

Innovative Talents Cultivating Mechanism Based on the Cooperation between the Innovative Laboratory and the Science and Technology Innovative Enterprise

Xiufen Ye^a, Tian Wang^a, Weixing Feng^a, Changhao Hong^b, Wenzhi Liu^c and Haibo Li^c.
College of Automation, Harbin Engineering University, Harbin, Heilongjiang, 150001, China^a, Youth League Committee, Harbin Engineering University^b, College of Information and Communication Engineering, Harbin Engineering University^c
Corresponding Author Email: yexiufen@hotmail.com

BACKGROUND

At this stage, many universities have regarded both the construction of high-level Research-oriented universities and cultivation of science and technology innovation talents as the key point of their self-development. But there are no mature feasible schemes about how to joint enterprise for cultivating talents in China at present. This leads to the situation that universities are facing the technical bottleneck problems of the rough and unqualified ability to implement the core technology, which makes them unable to effectively cultivate the innovative and entrepreneurial talents. Innovative enterprises are lack of both the core method and technology. This paper proposes a model to be implemented at Harbin Engineering University to solve this problem.

PURPOSE

Combined with the demand of innovative talents and the construction of university laboratory in current society, we will design a university-enterprise jointly training scheme and establish innovative entrepreneurial bases, and by refining experiences which are applied to cultivate current elite, we will provide a platform for the cultivation of innovative entrepreneurial talents. Meanwhile, the laboratory can provide better service for teaching, research and production to make a greater social benefit.

METHOD

In this paper, we propose an innovative multi-level talent cooperation cultivating mechanism between the innovative laboratory and the science and technology innovative enterprise, which provides a practical platform and the new laboratory operation mode for the cultivation of the students' comprehensive abilities. In terms of this cooperation cultivating mechanism, the laboratory construction, allocation of resources and cultivation of innovative talent are studied and the cultivate mode of the innovative entrepreneurial talents is realized via the methods of amalgamation of industry, education, research, the mode of enterprise technical training, students' participation in various enterprise competition and laboratory development.

RESULTS

On the basis of "mutual benefit", an innovative entrepreneurial laboratory has been built jointly depending on the rich educational resources and intelligent advantages of the university, the good working condition and the advantages of capital, equipment and technology in a science and technology innovative enterprise. Meanwhile, an innovative multi-level talent cultivating mechanism has been built through the cooperation between the innovative laboratory and science and technology innovative enterprise.

CONCLUSIONS

Through the innovative multi-level talent cultivating mechanism of cooperation between the innovative laboratory and science and technology innovative enterprise, we integrate the resources and various advantages. The resource sharing, complementary advantages, mutual benefit, double win and joint development have been realised. Meanwhile, we get the progressive echeloned students training mode and guide the students to build interest, enter the laboratory to practice and be engaged in the academic research by combining with the actual demand.

KEYWORDS

Cooperation; Cultivation; Innovative talent.

Introduction

With the continuing development of computer technology, machine intelligence gains broader development space, and its related curriculums are becoming increasingly important in higher education. Experimental teaching, which is the essential part of curriculums, has already attracted more and more people's attention (Wang, Y., Jing, L., and Xue, Y,2010; Kanakakis, Valavanis, and N.C.Tsourvel-oudis, 2004). It plays a significant role in improving the quality of teaching and developing students' practical ability as well as creative thinking skills. There has been a long time that higher education researchers have been exploring effective ways for experimental teaching. Therefore, basic experimental platforms on multi-discipline (such as Circuit Analysis Laboratory, Analogical Electronic Circuit Laboratory, Digital Circuit Laboratory, Signals and Systems Laboratory, etc.) have already been established with the help of existing electronic technology, and these multidisciplinary platforms provide students with corresponding experimental curriculum. Nevertheless, these measures fail to achieve the anticipated results (Harman, 2001; Zhou and Wang, 2014; Çetin and Tayauova, 2014). Methods and tools seem to be inappropriate especially along with the rapid development of electronic technology. Higher education researchers and staffs have reached a consensus on establishing a new set of talents cultivation system and methods.

