

## Thoughts and Practices on Cultivating Innovative Talents for Civil Engineering Specialty in Application-oriented Academies

Peng Dawen

School of Construction and Safety Engineering,  
Shanghai Institute of Technology  
Shanghai, China,  
Pengdw@sit.edu.cn

**Abstract**—Based on own situation of college, author discusses the vital factors on innovative talents cultivating in Application-oriented Higher Institutions from five aspects, such as specialty characteristics, teachers training program, reform of teaching method, reform of examination system and establishing system of innovative experimental teaching. Research indicate: specialty characteristics are basis of innovative talents cultivating; excellent teaching staff is key; reform of teaching method is the core; reform of examination system is important method for innovative activity excitation; system of experimental teaching is external environment for innovative sense and practical ability.

**Keywords:** *Application-oriented Academies; Cultivating Innovative Talent; Practices; Civil Engineering*

### I. INTRODUCTION

In June, 2004, the general secretary Hu Jintao stressed in the academician conference of Chinese Academy of Science and Chinese Academy of Engineering that “we must adhere to the strategic thoughts of taking talent as the primary resources, and regard the innovative technological and scientific talent cultivating as the strategic measures to promote the building of innovation-oriented country, and expedite building a magnificent new-type science and technology force”<sup>[1]</sup>. In April, 2009, premier Wen Jiabao pointed out in his tour of observation in SZ that “Only innovation can make us seize the opportunity and be dominant in international market, thus our enterprises can become more prosperous. Chinese should take the lead in the area of innovation”<sup>[2]</sup>.

The innovative talents so called refer to those who have the quality for innovation and can harvest the fruits through the innovative practices. As the accumulation point for building new-type national human resources bank and the innovative results, the academies play an important historic role in terms of cultivating innovative talents and upgrading the capabilities for scientific and technological innovation<sup>[3]</sup>.

As for the target of cultivating innovative talents for civil engineering specialty in application-oriented academies, if we want to create the innovative civil engineer for the front line of production, we have to introduce the new innovative concepts into the professional teaching area, reflecting and establishing the target, content, approach and model for teaching student from the perspective of cultivating the

innovative talents and by following innovative theories and approaches.

This article provides informative and constructive discussion on cultivating the innovative talents for civil engineering specialty in application-oriented academies, combined with the actual development status of School of Construction and Safety Engineering in the terms of chrematistic specialty construction, the faculty competence building, the teaching method and means reforming, the exam system reforming and the innovative experiment and teaching system building, etc.

### II. BUILD THE CONCEPTS AND PRACTICES WITH SPECIALTY FEATURES

Most of the newly-built application-oriented are derived from the original college having a large gap compared with “211 Project” Universities in terms of faculty competence, scientific research ability and discipline building, etc. Whether these colleges shall dance to “211 Project” Universities’ tune or cut out its own characteristic development way in the background of advocating the innovative talents cultivating today is a matter of life and death for the survival and development of our specialties.

Our experience is that application-oriented academies must place the features of their specialties though all their teaching process in order to cultivate the innovative talents by adhering to the principle of “basic + characteristic” features. In the premise that the student cultivation standard for civil engineer is guaranteed, we highlight our specialty features, which is the idea for the new-type front-line engineer cultivation.

Taking our School of Construction and Safety Engineering as an example, we have 6 undergraduate specialties and 1987 undergraduates in school, including students in 640 civil engineering specialty.

In Shanghai, Tongji University, Shanghai Jiaotong University, Shanghai University all set up the civil engineering. They have almost a hundred years of school running experience and the powerful influence in the market. As a new comer for undergraduate education in 2000, we have to do deep research in terms of the features of our specialty in order to make achievement in new-type front-line engineer in civil engineering and maintain our advantages in the competitive HR market.

Through the questionnaire and the human resources construction industry come from the safety engineering major. They are not only in a small number but also far away from the requirement on construction industry in terms of their specialty knowledge structure. The imperative requirement by construction industry on the safety technology staff brings new inspiration to cultivate the innovative talents for civil engineering, namely we can make full use of our interdisciplinary advantages in civil engineering and safety engineering specialty, to cultivate the composite talents for the construction industry who specializes in civil engineering as well as safety engineering<sup>[4]</sup>.

We bring forward the concept of “safe civil engineering” based on our specialty structure advantages, i.e. establishing the specialty features of “cultivating the safety technology talents dedicated to civil engineering field”. The undergraduates of “safe civil engineering” should be able to: analyze (make calculation and analysis by using the software of civil engineering specialty), measure (master the main measurement methods and devices used in civil engineering and can conduct the non-damage measurement for the structure independently), know the construction (be familiar with the construction process and technique in civil engineering and understand the safety regulations and practices in construction industry) and know how to dispose (can evaluate the safety state during the construction and can take the countermeasures thereof).

