Discussion on the Role of Information Disciplines in the Construction of New Engineering

Chun YU\textsuperscript{1,a}, Yong LI\textsuperscript{2,\ast}, Zhen-Jun JIN\textsuperscript{2,b} and Ning WEI\textsuperscript{2,c}

\textsuperscript{1}Basic Department, Non-commissioned Officer School of AAAF, Changchun, Jilin, P.R. China
\textsuperscript{2}College of Computer Sci. and Eng, CCUT, Changchun, Jilin, P.R. China
\textsuperscript{a}478298878@qq.com, \textsuperscript{\ast}liyong@ccut.edu.cn, \textsuperscript{b}jinzhenjun@ccut.edu.cn, \textsuperscript{c}weining@ccut.edu.cn

Keywords: New engineering; Information disciplines; Methods of talent training.

Abstract. New engineering has some new features such as new educational concepts, crossing disciplines and industry-university cooperation and education, and is closely related to the new generation of information technology. This paper discusses the construction of new engineering and the new educational concepts, new features, new models and new methods of talent training, explores the need of information talent training, the crossing innovation of specialties, the model reform of talent training and the construction of education system, and puts forward some viewpoints and suggestions on the role of information disciplines in the construction of new engineering.

Introduction

In recent years, a new generation of information technology represented by cloud computing, artificial intelligence, big data, Internet of Things and mobile Internet has promoted the great changes in human society as well as a new round of rapid development in new economy, new industries and new business formats. “Internet +” drives the networking and generalization of social development and people’s lifestyles; big data triggers a digital revolution in science and technology and social development; “Industry 4.0” makes enterprises more networked and intelligent; mobile payment becomes a new way of payment; a new generation of artificial intelligence leads the development of social and economic informatization further into deeper advanced intelligence stage. Countries all over the world have also seized the opportunities brought by the current generation of information technology to social and economic development, and have proposed and implemented driving development strategies of information technology innovation, to improve productivity, competitiveness and social development driving force. This new generation of information technology has also changed higher engineering education, and prompted the emergence of new engineering.

Since 2017, the new engineering construction initiated by the Ministry of Education has aroused strong and positive responses in various universities in China. The seminars of “Fudan Consensus”, “Tianjin University Action” and “Beijing Guide” on the construction of new engineering have been carried out successively\cite{1,2}, various colleges and universities have also proposed their own implementation plans on new engineering construction, and some colleges and universities have quickly put into practice. In December 2017, “Several Opinions on Deepening the Integration of Industry and University” issued by the General Office of the State Council proposed: “Adapt to a new round of scientific and technological revolution, industrial transformation and new economic development, promote the integration of disciplines and specialties, and accelerate the construction of new engineering”\cite{3}.

In January 2018, the Department of Higher Education of the Ministry of Education selected 612 new engineering research and practice projects, divided into two major categories, and these projects were officially announced in March 2018\cite{4}. The construction of new engineering in China has been fully launched. In the past more than a year, China’s educational, academic and industrial circles have had many discussions and controversies about the connotation and construction ways...
of “new engineering”, but there is a consensus that constructing new engineering is conducive to the
development of China’s new technology, new economy and new industries and the improvement of
engineering education[4]. By analyzing the new engineering construction in depth, it is not difficult
to find that new engineering has some new features such as new educational concepts, crossing
disciplines and industry-university cooperation and education, and is closely related to the new
generation of information technology as well as the computer and software engineering disciplines.
It can be said that the new generation of information technology has a direct and important impact
on the construction of new engineering.

Demand for Talents with Sustainable Competitiveness of New Engineering and Training
Objectives

When discussing new engineering construction and personnel training, it is necessary to pay
attention to the talent demand and talent training goals for new technology, new economy and new
industry development. The orientation of talent training objective is the basic principle of
engineering education and new engineering construction. The rapid development of the new
economy led by the new generation of information technology urgently needs the support of new
engineering talents and requires the cultivation of innovative talents for the current changes and
future development.