In this paper, an innovative multi-level talent cooperation cultivating mechanism between Harbin Engineering University -Artificial Intelligence laboratory and the science and technology innovative enterprise is discussed, the multi-level cooperation framework of multiple enterprises and schools is proposed. By the means of integration of small scale multi-level cooperation between colleges and enterprises, and a multi-level cooperation way, we built a certain scale of the school-enterprise cooperation platform. On basis of this, we discuss the implementation scheme of establishing a campus innovation laboratory according to the multi-level school-enterprise cooperation framework. The construction of innovation laboratory under the framework of multi-level school-enterprise cooperation has obvious advantages of low implementation difficulty, quick effect of students' innovation ability and good training effect.

Existing problems of college-enterprise cooperation

Some famous universities like Stanford are following to the industry–academic collaboration models. Stanford and Silicon Valley cooperation can be traced back to 1951, when Stanford founded the Stanford Research Park, which is the early form of Silicon Valley formation, but also is the first high-tech industrial park in the history of the United States. In the past few decades, such Stanford-born enterprises have become the mainstay of Silicon Valley (Gillmor, C. S. 2012). But these models do not work in the Chinese because of different national conditions. China's start in this field very late and has many problems of college-enterprise cooperation.

Scientific and technological innovation-oriented entrepreneurial enterprise is a practical path to the solutions like driving GDP growth, expanding domestic demand and tackling employment issues. Admittedly, innovative entrepreneurial enterprises possess relatively more complete and advanced laboratory equipment and clear-defined demands as well, but they also face the problems of poor performance of the core technology. For the technical bottlenecks of rough core technology, there is a strong need to take the advantage of cooperation between Innovative Entrepreneurial Enterprise and University Innovative Laboratory (Armand, 2006). The complementariness between universities and enterprises is beneficial to improving the teaching quality quickly, cultivating students' practical ability and the ability of creative thinking.

Though the college-enterprise cooperation has lot of advantages, it inevitably exists some problems. Due to the separation of experiments and subjects in some of laboratories,

teachers and students are less likely to more often get involved in laboratory equipment, which leads to the situation that experimental resources have been wasted for a long time and the laboratory equipments are not sufficiently used. Also, some laboratories are almost fully occupied by the enterprises. Because of that, schools barely have the chance to hold a dominant position in laboratory running, which makes the laboratory only available for a tiny period of time. In this case, it is unfair for universities to utilize laboratory resource when teachers or students cannot help but to book the laboratory in advance (Aspremont and Jacquemin, 2005).

Multi-level college-enterprise cooperation mechanism

Introduction to Multi-level college-enterprise cooperation mechanism

Deriving from the market regulation and allocation mechanism, the starting point of cooperation between enterprises and universities for talents cultivation is to achieve win-win cooperation. Nevertheless, Undergraduate majors of most colleges and universities, because of the social impact, the geographical characteristics of the industry and many other restricted factors, make it difficult to establish college-enterprise cooperation relationship on a certain scale (Franco and Haase, 2015). Under such circumstances, Harbin Engineering University AI Lab based on the method of breaking up the whole into parts, according to "reduce the scale of cooperation, enlarge the number of enterprises, increase the ways of cooperation", established micro-cooperation with a number of smaller enterprises and fully split up subjects into smaller units in the form of cooperation. In addition, different forms of experimental platforms can be set up in terms of the depth of cooperation subjects and then form a multi-level distributed college-enterprise cooperation framework (Langvik and Johansen, 2005).

The advantages of multi-level college-enterprise cooperation mechanism could be summarized as follows:

- (1) To establish a joint training base through cooperation with multiple enterprises, enterprises can be deeply involved in the training process of students' cultivation. When encountering with the limited cooperation scale, the specific needs of professional training could be decomposed in accordance with complementary principle as well as the actual size of cooperative enterprises. Additionally, training base is managed independently by the enterprise, which can provide students with paid-internship according to floating salary in the enterprise system.
- (2) Outstanding human resources and a favourable experiment environment in colleges and universities will attract enterprises to move the location of some product research and development sites from enterprises themselves to schools at which there is a great demand for employment, thereby easing the pressure from site providing and human resources and so on and so forth. The establishment of Cooperative Innovation Laboratory not only allows enterprises to minimize the investment for development, but also brings the updating enterprise technology into teaching methods on campus to facilitate students' cultivation. The enterprise is responsible for providing management advice to laboratory, while schools in charge of policies and system implementation continue to assimilate the entrepreneurial management experience.
- (3) School Innovation Laboratory established on basis of the independent profession, could directly get involved in students' cultivation and receive part of the orders from enterprises in the form of project cooperation. Professional teachers play a dominant role in leading students to complete product design and test. Sample design given to special laboratory or headquarters is required to be tested for final product. School laboratory takes product life cycle from product development to product operation as a carrier, which enables students to learn and develop in an active and practical approach.

