The Mode and Method of Establishing Industrial Virtual Simulation Laboratory Based on Industry-University-Research Cooperation

Xianguang Kong , Chuanzhen Cui , Ai Ke
School of Electromechanical Engineering
Xidian University
Xian,Shaanxi,710071,China
kongxg@vip.sina.com

Xiaoyu Huang, Yanlong Liu
School of Electromechanical Engineering
Xidian University
Xian,Shaanxi,710071,China

***Abstract*—The goal of this paper is to shorten the gap of industrial virtual simulation experiment environment for innovative talents of smart manufacturing between university and advanced technology companies and enterprises.This paper proposes the systematic method to establish a joint laboratory with advanced technology companies and enterprises through various forms of cooperation to get the free advanced software and data resources. The mode has been testified and applied successfully in building process and lessons of electronic equipment virtual simulation center. By this method has been used to the teaching reform project in Shaanxi Province, we have reached a cooperation with Siemens Industry software company and the user of Siemens. The innovation of this paper is to summary and practice the cooperation mode from the whole process point of view with technology companies and enterprises. The best industry-university-research model can be refereed and used in establishing industrial virtual simulation laboratory.**

Keywords—industry-university-research model*;*industrial virtual simulation laboratory*;*cooperation*; *joint laboratory*; *smart manufacturing

I. INTRODUCTION

[1] With the development of digital and information technology, product design, craft, manufacturing and other technical means change with each passing day. Especially the industry 4.0 and “Made in China 2025” plan introduced gradually , the trend of manufacturing enterprises is more obvious in digitization and intelligence. “The analysis of foreign cooperative innovation and enlightenment to our country”[1]was published in 2014 .From this paper ,we can learn about that the combination of education and industry is more and more closely.Through opening industry-university-research cooperative education and making full use of resources from schools, business, scientific research units, and many different digital intelligent environment[2],we can achieve the organic combination of teaching and practical, so as to cultivate innovative talents mechanical and electrical characteristics.

The problems in cultivation pattern of domestic higher education talents are: the practice teaching is weak; the engineering education is more serious; the cooperation between school and industry keeps at a distance; platform of innovation is wanted ; students' teaching resources cannot meet the needs. In order to know the model and method of the industrial virtual lab of universities at home and abroad, the project team carried out a wide range of investigation in domestic and foreign universities..Ping Ceng and Xi Li [3] have studied industry-university-research cooperation model and mechanism. From their papers,we can see that the domestic research cooperation form is single, and channels among three sides are not to get through. The main feature of industry-university-research cooperating education is to establish long-term cooperative relationship for college students providing practice and experimental research base and making full use of facilities and education resources of special talents, so as to combine the theory of learning with practice and to improve the quality of personnel training.

II. DEMANDS AND NECESSITY OF THE INDUSTRY VIRTUAL LABORATORY

For the establishment of a virtual laboratory,there is virtual laboratory based on LabVIEW before[4]. But the most of mechanical engineering in some universities still use traditional teaching means and environment causing students with traditional methods not to adapt and follow to enterprise actual work. It is difficult to meet the needs of China's advanced manufacturing industry transformation and upgrading.From the design, analysis, process, manufacturing, and other surface layers,schools are short of real simulation of enterprises virtual reality and the integration of advanced manufacturing environment from these layers.

1)To make up the limitation of the real experiment, and to introduce the concept of "full space-time";

Shaanxi province education reform project: Research on the model and method of the industrial virtual laboratory based on industry-university-research cooperation (13BY21); Key project on education reform of Xidian University :Digital intelligent and innovative talents under the new industrial revolution(A1314),Ministry of education-SIEMENS industry integrated reform program ; Experimental education reform project of Xidian University: Virtual experiment methods and reform on life cycle of typical electronic machinery product(JG1404); Xidian University graduates education reform project in 2015: Research on the method and research of the establishment of the practice base of the graduates based on industry-university-research cooperation(15Y13)

2)The full coverage of virtual simulation experiments could be founded in engineering basic training, advanced courses, production practice, curriculum design,and graduation design at the whole school;

3)By virtual simulation experiment, the abstract concept and its phenomenon we cannot see and touch visualize;

4)Virtual simulation experiments expand the experimental field.

