

THE "INTEGRATION OF SCIENCE AND EDUCATION, INTERNATIONAL COOPERATION" MODE OF TRAINING TALENTS IN GEOMATICS

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ABSTRACT:

With the rapid development of GNSS, high-resolution remote sensing, InSAR, LiDAR and other earth observation technologies, advanced technical conditions are provided for the training of talents in the field of geomatics. The discipline of surveying and mapping science and technology in Chang'an University has been integrated with engineering geology and geohazards over decades, forming one of the special research directions, that is, development of earth observation techniques and the applications in geological disasters. Therefore, we have formed the "integration of science and education, international cooperation" characteristic talent training mode. The specific initiatives include six aspects, namely, concentrating featured discipline directions, building scientific research platforms and teams, recruiting and developing outstanding talents, undertaking major scientific projects, strengthening the integration of science and education, and expanding international exchanges and cooperation, which ultimately serves the goal of improving the quality of personnel training in geomatics.

1. INTRODUCTION

Education, science and technology, and human resources are the foundational and strategic pillars for building a modern socialist country in all respects. We must regard science and technology as our primary productive force, talent as our primary resource, and innovation as our primary driver of growth. We will fully implement the strategy for invigorating China through science and education, the workforce development strategy, and the innovation-driven development strategy. We will open up new areas and new arenas in development and steadily foster new growth drivers and new strengths [1]. Postgraduate education is the highest level of higher education in China, an important channel for cultivating top-notch innovative talents for China's socialist modernization, and shoulders the important mission of high-level talent cultivation and innovation and creation [2]. General Secretary Xi Jinping pointed out at the National Conference on Postgraduate Education that postgraduate education has an important role in cultivating innovative talents, improving innovation capacity, serving economic and social development, and promoting the modernization of the national governance system and governance capacity [3]. The new time, strengthening and improving the system and mode of postgraduate talent cultivation is necessary to further promote quality education, comprehensively improve the quality of postgraduate training and promote the reform and development of higher education.

1.1 Majors and disciplines

The discipline of surveying and mapping science and technology at Chang'an University can originate from a secondary school in Engineering Surveying, Xi'an Geological School in 1953, and it became the first undergraduate major in Engineering surveying in the former Ministry of Geology and Mining in 1985. After 38 years of "Major establishment - characteristic development - National first-level construction" phases (Fig. 1) and 25 years of "discipline establishment - discipline development" phases (Fig. 2), the discipline now has three national-level majors, that is, Surveying and mapping

engineering, Geographic information science (GIS) and Remote sensing science and technology, of which two majors, i.e. Surveying and mapping engineering and Remote sensing science and technology, have passed the international engineering education accreditation. In Fig. 2, Chang'an University has a first-level doctoral program in surveying and mapping science and technology, a post-doctoral research station and three second-level doctoral and master's programs in geodesy and surveying engineering, cartography and geographic information engineering and photogrammetry and remote sensing, as well as a master's program in resources and environment (surveying and mapping engineering). In addition, the discipline was recognized as the first-class discipline in Shaanxi Province in 2018. The discipline has been awarded the "International Cooperation Cultivation Program for Innovative Talents" by the China Scholarship Council (CSC) to sponsor students to go abroad for joint training. The discipline has now formed a whole chain of international talent training system of "undergraduate - master - doctor - post-doctoral - international students".

