

On the Construction of Industrial College in Local Higher Education Institutions (HEIs) on the Horizon of Emerging Engineering Education (3E)

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ABSTRACT

In the context of the rapid development of the emerging engineering education (3E), the local higher education institutions (HEIs), which involve undergraduate colleges and universities, have launched and established the industrial colleges to realize the transformation and development of application-oriented school-running, and response to the construction of emerging engineering education (3E-construction). In this paper, the concept of industrial college was introduced, the connotation of industrial college was explained and clarified, and the different mode of industrial college was summarized. Based on the discussion on the operating mechanism of industrial college and the consideration of 3E-construction, the basic approaches and steps of building up industrial college were given. All of them, above opinions and pieces of advice, will provide reference for local HEIs to establish and construct their own industrial college.

Keywords: *Industrial college, Local higher education institution, Emerging engineering education, Cooperation mode*

1. INTRODUCTION

With the rapid development of economy and society and the transformation and upgrading of industries, the social demands for higher education have become more and more diversified and specific, and the classification and development of higher education institutions (HEIs) have become increasingly clear. The construction of high-level application-oriented universities has become the basic orientation of local HEIs, which involve the undergraduate colleges and universities. In order to realize the transformation and development of local HEIs into application-oriented ones, key arrangement and great driving force may come from establishment of industrial colleges, and the construction of emerging engineering education (3E-construction) is an important reference and the most effective approach. In the context of the current emphasis on the *new business* and the national initiation of 3E-construction, *Fudan Consensuses*^[1], *Tianda Actions*^[2] and *Beijing Guides*^[3] all propose in different expression and content that the 3E-construction requires the launching and construction of industrial colleges. For example, the *Beijing Guides* require that colleges, universities and other higher education institutions should construct the multi-agent collaborative education mechanism, break through the institutional barriers of social participation in talent training, and promote the combination of institutes and university,

the integration of industry and education, and the cooperation of school and enterprise. By establishing multi-level and multi-sector school-enterprise alliances, local HEIs can obtain the cooperation between enterprises, universities and research institutes in school-running, train students, employ graduates, and achieve the win-win cooperation and development each other. Colleges and universities should promote organizational innovation, explore the construction of a group of industrial colleges jointly built and managed with industrial enterprises, and build a couple of regional shared talent training practice platform integrating enterprises, school and research institutes.

However, many local HEIs still have some difficulties and confusions about how to build up industrial colleges. Some Local HEIs which have launched industrial colleges have a lot of different degree problems, in their industrial colleges, such as the inadequate supporting from government, the administrative management, lack of modern governance, they are difficult to achieve a win-win operating mechanism in the market economy, to solve the conflict and unbalance between the enterprises and universities, and to enhance the level of cooperation between local government and schools. Local HEIs should improve their service ability to enterprises, industries, governments and society by overcoming these problems^[4]. Some local HEIs, which have not yet established industrial colleges, usually mistakenly believe that the government and industrial

enterprises in the region lack the awareness of cooperation with colleges and universities. Industrial colleges cannot be established without large-scale enterprises, mature industrial bases or even government support. From the above basic judgment, local HEIs hold a wait-and-see attitude towards the establishment of industrial colleges, and lack confidence in the establishment of industrial colleges and universities. Therefore, how to establish industrial colleges and universities has become a problem that needs to be solved by some local HEIs.

As an actively exploration of university-enterprise cooperation, industrial colleges have obvious characteristics and outstanding features, although they also possess a series of problems in practices including the security administrative characteristics, unsound governance structure, lack of top-level design and service ability^[5].

2. CONNOTATION OF THE INDUSTRIAL COLLEGE

The industrial college is still a new concept, and it seems that everyone has himself opinion on it. However, what is industrial college, there is no unified understanding in theory and practice. Xu^[6] believes that the industrial college aim at the training of talents by the effective combination of industries and educational institutions, it is formed by universities and enterprises with a considerable scale in terms of philosophy, mechanism, mode and conditions, in which the integration of industry, university and research is deeply cooperative and interactive. Li et al.^[7-8] consider that the industrial college is to directly serve the needs of industries, enterprises, governments and the social and economic development, local HEIs, industries, enterprises, local governments, employers, and other units or organizations can effectively invest their funds, share their faculties, commonly construct the platforms and bases, synergistically train talents, collaboratively manage and use their resources and other elements by cooperation, to cultivate specialized talents and enterprises' staffs, to research science projects, to develop high-tech products, and to protect and inherit the regional cultural inheritances. The industrial college can be built in a university or enterprises through cooperatively school-running, operate in the mechanisms of secondary school or secondary colleges in the process.

Connecting with the development practice of industrial colleges, an industrial college must have the following characteristics. First, the goal is to share resources and achieve win-win. The other is the school-running institution established by the university with the discipline or specialty as the carrier, whose cooperation subject may be the government, industry, industry or enterprise in a certain region. Third, it has a sound independent operating mechanism. The agreement for school-running clearly stipulates the contractual relationship of responsibilities and rights of relevant stakeholders. Fourth, the service industry or enterprise object is clear. The modern industrial colleges

could solve the mismatch problems between the supply side and demand side. Guided by the demands of industry, closed to the needs of regional economic development, an industrial college builds the industrial chain oriented multidisciplinary intersection and cross-border integration of engineering education training mode. According to the requirements of the industrial chain design and planning engineering courses, they get through the last mile between school and industry.