Meanwhile, teachers' innovative ability can be improved as well and thus to fundamentally enhance talent-cultivation. Laboratories managed by school independently could establish a joint development agreement with the enterprises. To build multi-level college-enterprise cooperation framework, a distributed innovation experimental platform comes into being, which consists of construction of several joint training base, multiple special laboratories as well as school laboratories.

Establishment of School Innovation Laboratory in the multi-level college-enterprise cooperation framework

It is most likely to achieve the establishment of School Innovation Laboratory in the multi-level college-enterprise cooperation framework. When compared with other levels, the level also has the maximum coverage for students' cultivation. School Innovation Laboratory will follow the form of contract projects to receive orders from enterprises. This model that is drawing foreign advanced and innovative teaching philosophy is to take a great advantage of existing foundation and conditions as well as rich experiences in developing innovative talents, while also cooperate with the innovative enterprises having a strong sense of social responsibility to explore the development of innovation and entrepreneurial ability for college students. New pattern of laboratory management and talents selection mechanism need to be further researched and adopted based on the platform of college-enterprise innovation and entrepreneurship training base. It intends to build a scientific, effective and innovative training system in order to achieve efficient, sustainable high level of innovation and top-notch talent cultivation. Through the combination of students from different majors, the innovation and entrepreneurship teams can improve the level of innovation, and students' comprehensive ability could be developed at the same time. Furthermore, more students with potential ability would like to participate in innovative activities. On this basis, the management system and cooperation mode of college-enterprise innovation and entrepreneurship training base are required to be gradually improved, which aims to effectively develop socially responsible elite. The structure of college-enterprise innovation and entrepreneurship training as shown in Figure 1.

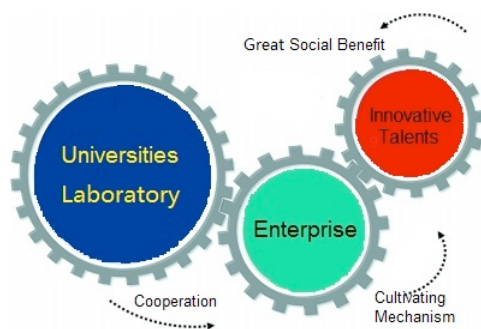


Figure 1: The structure of college-enterprise innovation and entrepreneurship training

Establishment of School Innovation Laboratory in the multi-level college-enterprise cooperation framework specific implementation methods as follows:

- (1) Summarize existing models of talent-cultivation in Innovation Laboratory to extract valuable experiences which are adaptive to the current development of elite. Oriented in innovative and practical talents' development, the aim is to achieve demand-driven training mode. Initially, according to the goal of talents' cultivation, the mode should embody practice concept so that the proportion of practice in the whole process of development becomes higher. The objective of developing innovation and practice which is closely related to social need could make students' ability connect to enterprises' demand. For the purpose of cultivating innovative talents, we will follow the idea that creates the relationship 1: 1 between theory and practice. Under the structure

of college-enterprise cooperation, students' innovative ability is supposed to be artificially cultivated and guided by absorbing enterprise management experience and simulating social need.

- (2) Develop elite serving as the fundamental purpose and set the plan of college-enterprise cooperation as well as build innovation and entrepreneurship training base to provide students with platform. Improving the condition of innovation laboratory and emphasizing the accomplishment of innovation achievements, the first priority for laboratory is to run 24-hour service during the period of operation, which are also equipped with well-designed experimental facilities and sophisticated devices. The currently professional teacher and student resources are shared by the whole university. The comprehensive training base aims to simulate the enterprise management mode.
- (3) According to the operating condition of training base and feedback from students' development, the feedback of student's growth information, sum up experiences then perfect the training plan and management system. The plan for talent-cultivation is required to be widely adjusted by making 1:1 developing mode more specific. Innovation Laboratory intends to help some groups of students who have potential to develop innovative awareness and ability so as to stimulate the whole groups of students, which is totally different from Specialized Laboratory, whereas the arrangement for Specialized Laboratory is to accomplish basic training for specialized courses that target the whole majors.
- (4) Introducing more innovative enterprises to join training base to provide students with a broader learning platform. Teachers could be sent electronic design companies for practical training regularly and senior engineers, who will give relevant professional lecture about technology application to students and teachers from time to time, are invited to be visit professors from well-known electronic companies like those from Shenzhen, Guangzhou, which can strengthen the coordination mechanism of regular communication between enterprises and school. Key teachers are supposed to go to the training base to know about information at fixed period, and they also bring the mode of the enterprise development into laboratories on campus. Enterprises should send their engineers to school who are responsible for guiding specialized laboratory work and solving core problems. School students hold seminars of which the themes are about skills and employment. The Innovation Laboratories arrange project leader to organize the communication between Specialized Laboratories and enterprises.

