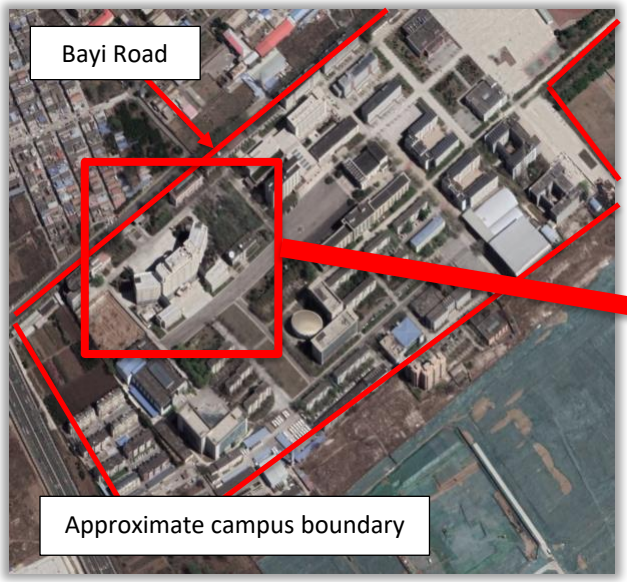
directly to the main gate at SEU. Chinese maps (see below) show a compound in blue labeled as “Space Engineering University” (航天工程大学). Satellite imagery of this location shows the campus with a large probable administrative building just inside the main gate. The approximate geographic coordinates for this building are 40 21 15N, 116 39 30E. The configuration of this building matches the ground-level image seen above.

Location of SEU campus near Huairou

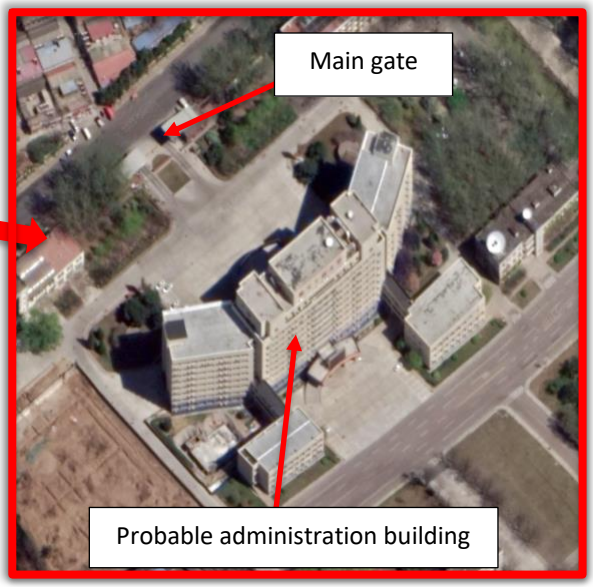
SEU campus identified in Chinese map

Source: sogou.com

Satellite image of SEU campus



SEU main entrance



Source: Google Earth

Leadership

SEU President
Maj Gen Zhou Zhixin

Source: 81.cn

Maj Gen Zhou Zhixin (周志鑫) has been the President of SEU since its creation in 2017. He was born in Anhui Province in August 1965. In 1986 he graduated from the PLA Electronics Engineering College in Hefei, and between 1989 and 1997 he received his graduate and doctoral degrees at Harbin Institute of Technology (HIT). He has worked in HIT's Space Science College, the China Academy of Sciences Automation Lab, and the China-France Joint Lab. According to Chinese sources, Zhou Zhixin later served as Director of the former Second Department Technical Bureau, which is also known as the Space Reconnaissance Bureau.

Chinese sources indicate Zhou Zhixin is "at the top of China's military satellite applications field." He was elected as a member of the Chinese Academy of Sciences (CAS) in 2015. Publication topics listed in his IEEE biography include synthetic aperture radar (SAR) imaging, machine learning for image processing, geophysical image processing, image denoising, and interference suppression. He was co-author of a series of papers in 2019 and 2020 that described artificial intelligence processes applied to SAR target recognition.

Organization

SEU describes itself as a "comprehensive university that trains personnel for space command management and engineering." The size of the undergraduate population is uncertain. However, one recruitment announcement in May 2020 listed targets for student recruitment by province that totaled 373 students from all of China. That would suggest that, given attrition, the undergraduate student body is perhaps 1,200 students.