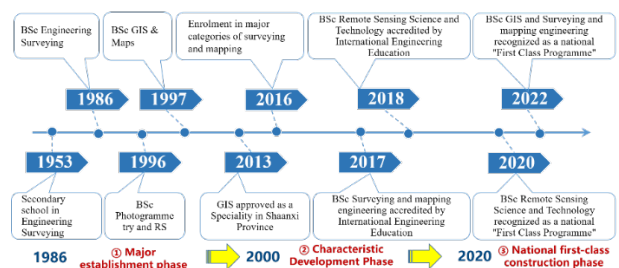


Fig. 1 The development phases of BSc of Geomatics in Chang'an University, China

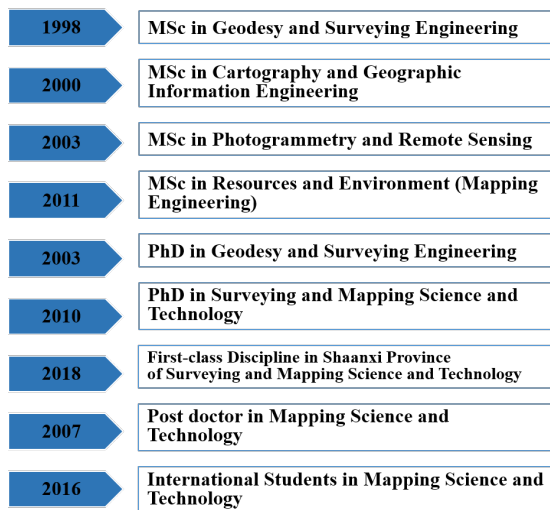


Fig. 2 The development phases of MSc and PhD of Surveying and mapping science and technology in Chang'an University, China

1.2 Faculty and talents and teams

Currently, there are 60 full-time faculty members, including 19 professors, 25 associate professors, among which 55 members have PhD degree, and 32 members have overseas study experience. As for the postgraduate's education, there are 18 full-time PhD supervisors and 32 master supervisors. In terms of talents, we have one double-appointed academician, two national distinguished professor, three national young professors and three provincial and ministerial talents (Fig. 3). Besides, there are two provincial teaching teams of "surveying and mapping engineering" and "remote sensing science and technology". Moreover, we were approved Shaanxi Province Innovative Talents Promotion Program and the "Three Qin Scholars" innovation team, and two "111" intellectual attraction programs in the Ministry of Education and Shaanxi Province.

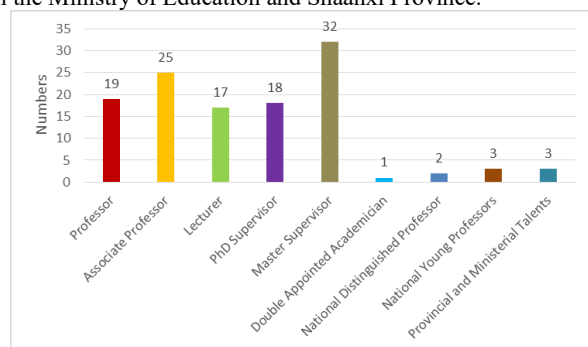


Fig. 3 Faculty and talents of Surveying and mapping science and technology in Chang'an University, China

To improve the quality of personnel training in geomatics, we have formed the "integration of science and education, international cooperation" characteristic talent training mode in terms of the specialized disciplines, high-level research platform, talents and faculty, major research projects, integration of science and education, and international exchange and cooperation.

2. SIX SPECIAL INITIATIVES

2.1 Specialized research directions

Firstly, in the last 20 years, with the development of China Beidou and Gaofen series remote sensing strategies, we participated the construction of Beidou and application of remote sensing actively and fused with our research specialties, namely, geohazards identification and monitoring, we have formed five specialized research directions, covering three secondary discipline directions. Firstly, as for discipline of geodesy and surveying engineering, we have two featured research directions, that is, GNSS navigation and positioning, as we have undertaken the construction of China Beidou Analysis and Service Center since 2012, which has operated stable and continuously up date, and ranked top three nationally among twelve agencies. Based on the precise GNSS service products, we also developed Beidou geological disaster monitoring equipment and Drone-throwing BeiDou monitoring equipment. Meanwhile, we have successfully developed the first maglev gyro total station in China, which has been successfully applied to more than 50 major national projects such as Hong Kong-Zhuhai-Macao Bridge, Qinghai-Tibet Railway, South-North Water Diversion and Xi'an Metro. Secondly, as for discipline of Cartography and Geographic Information Engineering, we have developed automated professional mapping platform, namely, Mapstore, which has been widely used in the fields of urban cartography, military cartography, and land and resources management. Thirdly, as for the discipline of Photogrammetry and Remote Sensing, we have developed GACOS Atmospheric Correction Service System and cloud platform for the geohazards identification, monitoring and early warning with multi-source remote sensing such as InSAR, high-resolution optical imagery and LiDAR. Therefore, we have formed one of the special directions of geomatics, namely, development of earth observation techniques and their applications in geological disasters.

