

Training mode and mechanisms for the excellent engineers programme

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ABSTRACT: The *Excellent Engineer Education and Training Program* strives to meet society's needs for trained personnel arising at this historic time in China's development. The programme has major implications regarding the development and potential reform of engineering programmes within higher education. To produce excellent engineers, a complex system is required of engineering training, with university-enterprise co-operation. At the same time, it requires a variety of internal and external conditions to be satisfied. Therefore, developing and maintaining high quality training must begin by establishing a dynamic training mechanism. This study is based on an analysis of the *excellent engineers* training mode and mechanisms required for its implementation.

INTRODUCTION

The core component of the *Excellent Engineer Education and Training Program* is university-enterprise co-operation. Its primary aim is to nurture individual engineering talent by implementing personnel training between universities and enterprises. The difficulty of finding employment after graduation via the increasingly narrow employment channels has become an important topic for educators to explore.

Today's college and university students face a challenging employment situation. On the one hand, this is due to overall employment conflicts. On the other hand, however, there appear to be structural contradictions resulting from a mismatch between the nature of the engineers being produced by colleges and universities and the type of engineer demanded by enterprises.

This structural contradiction lies between university-educated people, who are trained contrary to the demands of the enterprise, and the market. It is necessary, then, to reflect the demands of enterprise in higher education and encourage more university-enterprise co-operation. To achieve this *unity inside and outside* model, university education should be guided by the demands of the market and introduce more enterprise training models.

Colleges and universities rely on enterprises to participate in the excellent engineers training programme and to complete the tasks of an *excellent project*. Established engineering programmes are oriented toward large-scale engineering enterprises, which makes university-enterprise joint training of personnel very appropriate. Therefore, in order to develop the university-enterprise culture of excellence, the respective roles and strengths of the two sectors, university and enterprise, needs to be actively explored.

University-enterprise co-operation

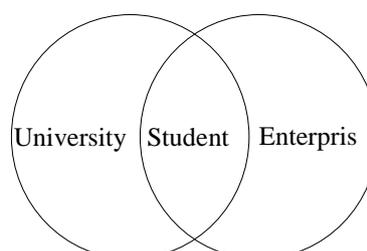


Figure 1: Excellent engineers training programme.

THE EXCELLENT ENGINEERS TRAINING PROGRAMME

In 2010, the Chinese Ministry of Education formally promulgated the *Excellent Engineer Education and Training Program*. The implementation of this plan was an important component of the Long-term Talent Development Plan (2010–2020) and the Long-term Education Reform and Development Plan (2010-2020). The excellent engineers programme is important for strengthening engineering education.

The Chinese Ministry of Education issued a document entitled, *Several Opinions of the Ministry of Education on the Implementation of Education and Training Programmes for Excellence Engineers*.

This report clearly indicated that the primary goal of the excellent engineers programme is the training of *...a large number of various types of high-quality engineering and technical personnel, with innovative ability to adapt to the needs of economic and social development. It should help build an innovative, industrialised and modern country. It also lays a solid foundation of human resources to further enhance the country's core competitiveness and overall national strength* [1].

THE EXCELLENT ENGINEERS TRAINING MODEL

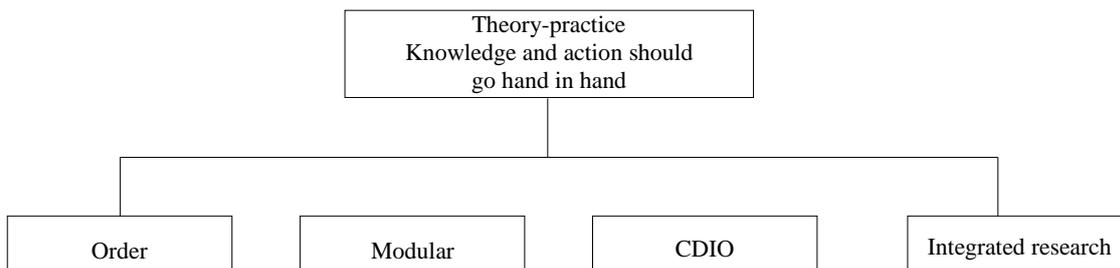


Figure 2: The various training models that can be used in the excellent engineers programme.

Order Training Model

The *order* university-enterprise co-operation model refers to teaching in universities being in accordance with the demands of the engineering industry. Such a model requires co-operation between the university and the enterprise. Table 1 compares order training with the traditional training model.

Table 1: Comparison of the *order model* with the traditional training model.