The cultivation problems and requirements of the mechanical talents for the first line of mechanical and electrical engineers in the manufacturing industry of the university are as follows:

- How to use the digital, information and other means to transform the traditional teaching experiments;
- How to integrate the business process and project experience into the traditional teaching experiments;
- How to help students build up the actual situation of the enterprise, to promote the students to take part in the practice and to change the passive situation of production practice;
- How to drive the teaching by scientific research,and improve the sharing scope and depth of scientific research and teaching resources;
- How to train the graduates to adapt the enterprise work , to master the advanced tools, and to be familiar with the work environment.

The construction objective of industrial virtual laboratory is to create a comprehensive and open experimental platform. The establishment of the lab needs a large amount of external resources including software, secondary development, data resources, software training, teaching material, capital and staff support.

1)Simulating the design, analysis, process, manufacturing and other service functions and processes of virtual simulation and integrating teaching experiment platform to solve the experiments not available, high cost, high consumption in real environment;

2)Carrying out the metalworking practice and mechanical and electrical engineering college teaching, production practice, course design, graduation design and other aspects around Engineering Training Center for the school engineering undergraduate students, supporting students to innovate, and reflecting the characteristics of large-scale training;

3)With the three layers of experience, practice and research of progressive experimental system to enhance the ability of theoretical practice and comprehensive coverage, to cultivate students' system concept and to improve students' practical ability and comprehensive application ability, which embodies the characteristics of comprehensive training.

4)Integrating advanced technology, project examples and business processes into industrial virtual experience center;Cultivating students' autonomous learning;Stimulating students' interest in learning.The virtual simulation experiment club trains students' development and innovation ability , releases all kinds of topics, participates in research projects and all kinds of competitions to create a shared product innovation design platform, embodies the advanced and innovative features;

5)Integrating industry-university-research cooperation into open experimental platform to strengthen the cooperation with the enterprise or advanced technology company. With advanced technology training base and industry-university-research cooperation ,using the introduction, digestion, sharing, win-win concept, and the latest digital technology,it can provide open platform for teachers and students, which reflects the characteristics of school-enterprise cooperation.

As a complement and development of real experiment, construction of advanced manufacturing virtual simulation experiment center will further promote and enhance the teaching quality of higher education.

III. COOPERATION MODE AND METHOD

In January 2014, the author applied for and received supports of the integrated reform project.And Tecnomatix/PLM/CAD/CAM/ and other 50 nodes Pieces in the international company has been installed. At the same time ,TeamCenter, Tecnomatix textbooks has been compiled with the company。

Through cooperation practice, the approaches to cooperate with advanced technology companies can be summarized as follows:

- The relational mode between party A and party B: Those things can be completely bought from the advanced technology companies, such as the software, services and secondary development etc. It is more suitable for the universities which has the relatively weak scientific research foundation and the sufficient funds.
- Cooperation mode project : By the cooperation program with the advanced technology company ,a series of support of software, certification and teaching material can be applied for. Because the software is mainly engaged in the teaching experiment, the company does not provide the secondary development kernel. The customization and secondary development need the companies to participate in. This mode is suitable for a certain influential industry enterprises and schools which has scientific research foundation and funds.
- Joint laboratory mode: Foreign advanced technology companies have more projects, but their human resource is not enough. The companies want universities to intervene in their research projects and to build a joint laboratory getting free software resources and the secondary development kernel, so as to serve the teaching. The mode is suitable for schools which has the scientific research strength but less capital.[5]

Around the mechanical design and analysis , Manufacturing & Technology and maintenance and management of electronic and mechanical products, the university should construct comprehensive teaching experiment platform facing the typical electronic mechanical products' life cycle. The platform simulates the design, process, production, maintenance and other business functions and processes. It also does the design and analysis of

mechanical and electrical integration products, process design and simulation, digital factory, product use and maintenance experiments, cooperating mechanical design, modern CAPP technology, digital chemical plant, virtual simulation, numerical control machine tools, finite element analysis and other courses of teaching and experiments.