In recent two years, the “Twenty People Forum” in China’s computer education community
heatedly discusses the topic of “Computer Education and Sustainable Competitiveness”. They
believe that in the information society that is rapidly changing now and in the future, “sustainable
competitiveness” is an ability adapting to future social changes and competition, and is an
innovative ability based on beliefs and technologies and a sense of responsibility towards the
society. Talents with sustainable competitiveness need to have a comprehensive quality and
adaptability that can enable students to adapt quickly and calmly in the future drastic social changes.
Literature [5] puts forward: “In order to meet the students’ needs of seeking knowledge, enhancing
ability and becoming talents, college education should not only undertake the task of transmitting
wisdom, imparting knowledge and solving doubts, but also need to build platforms, create
opportunities and provide lifelong education for students, to cultivate innovative talents with
sustainable competitiveness. To this end, it is necessary to cultivate students’ sense of responsibility
and mission for future global affairs and national development; to recognize the changes in the
process of social informatization, and the promoting role of science and engineering technology in
changes of social informatization and the influence on globalization; to recognize the knowledge,
quality and ability that should be possessed in these changes.”

This shows the purpose and mission of talent cultivation in colleges and universities in the new
era and new environment. This is also an important task for new engineering education. In the early
21st century when China began to build the national demonstration software colleges, the Ministry
of Education clarified that the software colleges “should take cultivating a large number of various
types of composite software talents as an important task while strengthening the training of software
professionals”[6]. Drawing lessons from the demand for software talents in the software industry at
home and abroad, many national demonstration software colleges require graduates to “be able to
systematically master and apply computer science and software engineering knowledge, have the
technical practice and business skills required by software companies, have the ability of rapid
learning and the ability to master new advanced technologies, be able to quickly engage in the work
and become the company’s productivity, have strong work enthusiasm and good team work spirit,
have good international communication and cooperation ability and make creative contributions to
the company”. In 2015, the undergraduate graduation requirements set out in the “Engineering
Education Accreditation Standards (2015 Edition)” formulated by the Professional Certification
Association of Chinese Engineering Education include “being able to apply the basic principles of
mathematics, natural sciences and engineering sciences, and identify, express and analyze complex
engineering problems through literature research” “being able to design solutions for complex
engineering problems” “being able to develop, select and use appropriate technologies, resources,
modern engineering tools and information technology tools for complex engineering problems” and “being qualified with autonomous learning and lifelong learning awareness and having the ability of learning continuously and adapting to development” [7].

Therefore, the objectives of talent training of new engineering are to cultivate innovative talents with sustainable competitiveness, and to train students with the good quality of compound innovative talents.

Reform of “Computer +” Profession Innovation and Talent Training Model of New Engineering

“Computer +” Profession Innovation in the Context of New Engineering

The construction of new engineering will promote the development of a number of new professions, most of which show the intersection and integration of disciplines, reflecting the need for new technology and new industry development. Some of these new professions are based on the extension and derivation of existing computer-based professions, some are organically integrated by multiple professions, and some are formed through the integration with the application industries. Literature [5] lists some current “computer +” profession examples, showing as follows.

1. The new engineering majors derived from “computer” include software engineering, network engineering, Internet of Things engineering, information technology and system, data science and big data system.

2. The new engineering majors formed by the cross-integration of “computer-based” disciplines are information security (cyberspace security), service science and engineering, robotics engineering, digital media technology and intelligent science and technology.

3. Majors of “computer +” series (professional direction) formed by the integration of “computer” and application include Internet finance, digital design and intelligent manufacturing and digital medical formed by combining with the application industry; electronic commerce, multimedia and digital games, biological information technology and digital geographic information systems formed by combining with the application fields. In order to adapt to the rapid changes of new technologies, new industries and new economy, the knowledge systems and training programs of the above-mentioned new engineering majors need to be adjusted and innovated, to support the increase of personnel training factors such as knowledge, ability and quality and the achievement of training objectives.

The knowledge system of “computer +” new majors can be constructed by the knowledge systems of computer profession, general education and crossed discipline, including basic theory of mathematics and computer science, basics of general education, core technology of computer system and software engineering, professional direction and application knowledge of computer and professional basic knowledge and core technical knowledge of crossed discipline. The training program should also include innovation and entrepreneurship education practice, enterprise internship training, social practice, quality education and so on.

In the process of building a new profession in new engineering or upgrading traditional professions, several key problems of the education system should be solved. It is necessary to develop new engineering education with new ideas and new models, to cultivate new talents with sustainable competitiveness; to build new professions of new engineering and knowledge systems through multidisciplinary integration; to adopt new teaching modes such as theory and practice combination, cooperation between industry and university in education, innovation and entrepreneurship education and international joint training to carry out talent training; to introduce new interactive and hybrid teaching methods like student-centered MOOC and flipping classroom to improve teaching effectiveness; to pay more attention to the construction of high-level teachers, establish an effective basic teaching organization and management mechanism, improve the evaluation and guarantee mechanism of teaching quality and establish a professional certification system for engineering education with Chinese characteristics and international substantive equivalence. Meanwhile, the construction of new engineering also requires a good educational
environment. And only through these can the construction of the new engineering education system be completed perfectly.