For this reason, we make ceaseless exploration and reform in terms of faculty competence, talents cultivating scheme, courses system and teaching methods, exam system, etc., and enhance the inherent strength building of “safe civil engineering”, and cut out a way different from other peer colleges and universities, to establish the “safe civil engineering” special brand with our characteristics in Shanghai and Yangzi River Delta area, which is the basis of cultivating the innovative talents that can meet the needs of our society.

### III. BUILD UP A FACULTY WITH PRACTICAL ENGINEERING EXPERIENCE

The concept of characteristic specialty features is not enough for cultivating and developing the high-quality innovative talents, which, however, depends on whether the faculty have the innovative teaching approaches, the practical engineering experience and the profound knowledge.

Our school owns 24 professional teachers for civil engineering, including 18 doctors (7 post-doctors) and 6 masters. But the high educational level does not mean the high quality. Many of our teachers lack of the practical engineering background and the strict engineering training and the creativity. In Germany, a competent teacher of science and technology must have 5 years of practical engineering experience<sup>[5]</sup>. Only elevation of our teachers' practical engineering level can guarantee the cultivation of

symposium we held, we found that most safety staff in the innovative talents. For this consideration, we've done the following work:

1) Be strict on the talent introduction to guarantee the quality of our faculty. During the talent introduction process, we not only introduce the doctors, but also introduce those high-quality teachers who have rich work experience and scientific research practice, including their study and work experience abroad. We also focus on the investigation on the teamwork spirit and dedication of the teachers we're going to introduce. In recent years, we've introduced 10 teachers who meet our requirements above, accounting for 70% of our whole members we introduced.

2) Strength on their engineering quality cultivation and constantly improve the engineering ability of the young teachers. School encourages our young teachers to go for the exams of all kinds of national registered engineers, and makes efforts to foster the “due type” teachers apt at both academic level and engineering practice. With our efforts, we have 3 grade-1 registered structure engineers, 2 registered geotechnical engineers, 3 registered supervising engineers, 2 grade-1 registered construction engineers, 2 registered consultation engineers and 7 bridge inspection engineers, which account for 80% of the faculty and make the teachers' practical engineering ability improve constantly and provide the good teaching conditions for the innovative talents cultivating.

The school also encourages and supports the teachers to join the practical activity in society and consciously put the young teachers in the front-line post to develop their innovation ability. For example, during the bridge test project in some city, our young doctors take their initiative to jump into the water and enter into the bridge hole despite of the harsh operation environment and dirty, using all kinds of instrument to inspect the bridge; during the vehicle load test experiment, they struggled for several days and nights to successfully finish the research projects. In recent years, the teachers dedicated to civil engineering specialty have actually participated in the engineering design, inspection and construction monitoring projects worthy of 6 million around.

3) Employ the partner-teachers from enterprises to jointly guide the undergraduates to design their graduation design works and to improve the teachers' competence. School also introduces the high-level engineer and technicians with front-line work experience from enterprise to jointly serve as the directing teachers together with our faculty for the graduation design works by the undergraduate, making the graduation design works guided by enterprises staff and our faculty account for 60%. Not only the themes of the graduation design works are closely related with the practical engineer but also the quality of undergraduates' graduation design works is improved. .

### IV. REFORM THE TEACHING METHODS AND TEACHING MEANS

The reform of teaching methods and teaching means should be started from developing the student's initiative and creativity consciousness, making the teachers' teaching in

class inspire students' learning initiative and promoting the transition of teaching process from mastering the knowledge to applying and developing the knowledge and making it the core for cultivating the students' Innovation consciousness and Innovation ability<sup>[6]</sup>.

Our school adopts the modern teaching means including VCD, CAI combined the real engineer cases to conduct the simulation teaching to students to improve our teaching level. For example, it will be hard to make student understand and teacher teach the dynamics of simply supported beam in construction design which is difficult for student to understand only by oral explanation, but now we make it easy by using the simulation experiment to illustrate it. Taking another example, by using the opportunity of building new campus in Fengxian district, we organize the teachers to take photo and film the construction process of the building selectively and attach the caption as the supplement to the teaching material, which is quite popular among students.

We ask the teachers to adopt the enlightening methods to give teaching, with the purpose of incenting the students' imitative and creativity, training their scientific thinking habits, developing the students' capacity of analyzing and solving the problems independently. In addition, we encourage the teachers to extend the enlightening teaching methods to the exercise class, discussion class, Q&A class, all kinds of experiment and practices, course design, etc. to form all kinds of teaching methods including class discuss, self-learning & guiding and problem probing, etc. in order to cultivate the students' innovation consciousness and innovative capability.

#### V. BUILD THE INNOVATIVE EXPERIMENT TEACHING SYSTEM

According to the spirit in the document Several Opinions on Further Deepening the Undergraduate Teaching Reform to Fully Improve the Teaching Quality<sup>[7]</sup>, the experiment teaching method should be converted from focusing on the knowledge imparting to the students' quality development, making the students actively think during the experiment, in order to develop their habit of analyzing and solving the problems independently and to cultivate their innovation consciousness, innovation thoughts and innovation ability.