3. LOGIC AND CONNOTATION OF 3E

In the beginning, the discipline consisted only of the classical division of philosophy. Then, scientific society established in the 17th century marked a breakthrough in the history of knowledge division. Physics, chemistry and biology were separated from natural philosophy and became independent natural science, while social science was separated from moral philosophy. In the 19th century, the modern discipline was basically formed, and the humanities became the general term for disciplines excluded from the natural and social sciences. The division of disciplines guaranteed the systematic of knowledge fields, also split the scientific integrity. A scholar ever considered that the classification of knowledge was caused by the limitations of human understanding. Facing the increasing complexity of economic and social development, the disempowering disciplines have become increasingly weak and powerless, interdisciplinary research has obtained steady development in the United States after the World War II^[9].

From the historical logic of discipline, the reconstruction of disciplines is of a normal state. The development of science and technology, the accumulation of knowledge, the change of paradigm, and the expansion of cognition all contributed to it, but social demand was the main driving force for the discipline evolution. So far, the disciplines interfere with each other, interact and intercross. Interdisciplinary research emerges continuously. The construction of interdisciplinary subjects by fusing and integrating two or more discipline branches maybe importance not only in higher education, but also will to the country level, for example, the United States government brings up STEM (Science, Technology, Engineering and Mathematics) talents in 2006, and regard it as the key global competitiveness. It has realized the connection between Science, Technology, Engineering and Mathematics.

The proposal of emerging engineering education (3E) is a reflection based on the comprehensive cognition of the times situation, the social demands, the current engineering education and the development and evolution laws of engineering disciplines. Firstly, the 3E responses to the requirements of economic and social development. In the stage of social and economic transformation, the realization of national strategy and the rapid development of new economy urgently need the support of new engineering talents, which puts forward new demands for the transformation of engineering knowledge and the reform of

engineering education. Furthermore, it grasps the development laws of engineering disciplines. The reconstruction of engineering disciplines will follow the evolution laws of engineering disciplines, actively carries out interdisciplinary exploration among branches of engineering, science and other disciplines, and promotes the reconstruction of engineering knowledge, knowledge innovation, production mode and the reform of knowledge organization system. The 3E-construction is not the local reform in field of engineering education, but is a new paradigm^[10] to promote the reform in professional structure of disciplines, the knowledge system, the forms, the teaching resources and education standards of engineering education, such as a full range of comprehensive reform, and ultimately achieve engineering education goal with the *new ideas, new structures, new model, new quality, and new system*^[11]. It will realize the harmonious development of engineering education and economic society. Its goal is also toward the future. It is not only a modernistic concept, but also a product of the development of social and economic transition. It is aiming at the contradiction between the supply of current engineering education and the demand of social and economic development, and the conscious reflection in the development and evolution laws of engineering discipline.

4. OPERATION MODES OF INDUSTRIAL COLLEGES

Practice shows that the industrial college can have different operating modes^[12]. According to the analysis of cooperation factors, the industrial colleges can be divided into three realization forms including the integration type, the interlocking type and the multi-agent integration type. From the view of the cooperation objects, it can be divided into the school-enterprise order type, the school-enterprise comprehensive type, the school-ground cooperation type, the school-bank cooperation type, the school-association type and multi-agent type. The multi-agent type mainly refers to the government's direct participation in the establishment of the industrial college. Different industrial college can obtain different goal, and its functions will be different. Different levels of colleges and universities have different needs for setting up the industrial colleges, which will inevitably lead to their different functions. The function of industrial college in high-level comprehensive universities is certainly different from that in local HEIs or higher vocational colleges. From the functional investigation, the industrial colleges can be divided into three types including the resource-sharing type, the co-development type and the industry-leading type. Resource-sharing type is a low-level cooperation model that focuses on resource sharing, such as sharing of talents and platforms. At present, the industrial college established by many universities is such a model. The co-development type means that based on resource sharing, it can also promote the common development of all parties and enhance their

strength and competitiveness. The industry-leading type refers to the deep strategic cooperation among all parties from the perspective of leading the industrial development, and the cooperation at the high-level industry standards and key technologies. Resource-sharing, co-development and industry-leading maybe the different stages of the development of the industrial college from the lower level to the higher level, reflecting the different development orientation of the industrial college when it was established.

5. APPROACHES OF INDUSTRIAL COLLEGE IN LOCAL HEIS UNDER THE 3E-CONSTRUCTION

Transformation and development have become the consensus of the reform in local HEIs. However, how to transform to application-oriented requires local HEIs to put it into practice from concept to action. To transform to application-oriented, ordinary HEIs should launch a series of application-oriented disciplines and faculties, reconstruct the curriculum system and teaching content, and reform the mode of training talents^[13]. For the transformation and development of local HEIs, the industrial college is a kind of educational practice to be explored and a new organizational form to be explored. The development prospect and organizational vitality of industrial college make local HEIs have a better future, which needs continuous exploration, practice, summary and innovation.