Western sources have identified several of the schools that are components of SEU, including:

- Space Command Academy (航天指挥学院)
- Space Technology Academy (宇航技术学院)
- Space Information Academy (航天信息学院)
- Space Service Academy (航天勤务学院)
- Graduate Student Academy (研究生院)
- Space NCO Academy (in Changping) (航天士官学校)

In addition to SEU's undergraduate and advanced degree program structure, Chinese and Western sources have reported that there are defense-related national key labs at SEU plus other research and training components. These include:

- National Key Laboratory of Laser Propulsion and Applications (激光推进及其应用国家重点实验室)
- National Laboratory of Electronic Information Equipment Systems (电子信息装备体系研究国防科技重点实验室)
- National Core Electronic Component Integration Technology Research Base (国家核高基集成技术攻关基地)
- Space Simulation Training Center (航天模拟训练中心)
- Space Experimental Training Center (航天试验训练中心)
- Space Monitoring and Control Station (航天测控站)
- Deep-Space Exploration Team Antenna Array (深空探测组网天线阵列)

Undergraduate Curriculum

The most complete description of the SEU curriculum structure appeared in a recruitment announcement posted at an official PLA information website, 81.cn, as seen below:


中国军网
www.81.cn

中国军网 / 中国军校 /

2019军校招生简章第十七站：航天工程大学

来源：黄埔一号v军校资讯　　发布：2019-06-13 09:04:48

Translation:

China Military Net
www.81.cn

China Military Net　China Military Schools
2019 Military Schools Recruitment Listing for 17th Base: Space Engineering University
From No. 1v Huangpu Military Schools Info　Published: 2019-06-13

This announcement included a list of the **undergraduate majors** offered and the **education goals** for each specialty. A translation of this information appears in the following pages.

Combat Environment Engineering (作战环境工程)

- Basic theory and fundamental knowledge of surveillance, space environment, military meteorology, battlefield environment engineering, and data processing;
- Cutting-edge theory and development trends for space environment science and technology, and combat environment engineering;
- Specialized knowledge and basic skills for space combat environment modeling, simulation, forecasting, and space environment big data analysis; and
- Capabilities associated with space battlefield environment.

Command Information Systems Engineering (指挥信息系统工程)

- Basic theory and basic knowledge of space mission organization command, command information systems, space systems engineering, space equipment;
- Theory and technology for combat command, military operations, information systems, and systems simulation;
- Technology and use methods for command information systems; and
- Basic capability for space mission command management and command information systems use and protection work.

Communications Engineering (通信工程)

- Basic theory for digital signal processing, signals and systems, and communications principles;
- Basic knowledge of space communications mission organization and information systems use;
- Basic principles and critical technologies for current switching technology, computer networks, wireless communications, fiber-optic communications, and satellite communications;
- Basic capabilities for organization and management work associated with research planning for communications and network systems, operations, use of communications and network equipment, and space communications missions.

Early Warning Surveillance (预警探测)

- Basic theory and fundamental knowledge of space target characteristics recognition and information fusion;
- Basic theory and critical technologies for space target surveillance and recognition, typical early warning monitoring systems, and organization methods for early warning monitoring missions; and
- Basic capabilities for systems use protection work associated with early warning monitoring mission planning and organization implementation.

Flight Vehicle Propulsion Engineering (飞行器动力工程)

- Basic theory and fundamental knowledge of flight physics, rocket propulsion, test launch, and control and management;
- Flight systems component structure and space launch duties organization and implementation of basic processes;
- Flight test technology and methods, propulsion systems theory and structure, propulsion systems testing technology, fuel flow control, propulsion systems malfunction diagnosis, signal sensing and processing, and other contents; and
- Organization management and other work basic capabilities for propulsion systems and safeguards and applicable tasks associated with space test launch.

Information Countermeasures Technology (信息对抗技术)

- Basic theory of digital signal processing and signals and systems, and specialized knowledge of radar technology and countermeasures, optical reconnaissance and countermeasures, and satellite communications and countermeasures;
- Basic knowledge of space science and technology and use of space electronic information systems;
- Basic principles and critical technologies for space electronic countermeasures;
- Capabilities for organization management associated with space domain information countermeasures technology research and related missions, and capabilities for conducting operations and defenses of typical equipment.