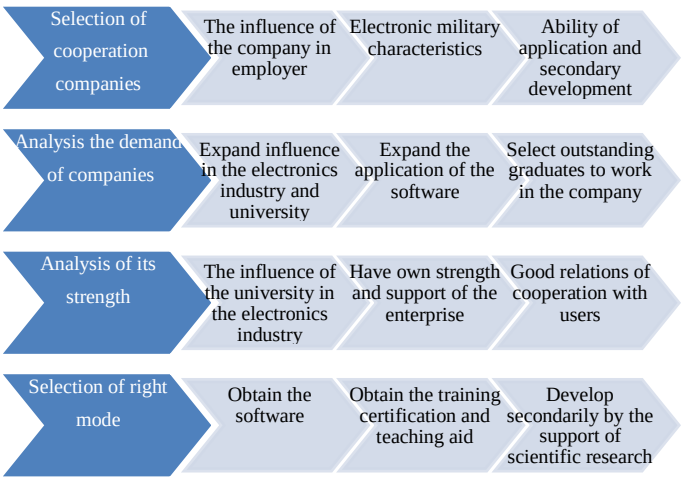

Fig. 1. Cooperative road map with Advanced Technology Company

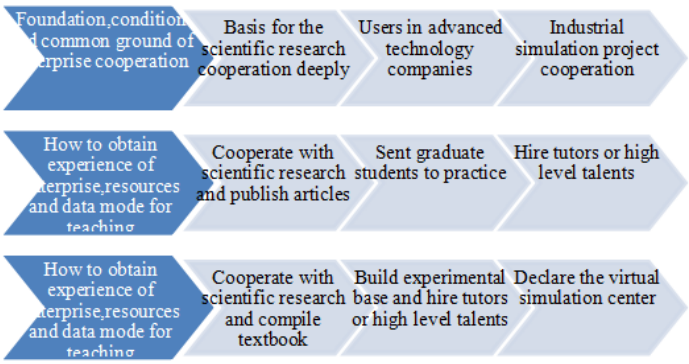

Fig. 2. Cooperative road map with Enterprises

The construction route of advanced manufacturing virtual simulation experiments center of electronic equipment is: First, do the top-level design , planning and the overall framework of science better; Integrate teaching and research,and scientific research guiding and nurturing teaching; Schools and enterprises should pay attention to the cooperation with international well-known companies; Integrate long term goals and stage plans and take a step by step approach in pursuing effectiveness. There are the virtual simulation experiment demonstration teaching base with demonstration and radiation effect in Shaanxi province. So it can declare a national advanced manufacturing virtual simulation experiment center in near future. Therefore, the advanced manufacturing virtual simulation experimental teaching center of electronic equipment will be oriented to all engineering students,fully reflecting the actual situation and complement each other, realizing the real experiment to complete the teaching function, and building integrated experience, practice, innovation and research and development of teaching and experimental system platform. Virtual simulation laboratory in the future will be extended to the digital chemical plant, supporting multidisciplinary professional collaboration, combining with industrial engineering, electronic packaging, business management, new product development and other social needs.[6]

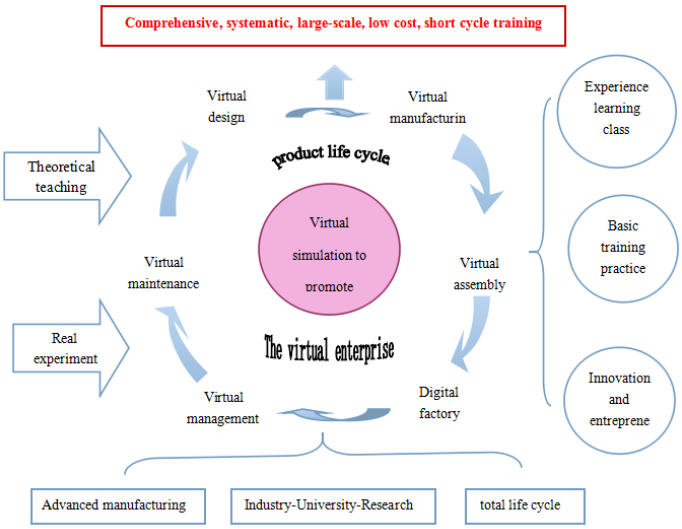

Fig. 3. Advanced manufacturing virtual simulation

"Virtual simulation experiment" simulates the enterprise from the design, analysis, process, manufacturing and other aspects of the actual situation, integrating virtual simulation technology, using virtual manufacturing environment and the full life cycle management of the environment. According to differences on the teaching purpose, virtual simulation experiments can be divided into feeling experience learning, basic training practice, innovation and pioneering exploration experiments. Through virtual and simulation technology, multimedia, network communication and other technical means, the theoretical teaching effect can be strengthen and the engineering practice ability and innovation ability can be improved .[7]It plays an important role in improving the quality of personnel training.