2.2 Scientific research platforms

Secondly, owing to the long-term multidisciplinary cooperation in our school, including the geological resources and geological engineering, geophysics, and surveying and mapping science and technology, we have participated in the construction of eight scientific research platforms, including National Key Laboratory of Loess Science (jointly built with Institute of Earth Environment, Chinese Academy of Sciences), Key Laboratory of Western Mineral Resources and Geological Engineering, Ministry of Education, Key Laboratory of Ecological Geology and Disaster Prevention and Control, Ministry of Natural Resources, Shaanxi Yellow River Scientific Research Institute, Department of Geological Hazards Research, National Centre for Remote Sensing, Ministry of Science and Technology. Most platforms are highly related to the earth observation techniques development and geological disasters analysis.

2.3 Outstanding talents and high-level research teams

In the past ten years, thanks to the "introducing and retaining" talent policy in our university, our department has introduced more than 15 outstanding talents and PhD graduates from the United Kingdom, Germany, Belgium, and Hong Kong and from Information Technology Research Centre, Beijing Academy of Agricultural and Forestry Sciences, Chinese Academy of Sciences, Wuhan University, and Northwest Northwestern Polytechnical University, covering the diverse disciplines including applied mathematics, signal processing, land resource management, agricultural remote sensing, GNSS, and InSAR. Besides, we also developed the "Chang'an Scholars" talent support program implementation to nurture young teachers. Currently, the talent echelon has taken shape, where 8 teachers are selected for national or provincial talent programs.

Besides, we were approved two Shaanxi Provincial Research and Innovation Teams related to geological disaster analysis, namely, Shaanxi Province Innovative Talents Promotion Program-Geological Disaster Monitoring, Early Warning and Prevention and Control Innovation Team, and Shaanxi Province "Three Qin Scholars" Innovation Team (a national first-class team) - Chang'an University Geological Big Data and Disaster Prevention and Control Innovation Team. Moreover, we were recognized two Shaanxi Provincial Teaching Teams of Surveying engineering, and Remote sensing science and technology.

2.4 Major research projects

In the last ten years, responding positively to the needs of major national strategies and projects, including the Sichuan-Tibet Railway, Ecological Protection and Quality Development in the Yellow River Basin, we have been awarded more than 30 projects by the Ministry of Science and Technology, including key R&D projects, the National Natural Science Foundation of China, including major project, instrument major project, key project, Hong Kong, Macau and overseas scholars programs shown in Table 1. We can clearly see that the most projects focused on the geological disasters, where the innovative theories, techniques, equipment and software or cloud-platforms are systematically developed. In addition, those projects have served in the construction of major national projects such as the Sichuan-Tibet Railway, ecological protection and high quality development in the Yellow River Catchment, and intelligent transportation.

Table 1 Some selected national major projects

No	Project title	Types of project	Period
1	Theories on the occurrence, evolution and prevention and control of major hazards and hazard chains in loess	National 973 Program Project, Ministry of Science and Technology	2014-2018
2	Sichuan-Tibet Railway Major Disaster Risk Identification and Prediction	Major project of the National Natural Science Foundation of China	2020-2023
3	Real-time monitoring and early warning of mega-landslides and research and development of technical equipment	Key R&D projects, Ministry of Science and Technology	2018-2021
4	Research and development of information holographic perception and intelligent control and safety guidance technology and equipment for large scale natural disaster traffic networks	Key R&D projects, Ministry of Science and Technology	2020-2024
5	UAV precise-delivered Beidou landslide disaster intelligence monitoring and early warning system	Instrument major project of the National Natural Science Foundation of China	2022-2026

6	Landslide identification and intelligent detection and warning based on air-space and ground based technology	Key project of the National Science Foundation of China	2018-2022
7	Joint research on US-China landslide monitoring and early warning with air-space and ground based InSAR technology for	Hong Kong, Macau and overseas scholars programs of the National Science Foundation of China	2020-2024
8	Early identification and monitoring and early warning of mega-landslides in karst mountains	Subject of key R&D projects, Ministry of Science and Technology	2018-2021
9	Real-time monitoring methods and early warning techniques for swelling soil landslides and engineering	Subject of key R&D projects, Ministry of Science and Technology	2020-2023
10	Research and development of integrated technology and equipment for unmanned aircraft throwing GNSS monitoring and early warning in high-risk environments	Subject of key R&D projects, Ministry of Science and Technology	2021-2024
11	Composite geohazard chain monitoring and artificial intelligence prediction technology	Subject of key R&D projects, Ministry of Science and Technology	2022-2025