**Reform of Educational Modes in New Engineering**

In the process of new engineering construction and personnel training, the reform and innovation of educational models is the most crucial. Literature [2] proposes that the development of a new economy requires us to establish a more diversified and individualized engineering education training model, to comprehensively promote the successful experience of the “Education Training Program of Excellent Engineers”, Demonstration Software College and Microelectronics College and the National Education System Reform Pilot Academy, to explore and implement the “new mode” of engineering education personnel training, to integrate innovation and entrepreneurship education into the whole process of engineering education, and to strive to cultivate students’ innovative spirit, entrepreneurial awareness and creativity. In the teaching practice of computer-related new engineering majors, the following teaching modes can be taken into account.

(1) Education model for system capacity development [8]. This is a research-based, inquiry-based and comprehensive education system and teaching model of computer profession, requiring to comprehensively improve students’ computer system capabilities in system curriculum setting, curriculum design and practice link. The system is a combination of several interconnected, interacting and interdependent parts, with a certain structure and function, and is an organic whole under certain circumstances. System capability is to design, implement, optimize and operate a system based on determined system functions, to achieve engineering goals. In terms of capacity building, computer systems can be divided into three levels, computer basic system, computer environmental platform system and computer application system. The basic content of system capability training is to master the interface of each software/hardware part of the system, the operation coordination and the logical association of various components within the system, to understand the external characteristics presented by the system and human-computer interaction mode, and to emphasize the efficient implementation of system functions from the perspective of system structure. System capacity training has outstanding engineering education characteristics and is the basic ability to solve complex engineering problems. With system capabilities, computer application and innovation capabilities will also be strengthened and enhanced.

(2) Educational mode of industry-university cooperation and education [9, 10]. Since 2014, the Ministry of Education has implemented the “Industry-University Cooperative and Collaborative Education Project”, aiming to build a school-enterprise docking platform and to promote the reform of talent training in colleges and universities with the latest needs of industry and technology development. By 2017, hundreds of companies have jointly launched tens of thousands of collaborative education projects with colleges and universities, involving teaching content and curriculum system reform, new engineering construction topics, innovation and entrepreneurship education reform, college students’ internship training, teacher training, practical conditions construction, off-campus practice bases construction and innovation and entrepreneurship joint fund. The investment and use costs of software and hardware of enterprises have reached more than 3 billion yuan, and most of the enterprises are IT enterprises [11]. In fact, in the early days, many colleges and universities have cooperated with enterprises to implement an education model for IT industry application and practice, such as Training Program of Excellent Engineers, Training Program of Engineering Leaders, the CDIO Program and Project Learning Program, obtaining good practical effect and successful experience.

(3) Innovative educational mode of multidisciplinary crossing and integration. In recent years, with the continuous deepening of interdisciplinary integration, many colleges and universities have established various interdisciplinary colleges and research institutes, developed double-degree training programs, and conducted innovative educational mode of multidisciplinary crossing and integration, such as integration between information technology and science and engineering majors, double degree or major and minor majors of engineering and management integration and innovation education of Internet + multidisciplinary crossing and integration.
(4) Informational education mode based on MOOC/SPOC/ flipping classroom [11, 12]. In recent years, with the arrival of the large-scale online open course MOOC, the deep integration of information technology and higher education has changed the traditional teaching methods and promoted the improvement of educational quality. In China, the “National College Computer Education MOOC Alliance (CMOOC Alliance)” established in 2014 has effectively carried out the construction and promotion of large-scale online open courses, with 500 members of the colleges and universities distributed in all provinces and cities in the country. The CMOOC Alliance has developed a number of high-quality online open educational courses, implemented student-centered “Internet + Collaborative Education” concept, proposed and implemented the collaborative teaching innovation mode of cross-regional cross-school online open course “1+M+N” with Chinese characteristics, realized the reform of MOOC/SPOC-based flipping classroom and online and offline hybrid teaching method, promoted the large-scale application of MOOC, supported the teaching reform and educational level improvement of colleges and universities in all provinces and cities nationwide, and promoted equal access to education and the connotative development of the computer education quality in Chinese colleges and universities. The innovation of the educational mode of CMOOC Alliance not only plays a leading role in the development of online open curriculum education in Chinese colleges and universities, but also provides strong support for new engineering education.