Measurement and Control Engineering (测控工程)

- Basic theory and fundamental knowledge for antenna telemetry and remote control, and space vehicle orbit determination and control;
- Missions and methods of space measurement and control ground-based systems;
- Space antenna measurement and control systems, satellite management, and measurement and control information processing and applications; and
- Basic capabilities for organization management and other work associated with space measurement and control equipment use and tasks.

Navigation Engineering (导航工程)

- Modern navigation engineering techniques and methods, satellite navigation principles and technology, principles of military-use time integration, time broadcast, and navigation improvement, and specialized knowledge of navigation equipment functions, structure and engineering principles;
- Basic knowledge of operations management, data processing and application services for Beidou satellite navigation systems, and basic operations skills for modern navigation equipment and systems; and

- Capabilities to conduct research, design, and operations analysis for modern navigation equipment and systems; and
- Capabilities to conduct operations, maintenance, and management of Beidou satellite navigation systems and equipment.

Operations and Mission Planning (运筹与任务规划)

- Basic theory and basic knowledge of space mission organization command, space equipment basic principles, mission planning, and system modeling;
- Theory and technology for combat command, military operations, mission planning, and systems simulation;
- Technology and methods for space mission operations and mission planning;
- Basic capabilities for space mission command management and planned use of space equipment.

Optoelectronic Information Science and Engineering (光电信息科学与工程)

- Basic principles and fundamental knowledge of optics, electronics, space environment engineering, and computers;
- Cutting-edge theory and development trends for space science and technology, and optoelectronic information technology;
- Principles of optoelectronic probing technology and typical space situational awareness equipment systems; and
- Basic capabilities for mission organization management and related optoelectronic equipment use associated with space target surveillance, space environment probing, and space security analysis.

Radar Engineering (雷达工程)

- Basic theory and fundamental knowledge of radar principles and systems, radar signals, and data processing;
- Cutting-edge theory and development trends in radar technology;
- Basic principles and critical technologies for radar track measurement and typical radar field tests, and organization methods for radar field test tasks in space measurement and control missions;
- Basic work capabilities associated with radar field test mission planning, organization, and implementation, and the use of system safeguards.

Reconnaissance Intelligence (侦察情报)

- Basic theory and fundamental knowledge of military intelligence, intelligence reconnaissance technology, intelligence analysis and processing, space intelligence fusion and reorganization, and space intelligence applications;
- Theory and technologies for intelligence and informatics;

- Technical measures and methods to conduct processing, classification, recognition, analysis, integration, and production for all information collected from space; and
- Basic capabilities associated with space intelligence processing and application, and mission intelligence safeguards work.

Remote Sensing Science and Technology (遥感科学与技术)

- Fundamental theory and knowledge of optical remote sensing, microwave remote sensing, and high-spectrum remote sensing;
- Current situation, development trends, and applications related to the remote sensing domain;
- Specialized knowledge and basic skills for remote sensing information collection, processing, analysis, and interpretation; and
- Management capabilities associated with space remote sensing information processing and basic processes.

Space Equipment Engineering (航天装备工程)

- Basic theory and basic knowledge of space systems engineering, flight vehicle engineering, space propulsion, automated control principles, electrical engineering, and computers;
- Comprehensive knowledge of space science and technology, space engineering, and development trends for space equipment systems;
- Principles and critical technology for typical carrier rockets, space vehicles, and ground-based equipment, and organization command methods for space mission equipment and safeguards;
- Basic capabilities for command management work associated with space equipment use, protection, testing, product inspection, research and development, and space service safeguards.

Weapons Launch Engineering (武器发射工程)

- Basic theory and fundamental knowledge of flight vehicle testing, launch, control and management, and propulsion;
- Methods and technology for conducting space missions;
- Signal detection and processing, flight control, space propulsion systems principles, and rocket test launch operations methods; and
- Organization management and other work basic capabilities associated with space test launch systems and safeguards and applicable tasks.

Course Load Examples

Another education website, eol.cn, was found with posted sample **core-curriculum course loads** for a selection of these SEU undergraduate majors. These listings appear below.