2.5 Integration of science and education

To strengthen the creative and practical skills of postgraduates, we have taken two main measures, namely "Joint School-Enterprise Practice Project" and "Integration of science and education program". Firstly, we have applied three Ministry of Education Collaborative Education Projects. That is, (1) Reform and Construction of Course Group on Remote Sensing Geoscience Application under the Deep Integration of Industry and Education; (2) Intelligent Remote Sensing Industry and Education Collaborative Practice Base between Chang'an University and PIESAT; (3) Virtual simulation helps to build a model course on "Topics in Geological Hazard Monitoring". Meanwhile, we applied for successfully the Innovation base for the integration of industry-university-research in the monitoring of geological hazards and engineering safety with Xi'an Dadi Surveying And Mapping Co., Ltd. Secondly, we applied for the research project on teacher education reform and teacher development in Shaanxi Province, that is, "Practice and exploration of research-feeding teaching by teachers of navigation and mapping in higher education". We integrate the scientific research results into the development of professional courses. Accordingly we have applied for approval of five first-class courses and online courses in Shaanxi Province, including "Modern Surveying and Mapping: Technological Innovation and

Major Engineering Applications”, “Earth Observation Technology and Applications”, “Navigation and positioning”, “Virtual Simulation Experiment on Constellation Design and Performance Testing of BeiDou System”, and “Innovation and practice in the application of underground space mapping technology”.

2.6 International exchange and cooperation

We have expanded the international exchange and cooperation in various fields. Firstly, we have hosted two "111" Innovation and Intelligence Base Projects from Ministry of Education, China Scholarship Council, and Shaanxi Province, that is, “Western geological hazards and geological engineering” and “Geological disaster high-precision monitoring and early warning and prevention”. Accordingly, professors or scientists from over ten countries have visited our university or given online speeches. Secondly, we have been granted five foreign expert programs, including International cooperation training program for innovative talents, which can send around 8 students to study overseas each years based on our own assessment. In the last ten years, over 20 PhD students have studied in famous universities in United State, Canada, Germany, England, Finland, and Spain supported by China Scholarship Council. Thirdly, we have signed Chang’an University-Spanish University of Alicante Joint Doctoral Training Agreement. One PhD student has graduated and one PhD student is under the study in Spain currently. Fourthly, we have developed 5 international full English courses as shown in Table 2.

Table 2 Some selected international courses

No.	Course	Teacher	University
1	The theory and application of Geodesy	Peiliang Xu	Kyoto University, Japan
2	Earth observations	Michael-Foumelis, Giorgos-Mallinis, Antonios-Mouratidis	Aristotle University of Thessaloniki, Greece
3	Modelling land use change	Anton Van Rompaey	University of Leuven, Belgium
4	Ecological Remote Sensing and Radar Technology	Tiejun Wang	University of Twente, The Netherlands
5	Soil Moisture Climate Data Record: Satellite Data Fusion and Soil Moisture Dynamics	Yijian Zeng	University of Twente, The Netherlands

3. TALENT DEVELOPMENT RESULTS

3.1 General assessment

During the last 38 years, Chang’an University has trained more than 8,000 talents of undergraduates, master, PhD and international students, including dozens of outstanding talents awarded National model workers, National advanced workers, National outstanding youths and Ten thousand people plan etc. They have become the backbone of the Ministry of Natural Resources, Ministry of Emergency Management, Ministry of

Transport, Ministry of Urban and Rural Construction and universities.

The discipline of Surveying and mapping science and technology ranked within top 10 in the mainland of China after the fast development in the last 20 years. Currently, there are over 100 master students each year selected from 600 undergraduate students from over 30 universities in the mainland of China. And up to 20 PhD students enrolled in our discipline each year. In addition, in total 20 overseas students applied for the master and PhD degree on our discipline in the last 7 years. Through the practices in above six aspects over 10 years, students' innovative ability has been strengthened. Seven PhD theses were awarded as the outstanding doctoral theses in Shaanxi Province (Table 2).