Specific practicing process and effect of college-enterprise cooperation

College-enterprise laboratory cooperation chooses different operating mechanisms according to different cooperation modes. The common goal is to make a better laboratory for teaching, research, production and greater social benefits. The main operating mechanism consists of the following four aspects.

Training mode through amalgamation of industry, education and research

"Harbin Engineering University - Laboratory of Artificial Intelligence" is a typical mode through amalgamation of industry, education and research. The company provides equipment while schools provide places. The two sides could send people and staff to finish the establishment of laboratories together. Resources and results could be shared with each other to accomplish the development of scientific research. Laboratories are not only the places that are used to do experiment and teach courses such as "Single-chip Microcomputer Principle", "C language programming" and so on for senior undergraduates, but also can offer teachers technical support for research. Students who come into the laboratory can understand corporating culture and get familiar with enterprises' regulation,

which could strengthen students' corporate identity, develop their sense of responsibility and professional dedication spirit, enhance collaboration awareness, improve organizational and managing skills and decision-making ability. By getting involved in scientific research, teachers can forge a deeper connection with enterprises and acquire information about the latest industry development. There are great benefits that can improve the overall teaching standard of the school and scientific research efficiency as well as create opportunities for innovation. Actually, through the combination of talents and technology, cooperation from enterprises promotes the achievements transformation.

Enterprise Technology Training Mode

The company offers laboratory equipment and chips, and send engineers to give students free training. Students volunteer can participate in training which is in the form of intensive classes, and those who have passed the evaluation can get the technical certificate issued by the company. "Harbin Engineering University - Artificial Intelligence Laboratory" that takes this model has been widely welcomed by the students. They are able to learn the latest knowledge of Single-chip Microcomputer and also can exercise their practice and innovation ability. Moreover, the technical certificate contributes a lot to their job hunting. What the enterprises concern is the social effect: the enterprises have opportunities to get a lot of publicity as well as to improve their own reputation and value of intangible assets through college-enterprise cooperation. By doing so, enterprises can attract some excellent students into their own business. Students could be more suitable for job demand, for they are accepted the training idea from the enterprise itself in advance. Therefore, college can become powerful talent-cultivation base for enterprises.

Participating in various competitions organized by enterprises

Innovation Laboratory in Harbin Engineering University adheres to both theory and practice. Skills development and quality improvement are equally important. That is the reason why imparting knowledge, course experiment and innovation design as well as scientific research are throughout the whole process of lab teaching. Various types of electronic design contest are held in college per year such as "China Robot Competition", "TI cup Analog Electronic Design Competition" and etc. Under the guidance of laboratory, students win a total of more than 340 prizes in various competitions since 2014. These competitions that are popular among students can inspire their passion and enthusiasm for learning and practice. Innovation laboratories take the opportunity of contest. In order to make students fully developed, the open laboratories are equipped with sophisticated instrument and practical experienced teachers who offer valuable guidance. The results turn out that these competitions can greatly improve the overall quality of students.