Advanced manufacturing virtual simulation experiment center experimental project is shown below:

- Virtual manufacturing (design, analysis, numerical control processing integration) experiment: In school learning stage, students are lack in using equipment, especially for high-end CNC machine tools.
- Virtual manufacturing (design / analysis /3D printing integration) experiment:It is basic qualities of a mechanical engineer to master the principle of 3D printing and operation.
- Virtual design experiment(multidisciplinary comprehensive analysis and simulation).
- Virtual design experiment(electronic equipment mechanical structure analysis and simulation) .
- Virtual assembly simulation experiment.
- Digital factory simulation experiment.

- Virtual maintenance experiment (product roaming and interactive experience) .

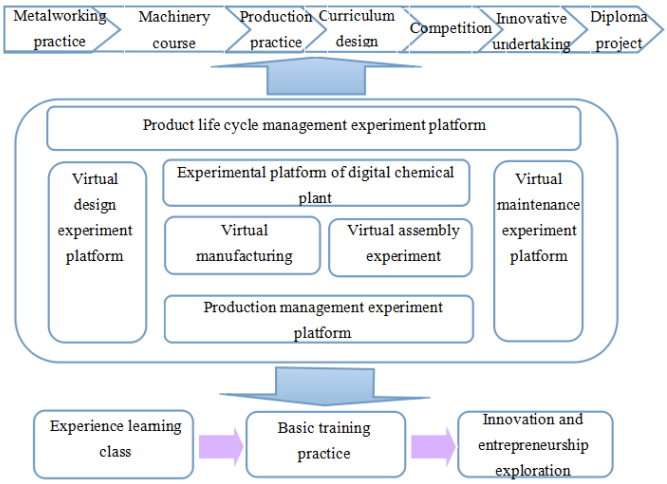

Fig. 4. Schematic diagram of the experimental project of advanced manufacturing virtual simulation experiment center

IV. Achievement of Industry-University-Research

1) Enhance students' quality: Based on the cooperation, organically integrating the school environment and business environment into the training process of students to cultivate students' scientific quality and comprehensive ability. Students can contact with reality through practical work and activity in enterprises and institutions enhancing the contacts between theory and practice, consolidating and expanding professional knowledge, improving the ability to work.

2) Ensure practical research: Based on cooperation which contains production studies and research with cooperative units, making projects in conjunction with research, it makes research topics come from real production, construction, management and actual services, which is having a topic with significant socio-economic or engineering technical background topics. It can greatly mobilize the enthusiasm and initiative of students, enhance their sense of responsibility, stimulate students' innovative spirit.

3) Promote development of the industry:Through the cooperation with "reliability test and simulation" laboratory established by the mechanical institute as well as other projects of cooperation, we can identify the two cooperation partner in industry including the institute and a company and then transplant project templates and processes to the school lab, completing teaching-experiment-research-cooperation integration model from the software providers and application users to teaching, experiment.

Making good use of existing industry-university-research cooperation basis, virtual simulation labs may get advanced software platform and business templates and invite experts in relevant technology companies and front line engineers in enterprises and research institutes to give lessons. Supporting teachers to participate in enterprise projects in development cooperation or joint application project, and building the open laboratory in which teaching information and market are synchronized, teaching and research are fused together.

V. Conclusion

A. *The basic ideas of the research*

Through the cooperation to establish school-enterprise joint laboratory, the use of the laboratory will absorb partners software, data, talents, scientific research and all aspects of resources. Low cost, high efficiency, high quality, sustainable construction of the laboratory with characteristics of the school will cultivate talents who meet the needs of industry.

B. *The main contents of this project include four aspects*

Personnel training and construction requirements of industrial virtual laboratory ;The construction models and methods of the laboratory cooperating with Advanced Technology Company; The construction models and methods of the laboratory cooperating with the enterprise or the Institute;The scheme to construct industrial virtual laboratory.

C. *Conclusions of this project*

Through the practice of the cooperation in various business units, it is proved that the method is feasible and can be popularized in the establishment of industrial virtual laboratory.

D. *Characteristics and innovation of the project*

Through the cooperation of industry and research, it is a good solution to solve the problems of the software, data and talents of the industrial virtual laboratory, and it is also a better solution for the industry to solve the urgent needs of personnel training.

E. *Breakthrough progress in the research of this project*

New perspectives in theory: the integration of the two aspects of the construction of cooperation will promote each other, forming a positive interaction between teaching and research.New initiatives in practice: different modes of cooperation with the advanced technology company, enterprise or institute bring the school-enterprise joint laboratory into the industrial virtual laboratory system。

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