Table 3 Outstanding doctoral theses in Shaanxi Province

No.	PhD Student	Doctoral supervisor	Title of Doctoral Thesis	Year
1	Wenju Fu	Yuanxi Yang, Qin Zhang	Research on GNSS real-time precision satellite clock difference estimation and online quality control method	2021
2	Xiaolei Wang	Qin Zhang	Ground-based GNSS remote sensing research on near-earth space water environment monitoring	2020
3	Feifei Qu	Qin Zhang	Time-series InSAR monitoring technology and application study of slow ground deformation	2018
4	Guanwe n Haung	Yuanxi Yang, Qin Zhang	Quality evaluation of GNSS satellite-based atomic clocks and study of precision clock aberration algorithms	2015
5	Xianqiang Cui	Yuanxi Yang	Extension and application of adaptive robust filtering theory for dynamic localization of colored noise	2014
6	Wei Qu	Qin Zhang	Crustal deformation in the Fenwei Basin based on space geodetic inversion theory	2013
7	Chaoyin g Zhao	Qin Zhang	Differential interferometric radar technique for discontinuous deformation monitoring	2011

3.2 Case studies

Firstly, in case of serving major national projects, six graduates from our discipline took part in the Everest elevation survey in

2020, including the chief field commander, Guopeng Li and general technical director, Zhanke Liu. The group photo (Fig. 4) was taken at Everest base camp in May 19, 2020 [4].



Fig. 4 Alumni of Chang'an University at Everest base camp (from left: Weiqi Zhang, Guopeng Li and Wenliang Sun)

Secondly, over 50 postgraduates participated in the "Internet+" and "Challenge Cup" to win more than 20 provincial-level and national competitions. Some selected topics are as follows, "Wide-area dynamic geological hazard monitoring and early warning cloud platform", "Beidou + cloud platform landslide intelligent monitoring system", "Intelligent traffic detection system based on monocular vision" and "UAV life exploration system based on Beidou and multi-sensor information online fusion". Based on the geological hazard identification with InSAR technique, deformation monitoring with Beidou equipment and geohazards early warning with cloud platform, we have successfully forecasted the landslides failure 5 times without any casualties [5,6], which were widely reported by many mainstream media like "China Daily" and CCTV News (Fig. 5).



Fig. 5 The postgraduates of our discipline were reported by CCTV News (Up) and Spain INFORMACION (Down)

Lastly, Xiaojie Liu was a master and PhD student of Chang'an University in surveying and mapping science and technology, and the first student to receive a double doctorate from Chang'an

University and Spain. He was awarded the honorary title of 2022 Outstanding Graduate of Shaanxi Province. Dr. Liu, who received his undergraduate degree from Lanzhou University of Technology, has received 26 achievements and awards during his six years' study at Chang'an University, including 8 SCI papers (with a cumulative impact factor of 52.4), one highly cited and one F5000 papers, and national scholarships three times. In terms of practical innovation, he presided over one outstanding doctoral project, one DLR project, and participated in four innovation competitions, and took the lead in winning one silver award of "Internet+" in Shaanxi Province; and participated in four projects of key R&D project, Ministry of Science and Technology and National Natural Science Foundation of China (NSFC). He was responsible for the emergency data processing of the "11.10" Baige dammed lake on the Jinsha River in 2018, and his results were adopted by the Ministry of Natural Resources and selected as one of the key consulting projects of the Chinese Academy of Engineering led by 25 academicians for the "Study on the Prevention and Control Strategies of Major Geological Disasters in Tibetan Region and China-Nepal Transportation Network". He presented his research results at the 2019 IGARSS conference in Japan. During his study in Spain, he worked with Professor Roberto Tomas of the University of Alicante to successfully warn of landslides in the city of Alcoy and prevent casualties in time. The story was reported by Spain "INFORMACION" and "China Daily" (Fig. 5) [7].

4. CONCLUSIONS AND OUTLOOK

In response to the lack of innovation and practical ability in the training of postgraduates in the new era, the discipline has constructed a "six-in-one" innovative surveying and mapping research training model in terms of concentrating specialized research directions, building scientific research platforms, recruiting and developing outstanding talents and high-level research teams, undertaking major research projects, strengthening the integration of science and education, and expanding international exchange and cooperation. Through more than ten years of practice, the discipline has rapidly enhanced its domestic reputation, improved the quality of talent training, played an important role in major national strategic projects in the western of China, and been widely praised by employers.

In the next 10 years, the discipline will focus on three distinctive research directions, namely Intelligent Navigation and Ubiquitous Mapping, Earth Observation and Environmental Disasters, and Spatial and Temporal Data and Intelligent Natural Resources, to further attract and nurture high-level talents, deepen international exchanges and cooperation, and cultivate innovative talents in the field of geomatics.

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