(5) Joint talent training mode of internationalized “X+Y”. With the globalization of higher education, China needs to cultivate innovative talents with international competitiveness. At present, more and more colleges and universities have carried out cooperation activities with international elite schools, in which the joint talent training mode of internationalized “X+Y” is the most sophisticated, such as “2+2”, “3+1”, “4+0” or semester exchange learning mode; there are also colleges and universities sending students to foreign well-known enterprises or internationalized companies for internship training, which allows students to experience industrial practice and industrial environment, improves their competitiveness of internationalization and industrialization, and help them adapt to the professional role in the industrialized environment as soon as possible. The cooperation and open education with famous international schools can cultivate internationalized new engineering talents.

Industry, University and Research Alliance Practice of Information Technology New Engineering

In order to promote and serve the new engineering construction and the “Excellent Engineer Education and Training Program Version 2.0”, cultivate diverse and innovative excellent engineering and technical talents, and help the surpassing development of information industry and the integration, transformation and upgrading of traditional industries, approved by the Ministry of Education and the Ministry of Industry and Information Technology, the “Industry, University and Research Alliance of Information Technology New Engineering” [13] was established in November 2017. The alliance is a community of voluntary organizations including universities, industry enterprises, research institutes and industry associations, having 563 colleges and universities and more than 100 enterprises. On January 14, 2018. “The First Annual Meeting of the Industry, University and Research Alliance of Information Technology New Engineering and the Industry-University Cooperation Forum in the Field of Information Technology” was held in Beijing.

The mission of the Industry, University and Research Alliance of Information Technology New Engineering is to explore technological innovation models for industrial needs; to develop the educational ecological environment of the in-depth integration of industry, university and research; to create a training paradigm for the outstanding talents of the large engineering concept; to form an evaluation system for the innovative talents in the information industry; to lead the overlapping development of the information technology professions in China. Therefore, the Alliance has established 30 working committees, including Cloud Computing and Big Data, Data Science and Big Data, Internet of Things Engineering, Service Science and Engineering, Artificial Intelligence

The Role of Information Disciplines in the Construction of New Engineering

As new engineering comes into being under the driving of new technologies, new economy and new business formats, and new forms of social and economic development are closely related to information technology, information disciplines will play a very important role in the process of new engineering construction and talent cultivation.

The Influence of Information Disciplines on the New Characteristics of New Engineering

New engineering is characterized by new features such as new technology, new knowledge, discipline crossing, emerging industries and innovation, while the education of computer science disciplines naturally have important impact on these new features.

(1) New technology: The new generation of computer and information technology is the mainstream of current technological innovation, and also the focus of the crossing and integration of cross-disciplinary new technology, providing emerging core technology connotation for new engineering.

(2) New business format: The “Internet +” industry is currently the most active new business format in the world, bringing many industrial development models and technological innovations and revolutions, and is the source and driving force of new engineering innovation.

(3) New crossing: The “Computer +” major is the commonest cross-integration form of professional disciplines, laying a solid foundation for new engineering innovations and becoming the largest discipline community of emerging disciplines in new engineering.

The Integrating Role of Information Disciplines in the Professional Knowledge System of New Engineering

(1) New knowledge: New technologies, such as cloud computing, artificial intelligence, big data, Internet of Things, mobile Internet and intelligent services, bring new knowledge systems and technical content to the professional knowledge system of new engineering, and innovative courses based on these new technologies are emerging continuously.

(2) New theories: Fields like computer science, big data and data science and new generation of artificial intelligence continue to introduce new theories and new knowledge to support the continuous development of new economy and new business format and provide a new theoretical basis for new engineering education.

(3) New integration: Various emerging engineering majors are deeply integrated with information disciplines and are also closely related to information technology application industry. This new integration of cross-disciplinary knowledge, technology and application would also promote the reform and innovation of the connotation and methods of new engineering education.

The Leading Role of Information Majors in the Reform of New Engineering Talent Training Mode

(1) New mode: The National Demonstration Software College first explores the new mode of industrial talent training, providing new engineering construction with teaching models such as
school-enterprise cooperation and education, innovation and entrepreneurship and engineering practice, disciplinary field crossing and engineering and management integration, international education and joint training. And the later excellent engineer training program and industry-university education program are developed on the basis of this model.