	Order type	Traditional type
Training model	University-enterprise co-operation on the development of the unity of knowledge and action	School training - practical training weak
Practical environment	Good external environment to achieve optimal allocation of teaching resources	Practical environment and teaching resources are scarce
Career planning	Facilitating enterprise skills; promoting <i>people matching posts</i>	Increased recruitment, training costs because of a skills mismatch
Professional development	Stimulating professional development; reduce employment transition period	Employment orientation is not clear; theory wearies students

The university-enterprise order model has several advantages compared with other models of co-operation for training. These advantages include:

- The order training model welcomes businesses. Business is able to co-operate with universities, in a positive and open attitude, towards cultivating excellent engineers.
- From the university perspective, the order training model creates favourable student opportunities in external environments. For example, an enterprise equipped with advanced teaching facilities and engineering equipment may be able to teach students advanced production concepts and skills. It would not only save the university significant teaching resources, but also improve the quality of training.
- From the enterprise perspective, the order training model not only trains personnel for the future development of the enterprise, but does so while reducing costs in both recruitment and training. Ultimately, university-enterprise co-operation effectively better matches personnel to posts and reduces enterprise costs.
- From the student's learning perspective, the order training model provides clear direction to future employment opportunities. Additionally, order training encourages students to engage with the enterprise's productive activities. Students actively learn about enterprise management, which reduces the difficulty of adapting to future employment [2].

Modular Training Model

The modular training concept of university-enterprise co-operation brings universities and enterprises together to draw up training plans and define objectives for excellent engineers. The training plans are used to define teaching content. Through modular teaching, students develop skills important to the enterprise. The modular training model integrates teaching modules to accommodate students' learning needs.

Universities and enterprises through a joint teaching model can design more targeted learning with a flexible combination of knowledge and mastery of skills. Flexible modules can accommodate the diverse characteristics of students, e.g. there will be varying business needs for different businesses requiring the development of a variety of training programmes. Ultimately, the universities, enterprises and students all benefit from this model, as briefly shown in Table 2.

Table 2: Comparison of the modular training model with the traditional training model.

	Modular	Traditional
Training	Market- and enterprise-oriented, expanding student employability	Teaching to the examination; the market is slow to respond with employment opportunities; professional training is restricted
Employment	Selection of the appropriate enterprise for co-operation; building a broad platform for learning and development	Narrow channels of employment

The advantages of the modular training model include:

- The modular training model reveals many weaknesses in the traditional educational model. The newer model is designed to meet the needs of enterprises and realises the advantages of centralised resources in promoting and developing universities and enterprises [3]. The students' learning is practical and closely integrated with enterprise demands.
- In the modular training model, enterprises provide students with a broad base for learning and development. The implementation of the teaching mode in the enterprises realises a diverse training model.

CDIO (Conceive, Design, Implement, Operate) Training Model

The CDIO university-enterprise co-operation model can reflect changing trends across the industry by identifying different systems to be developed. Using surveys and analysis, core competency elements can be determined to guide the CDIO process. Conceive, design, implement, operate can exploit the technology of enterprises in university and enterprise teaching, as well as keeping the theoretical teaching of the university and the practical teaching of enterprises closely linked. The CDIO model encourages excellent engineers training by developing high-quality practical skills. One of the CDIO five school-enterprise co-operation models requires the addition of *instructional design + theoretical education and practical training + ability upgrade + engineering application + feedback*. These features will help ensure that engineering graduates have a solid theoretical foundation, good capabilities, good engineering skills, strong innovative ability, effective team working and good communication skills [4].

Integrated Research Training Model

Modern higher education is in a period of reform. The traditional teaching model and teaching philosophy are no longer able to meet the needs of society and, therefore, cannot support the historic mission of universities; namely, personnel training, scientific research and serving society. With the rapid development of science and technology, adopting critical technologies can provide a crucial advantage for enterprises. Finding individuals with the right skills and knowledge for these enterprises is crucial.

Product design and development are key to a business development strategy. Accordingly, enterprises require talented individuals to secure their own future. The integrated research model meets the development requirements of schools, while still benefiting both the businesses and the students. The integrated research training model can improve the innovative capacity of technical personnel, which is directly linked to product development and production. University research can be put to productive use in the long-term development of enterprises [5].

MECHANISMS TO SUPPORT THE EXCELLENT ENGINEERS PROGRAMME

Financial Support for the Excellent Engineers Programme

Universities should provide financial support for the training of excellent engineers. This is possible by establishing a diversified funding chain and setting aside a budgetary allocation from the state and the government's education budget. Since enterprises are primary beneficiaries of the excellent engineers programme, they also should contribute to it.

Universities in collaboration with enterprises could develop a way to raise and use funds. For students completing an internship within an enterprise, an intern allowance should be awarded by the enterprise itself or, alternatively, jointly by the enterprise and the college or university. Such an allowance would reduce the cost of enterprise education borne by the student. A training model promoting strong co-operation between colleges and enterprises can achieve the aims for personnel training [6]. Figure 3 provides an overview of the factors involved in corporate training as part of the excellent engineers programme.

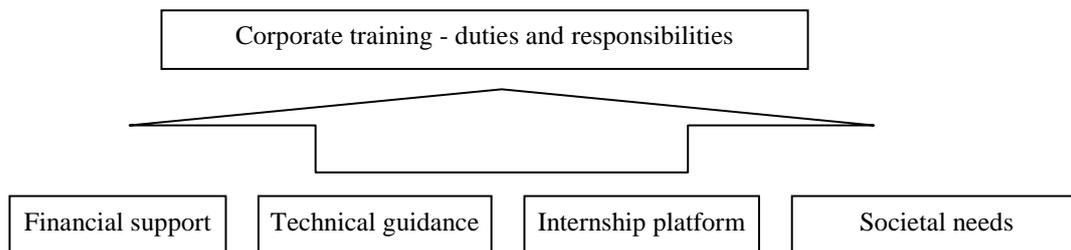


Figure 3: The basic elements of the excellent engineers programme.