For this reason, we utilize the fund for building Shanghai Education Committee's premium discipline City Safety Engineering, to set up a civil engineering safety test & experiment center with advanced equipment and versatile functions in campus, which is intended to cultivate the students' ability to learn hands-on and focus on the innovative experiment. This test & experiment center has the following features:

1) Conduct the comprehensive and design-oriented experiment. The guiding teachers only give the experiment purpose, requirement and conditions, and the students themselves design the experiment scheme and make it happen. For example, the guiding teachers may ask the students to finish the experiments for the whole process of steel string concrete beam making, from component part design, template making, reinforcing steel bar binding,

concrete mix proportion calculation, pouring of concrete, maintenance to the component part loading, stress and deflection test, etc. Before the experiment, the students are requested to map out the experiment outline and calculate the experiment result; after the experiment, the students are requested to analyze the experiment result and formulate the experiment report. During the whole process of the experiment, the students' passion for the experiment is heightened unprecedentedly and the students participate in the experiment in groups and everyone assumes its role and works overtime and the students develop their collective cooperation consciousness and achieve very good experiment results.

2) The test & experiment center makes all kinds of the typical structural model of large size, such as the multistory building, the high rise building, the simple-supported beam, continuous rigid frame bridge, arch bridge and cable stayed bridge, etc. In these models, we deliberately make some defects, such as the run-through crack in the cross section, the bared reinforcing steel bar, the rust, the weak strength in local concrete, the size contraction in local cross section, the pedestal damage, etc., with the purpose of letting students find out these defectives with the help of instruments when learning the structural measurement, in order to improve their practical engineering measurement ability.

#### VI. REFORM THE EXAM SYSTEM

The purpose of teaching reform is to cultivate the safe civil engineering talents with the innovative spirit and practical ability. As an important part of the teaching work, the exam can effectively help us understand our teaching status and serves as the important method of evaluating the teaching effect. Current exam system has many problems such as the single written form, relying too much on the exam score in terms of evaluation, and emphasizing particularly on students' rote learning, and the closed exam in the form of paper. Such kind of exam system can neither examine the students' real level and practical ability nor reflect their comprehensive quality, but only encourage the rote learning method.

The process of cultivating the innovative talents is also the process of making students experience how to accept and learn the knowledge, the process of enabling the students to develop their self-learning ability. This process is the final purpose of the education and can be of help to students in their whole life. The purpose of the exam is not only to let students master what they've learnt but also to make them master how to learn through the exam; the exam content and scoring standard should be designed aiming at the students' ability, quality and innovation consideration. We reform the exam system in terms of the following aspects:

1) Reform the exam form. We encourage the teachers to adopt all kinds of exam forms, converting their efforts from examining the students' memory of knowledge to cultivating the student's comprehensive ability on analysis and application. The teachers can adopt various evaluation form for different discipline and courses, focusing on cultivating the students' innovative thoughts and innovation ability. The exam form can be the closed form, the combination of open

and close form, oral exam, interviewing exam, experiment operation, and experiment design and paper as well as short thesis, etc. or the combination of them, focusing on evaluating the students' specialty quality, innovative ability and their ability to learn hands-on.

2) Reform the exam content. The teachers are required to put more efforts on examining the students' practice, application, their thoughts, comprehensive ability as well as their innovative capacity on the basis of examining their basic concepts, principles and calculation ability. The content of the exam questions can be selected by students, so they can give full play to their potential and intelligence and their interest in innovation can be stirred to the greatest extent, making the exam a happy thing; by doing so, the exam could have been "student-oriented".

3) Reform the study achievement evaluation. To cultivate the students' innovation capability, we can set up the "innovation score" in the teaching process, which introduces the scores for innovative ideas into the study achievement evaluation. We should recognize the students' innovative conception in their study process and their innovative ideas occurring when they answer some questions, making this become the initiatives of inspiring the students to conduct the innovative actions.

We can change the centesimal score system to the grade score system, which can unchain the teachers and students from the shackle of score and make them put all their efforts into the teaching reform and innovation ability cultivating.

## VII. CONCLUSION

The illustration of this article shows us that the focus on the specialty features building and the adherence to the different development path are the basis of cultivating and developing the innovative talents for the civil engineering of application-oriented academies; building the faculty with innovative teaching thoughts, the rich practice experience and the profound knowledge is the key to cultivate and develop the high-quality innovative talents; reforming the teaching methods the core to heighten the students' learning initiative and convert the teaching process from the knowledge mastering to the knowledge application and development and to cultivate the students' innovation consciousness and innovative ability; reforming the exam form is an important initiative to inspire the students to conduct the innovative actions; setting up the innovative teaching system is the external environment in which we can cultivate the students' ability to analyze and solve the problems independently and develop their innovation consciousness and their ability to learn the hands-on. If we adhere to the reform and stick to innovate our ideas, the application-oriented innovative talents cultivating will not be turned out to be vain.

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