Remote Sensing Science and Technology

- Error Theory and Data Processing (45 hours)
- Fundamentals of Remote Sensing Physics (36 hours)
- Fundamentals of Photogrammetry (72 hours)
- Digital Image Processing (45 hours)
- Remote Sensing Principles and Applications (54 hours)
- Remote Sensing Imagery Interpretation (36 hours)
- Principles of Geographic Information Systems (45 hours)
- GPS Principles and Applications (45 hours)
- Air and Space Data Collection (45 hours)
- Principles of Imagery Transmission (72 hours)
- Microwave Remote Sensing (36 hours)
- Remote Sensing Application Models (45 hours)
- Digital Photogrammetry (72 hours)
- Near-Scene Photogrammetry (45 hours)
- Laser Radar Data Processing and Application (36 hours)
- Space Data Bases (54 hours)
- Space Analysis (45 hours)
- Network GIS (54 hours)

Information Countermeasures Technology

- Analog Circuit Applications (24 hours)
- Analog Circuit Fundamentals (56 hours)
- Antenna Positioning Systems and Technology (40 hours)
- Communications Circuits and Systems (64 hours)
- Computer Principles and Applications (56 hours)
- Data Structures (C++) (32 hours)
- Design and Testing of Digital Systems (32 hours)
- Digital Circuits (56 hours)
- Digital Signal Processing (48 hours)
- Electromagnetic Field Theory (64 hours)
- Fundamentals of Control Theory (48 hours)
- Implementation of Network Attack and Defense Technologies (32 hours)
- Information Network Technology (32 hours)
- Information Systems and Security Countermeasures Theory (48 hours)

- Information Systems Security and Countermeasures Technology (48 hours)
- Information Theory (32 Hours)
- Introduction to Microwave Engineering (48 hours)
- Object-Oriented Program Design (32 hours)
- Design of High-Performance Embedded Systems (32 hours)
- Principles of Digital Communication B (48 hours)
- Principles of Operating Systems (32 hours)
- Signals and Systems A (64 hours)
- Software Engineering Design and Implementation (32 hours)
- Structure of Multi-Core Computer Systems (48 hours)
- Testing of Communications Circuits and Systems (24 hours)

Weapons Launch Technology

- Advanced Computational Mechanics (32 hours)
- Weapons Launch Trajectories (32 hours)
- Computational Fluid Dynamics (32 hours)
- Design of Power Generation Systems (48 hours)
- Fundamentals of Fluid Dynamics (32 hours)
- Fundamentals of Virtual Flight Technology (32 hours)
- Gas Jet Fluid Dynamics (38 hours)
- Introduction to Flight Vehicle Systems (48 hours)
- Introduction to Systems Engineering (48 hours)
- Launch Dynamics (48 hours)
- Launch Systems Design I (48 hours)
- Launch Systems Design II (32 hours)
- Reliability Engineering (32 hours)
- Structural Dynamics (48 hours)
- Testing Technology (48 hours)
- Vibration Fundamentals (48 hours)

Conclusions

The establishment of a Space Systems Department within the PLA for consolidated management of all space operations is one measure of the emphasis that China is placing on space and on military missions in space. The creation of a Space Engineering University soon after, with the curriculum described above, likewise shows the level of investment the PLA is making in the development of space officers, educated in their own school for missions performed by their separate service. The new service is technically the Strategic Support Force, with space being one of its departments. However, nomenclature that makes this look like a staff department may be intended to downplay the significance of a space arm of the PLA, which carries a hint of the militarization of the space domain.

The curriculum, as detailed in recruiting materials, shows the serious breadth and depth of the missions that these officers are being trained for. The **engineering disciplines** covered include space equipment, space vehicle propulsion, space navigation, optoelectronic and radar image technologies, and information countermeasures technologies. The **space operations** that this curriculum prepares the junior officer for include space vehicle testing, launch, and control; space based-communications; space-based surveillance; and space intelligence collection and processing. The curriculum is, in a way, a template for the space operations that the PLA sees itself tasked with in the future.

The depth of the education offered is further indicated by the sample course loads that were posted for some SEU majors. The Remote Sensing Science and Technology program, for example, adds up to about 890 class hours, roughly equivalent to 60 semester hours or about two years of university work. (Again, this is just the core program for the major; other required or optional courses available were not found in this research.) This program includes full-semester courses in remote sensing physics, digital image processing, imagery transmission and interpretation, microwave and laser radar data collection and processing, global positioning systems, geographic information systems, and several types of photogrammetry.

What is observable at present about this new school and its programs seems to show a seriousness behind China's effort to create well-trained space operations officers. The PLA seems intent on graduating several hundred officers a year who will be well-prepared for the full range of current and future Chinese space missions. This seriousness should not be surprising given that China is currently outspending every country in the world except the United States on space missions.