Enterprise Obligations

As beneficiaries of enhanced engineering personnel training, enterprises need to assume certain obligations and responsibilities, which include:

Creating mechanisms to support teacher training. High-quality teachers are important to the success of the excellent engineers programme, and are the key to the whole training process. The excellent engineers plan integrates practical and innovative educational activities into a new training model. But there is no template to follow and so it requires teachers and universities to experiment, so as to develop this new model. It requires teachers train engineering personnel to have practical experience, as well as theoretical knowledge [7]; i.e. the teachers should have a solid foundation in both theory and practice.

Improving mechanisms that organise and support university-enterprise training. Ensuring the smooth implementation of the excellent engineers training programme requires mechanisms for university-enterprise co-operation. A main requirement is to strengthen university-enterprise communication, including that of personnel training in the enterprise. In addition, there needs to be overall planning for university-enterprise co-operation, including the organisation of institutional obligations [8]. In order to achieve effective co-operation between universities and enterprises requires the development of new, regulatory agencies to complete the day-to-day management of these added responsibilities. The major organisational support mechanisms can be divided into three categories, as shown and summarised in Figure 4.

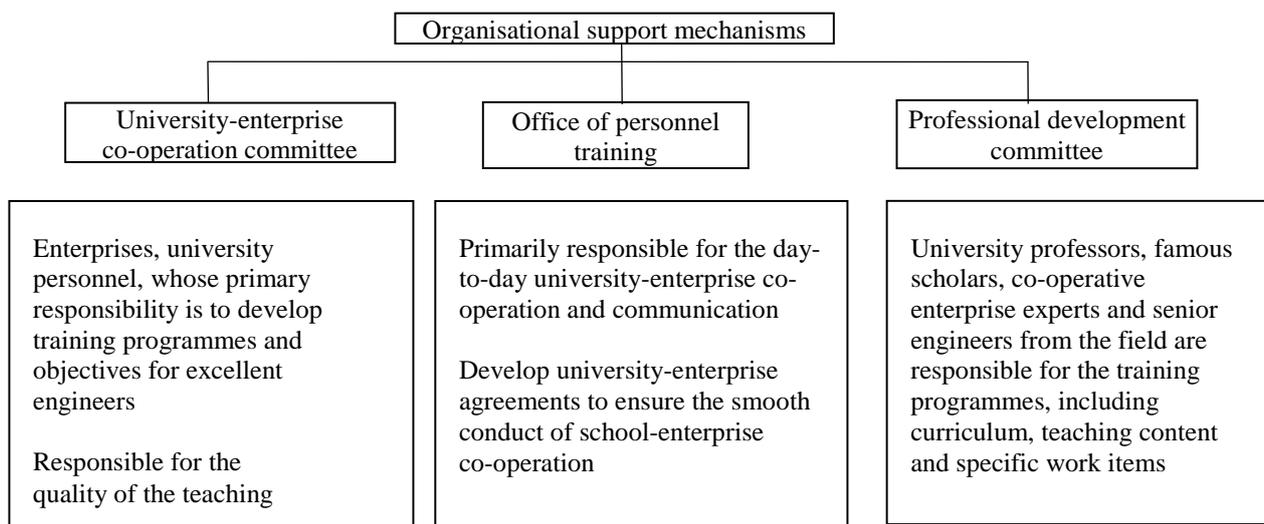


Figure 4: Organisational support mechanisms.

Creating benefit-sharing and risk-sharing mechanisms. In the university-enterprise co-operation model, both sides have their own responsibilities and interests. They will need to share responsibilities to achieve the benefits of the co-operation. The university-enterprise co-operation model helps enhance the excellent engineers culture. Both universities and enterprises have undertaken various training obligations and should be the beneficiaries of the co-operation.

However, at the same time, each member of the co-operative arrangement should remember they are only a part of a tripartite consisting of the universities, enterprises and students [9]. A risk-and-benefit sharing mechanism would give

enterprises the choice of excellent students to whom they provide support which, in turn, creates enthusiasm in the student about the enterprise. This mechanism can enhance the students' employment opportunities. This, then, promotes a virtuous cycle for all three parties. Sharing in the benefits also means sharing the responsibilities and the risks. These risks need to be clear on both sides, university and enterprise alike. Signed agreements defining these responsibilities will ensure the veracity of the arrangements.

CONCLUSIONS

The national engineering education *Excellent Engineer Education and Training Program* supports the long-term missions of both universities and enterprises by a process of university-enterprise co-operation. Joint training between universities and enterprises, through implementation of innovative training mechanisms, can enhance the overall quality of students and provide personnel support for enterprises.

The university, with its own characteristics, should actively explore new models of personnel training that encourage and support national development. Cultivating talent according to current demands has vital significance for the long-term development of an enterprise. The excellent engineers training model can achieve a positive outcome for university, enterprise and student alike.

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