Open laboratory

To fully take advantage of college-enterprise laboratory resources, the laboratory must run in a totally open mode which means that we must change the previous rule that students are permitted to come into the laboratory only when taking experiment classes. After the completion of the specialized experiment which is in the syllabus, staff should be assigned to keep the innovation laboratory open. For lower-grade students who do experiment less frequently cannot even know how to use experimental instrument. Students can spend their summer vocation practicing so that they have chance to get familiar with experimental instrument such as oscilloscopes, function generators, DC power supply, AC millivolt meter and other equipment. These students could be more skilled after they experienced specialized training, which can save a lot of time familiarizing equipment and ensure the result of experiment teaching in the latter experiment courses. Actually, there is still a situation which is necessary to be considered in which all students learn differently. Although most students finish the experiment within the stipulated time, small groups of students still cannot make it. Even though students get the final data and results, they are unable to know

exactly why they got a set of data. Consequently, alternative plans are applied into experiment teaching. Those who are more competitive are able to get involve in more advanced and comprehensive experiment. Since the equipment in the open laboratories is available to use, students who are not good at doing experiment can practice their skills during spare time. Every year teachers will design some innovative experiment projects for students to choose. Enterprises and school will provide a certain amount of financial support. The experiment projects are supervised by teachers until their completion. In addition, besides various forms of electronic design contest, graduation projects can also be accomplished in the laboratories. Multi-level open laboratories motivate different levels of students to develop their innovation consciousness and practical skills which benefit their future, and the existing laboratory resources are full used by students, the utilization rate of the resources has increased from less than 30 percent to more than 86 percent now. Nearly 500 students benefit from it up to now, whether to continue their studies or choose employment, more than half of them have been admitted by the famous university, and the others went into the well-known enterprises.

Conclusions

School-enterprise cooperation and the establishment of innovation laboratory is a new measure to promote educational reform and improve the quality and efficiency of running schools in China. In this paper, we first analyse the existing problems in joint cultivation between colleges and enterprises, and put forward a multi-level innovative laboratory and scientific and technological innovation oriented talents cultivation mechanism between colleges and enterprises combined with the existing social background and social needs. And we carry out a detailed discussion on the key elements of the operating mechanism, laboratory construction, resource allocation, the cultivation of innovation talents. Because universities have rich educational resources and intellectual and innovative enterprises have good practice conditions, funding, equipment and technical advantages, through the integration of universities and innovative enterprise resource, on the basis of "mutual benefit and reciprocity", we build a new innovative laboratory to achieve resource sharing, complementary advantages, mutual benefit, win-win and joint development.

References

- Armand, J.-L. (2006). University-industry cooperation: the French perspective in the European perspective. *Journal of industry-academic- government collaboration*, 5, 1-6.
- Aspremont, C., & Jacquemin, A. (2005). Cooperative and Noncooperative R&D in Duopoly with Spillovers. *American Economic Review*, 45-54.
- Çetin Bektaş, & Tayauova, G. (2014). A model suggestion for improving the efficiency of higher education: university–industry cooperation □. *Procedia - Social and Behavioral Sciences*, 116, 2270-2274.
- Franco, M., & Haase, H. (2015). University–industry cooperation: researchers' motivations and interaction channels. *Journal of Engineering & Technology Management*, (forthcoming), 41-51.
- Gillmor, C. S. (2012). Fred terman at stanford: building a discipline, a university, and silicon valley. *Physics Today*, 58(10), 854-855.
- Harman, G. (2001). University industry research partnerships in Australia: extent, benefits and risks. *Higher Education Research & Development*, 20(3), 245-264.
- Kanakakis, V., Valavanis, K. P., & N.C.Tsourvel-oudis. (2004). Fuzzy-Logic Based Navigation of Underwater Vehicles. *Journal of Intelligent & Robotic Systems*, 40, 45-88.
- Langvik, T. A., & Johansen, F. R. (2005). Innovation and regional development. *AI&Soc*, 11, 234-243.
- Mappsc, D. G. R., Paul Morrison, R. N., Msocpldev, F. S. R., Mn, E. F. R., Helen Edwards, R. N., & Mn, M. C. R., et al. (2003). University and industry partnerships: lessons from collaborative research. *International Journal of Nursing Practice*, 9(6), 347-55.
- Wang, Y., Jing, L., & Xue, Y. (2010). University-Industry Cooperation Game Research Based on Different Psychological Types and Demands. *Information Management, Innovation Management and Industrial Engineering (ICIII)*, 2010 International Conference on (Vol.1, pp.583 - 587). IEEE.

Zhou, Y. F., Wang, M. H., & University, J. A. (2014). A study on the sustainable development and operation mode of the university-industry cooperation. *Journal of Jilin Institute of Architecture & Civil Engineering*, 27(18), 5024-5031.

Acknowledgements

This work was supported by the Undergraduate Teaching Reform Research Projects (JG2016BZD10 & JG2014BYB15), Harbin Engineering University.