5.1. Transformation of Local HEIs Needs Organizational Innovation in the 3E-Construction

As a social organization, local HEIs must meet the corresponding social requirements, perform corresponding social functions and play an important social role. The *Fudan Consensuses* puts forward that the 3E-construction should be based on the background of *new business* and *new industry*. It is necessary to establish the innovative, comprehensive and whole-cycle new concept of engineering education, construct a new structure of disciplines and specialties combining the emerging engineering disciplines and the traditional engineering ones, optimize the layout of disciplines and specialties, promote the intersection of the existing engineering disciplines and other disciplines, and actively develop new engineering specialties. Particularly, local HEIs should play a supporting role in regional economic development and industrial transformation and upgrading. The *Tianda Actions* puts forward that the 3E-construction in colleges and universities should accept the laws of interaction between world higher education and previous industrial revolutions, face the new trends and requirements of technological and industrial development in the future, explore the establishment of a new engineering paradigm based on the experience of existing technological paradigm, scientific paradigm and

engineering paradigm, strengthen the research on the demands of engineering sci-tech talents for industrial development and construct the new structure of engineering specialties, optimize the organizational model of collaborative education in the colleges and universities, break through the bottleneck of system and mechanism by establishing some new interdisciplinary institutions and industrialization colleges, and provide an organizational guarantee for the cross-disciplinary and cross-professional of the new engineering talents. With the development of 3E theories, some universities have taken practical actions to implement the approaches of 3E-construction. Some universities have persisted the ideas of student-centered, output oriented and a sustained improvement, cultivated the high-quality talents for the society, paid attention to the students' ability, combined the talents training with professional advantages, the major national development strategy, and the teaching and education innovation with the curriculum reform^[14]. These projects of 3E-construction have already touched on the organizational goals and organizational functions of HEIs, which will certainly call for the organizational innovation in the development of 3E.

5.2. Industrial College Is an Inevitable Choice for the Transformation of Local HEIs

To meet the demands of the development of *new business* and *innovation driver*, local HEIs should change the traditional hierarchical management form of university organization, establish the application logic to match the diverse internal organization structure which can realize the sharing and open of resources, effort to achieve with the government, industries, enterprises and other internal and external factors, realize the application-oriented transformation development. To local HEIs, the most important content of the integration of industry and education is to train application-oriented talents according to the needs of the industry and gradually improve the level of applied scientific research. Application-oriented talents do not refer to certain majors, nor do they mean to lower the academic level and training quality, nor do they mean to reduce HEIs to higher vocational colleges^[15]. As a kind of school-running strategy and mode, the integration of industry and education and school-enterprise cooperation not only meet the organizational development requirements of them, but also meet the development needs of industries and enterprises, which can be promoted from the aspects of organization, specialty, teachers and courses. However, the integration of industry and education and school-enterprise cooperation must be realized by relying on a certain organizational form, so that society, universities and industries can participate in it and give full play to their roles. Therefore, industrial college, as a platform for collaborative development, has become an effective new organizational form.

5.3. Basic Steps of Setting up an Industrial College in Local HEIs

Based on the above analysis, the basic steps of constructing industrial college in local HEIs can be given. Based on the above analysis, the basic steps of constructing industrial college in local HEIs can be given. The first step is to analyze the industries, enterprises and the needs of the development of regional economy and society. The resource endowment, the culture of local society and the characteristics of regional economy differ in thousands of ways in different area, which is consist of different industrial base and development needs. Therefore, local HEIs should carefully study the demands of regional economic and social status and planning in area, and take the new business form as the basic premise of industrial college construction. The second step is to reorganize the related disciplines and specialties and build the module curriculum system, to adjust and integrate the disciplines, specialties and curriculum. The third step is to construct the governance structure, the management system and the guarantee mechanism of industrial college. The fourth step is the trial running of the industrial college and continue to improve and optimize.

As a new organizational form, industrial college provides an organizational guarantee for the transformation of local HEIs and can break the institutional barrier of school-enterprise cooperation, industry and education integration. Local HEIs can play the advantages of industrial college, through the platform construction to promote integration, cooperation between colleges and education on the talent training and scientific research, commonly research the problems in the industrial development, get more education resources. Of course, the construction of industrial college should adopt the strategy of gradual promotion and continuous progress, ensure the sustainable development of the integration of industry and education.

6. CONCLUSION

With the deepening of China's engineering education reform and the start of Emerging Engineering Education, the HEIs have launched and established the industrial colleges to response to the construction of emerging engineering education. They must meet the corresponding social requirements, perform corresponding social functions and play an important social role, change the traditional hierarchical management form of university organization to meet the demands of the development of new business and innovation driver, and set up more and more industrial colleges step-by-step to adopt the strategy of gradual promotion and continuous progress, ensure the sustainable development of the integration of industry and education.

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