(2) New methods: Pj BL based on project learning method, mixed teaching method based on MOOC/SPOC/ flipping classroom and multi-school collaborative teaching method based on online open course are all started from computer major, providing a methodology for professional teaching in new engineering.

(3) Good experience: The successful experience of the school-running and talent training mode reform of software colleges is worthy of learning for new engineering education. It can be seen that most of the universities with better achievements in new engineering construction are universities with successful experience in building demonstration software colleges.

The Demonstration Role of Information Disciplines in Industry-university Cooperation and Education and Excellent Engineers Program

(1) Front runner: Many computer colleges and software colleges are the front runners in new technology and new economic education, industry-university cooperation and education, cross-integration of disciplines as well as the construction of new engineering. At present, many new engineering majors and even new colleges are established by computer colleges and software colleges, such as the Internet of Things College, the Network Engineering College, the Big Data College, the Artificial Intelligence College and the Information Security College. And all these colleges are actively implementing industry-university cooperation and education program.

(2) Being good at coordination: The Computer College and Software College have implemented excellence programs in depth, and are best at coordinating various social resources to support the running of new disciplines. Due to the characteristics of information technology and software industry, the cooperation between universities and IT enterprises often has a high starting point, rapid implementation, deep cooperation and great achievements. The software engineer training model in Software College and the collaboration approach with IT enterprise resource provide pioneering experience for the excellent engineers cultivation program.

(3) Laying solid foundation: IT enterprises are the enterprise group giving the largest investment and support for school-enterprise cooperation. The Information Technology College, Computer College and Software College in many universities have long maintained close cooperative relationship with IT enterprises and established a large number of joint laboratories, student union clubs, student internship bases and maker space for students’ innovation and entrepreneurship, laying a solid foundation for the development of new engineering professional education.

The Demonstration Role of Information Professional Certification in the Quality Evaluation and Guarantee of New Engineering

(1) Forerunner: Information majors, especially computer and software engineering, are one type of majors conducting engineering education professional certification the earliest in China, and also the first class to run a school in accordance with the thinking of engineering education certification, trying first in the evaluation and guarantee of new engineering quality.

(2) High standards: professional quality certification and evaluation of computer and software engineering have always adhered to high standards; many computer majors have carried out engineering education professional certification in advance in colleges and universities; most national demonstration software colleges have been professionally certificated and evaluated by software industry experts.

(3) Internationalization: The Computer College and Demonstration Software College of key universities in China mostly maintain a high level of international education and have close communication and cooperation with top foreign universities. These colleges adhere to the international equivalent quality standards for professional teaching, are easy to achieve international standards, and have been recognized internationally. The students they have trained are welcomed and praised by IT companies at home and abroad.
The Reference Role of School-running Practice Experience of National Demonstration Software Colleges in the Construction of New Engineering Education Ecosystem

(1) Demonstrator: The National Demonstration Software College has been the focus of governments at all levels and IT companies from the very beginning, and also the pioneer and demonstrator of industry-university cooperation and education. Most of the software colleges attach great importance to systematically establishing an educational ecosystem combining government, industry, university and research, to form a scientific, reasonable and effective educational value chain and ecological system of cultivating talents for the industry.

(2) Being good at practice: The national demonstration software colleges all have more than 15 years of practical experience in integration education of government, industry, university and research, especially in the aspects of students’ internship training, practical ability training and innovation and entrepreneurship education, so that it can be the reference for the colleges and universities to carry out new engineering construction.

(3) New ecology: The development of educational ecosystem combining government, industry, university, research and application in Computer College and Software College is gradually becoming perfect currently, and a relatively complete “computer +” new engineering education ecosystem can be further built on this basis, playing a leading role for other professions.

Summary

At present, the rapid changes in technology, industry and social forms at home and abroad bring great opportunities and challenges to the development of new engineering higher education. Informatization, networking and intelligence add the latest technological connotation to the new engineering construction, while the computer and software engineering disciplines play a leading role in the construction of new engineering. We should quickly seize the opportunity of new engineering construction, for new technologies, new industries and new business formats, reform educational models, innovate teaching methods, build an educational system and ecological environment of new engineering, and train high-quality new engineering talents with sustainable competitiveness for IT industry.

References


