Build an Integrated Scene Teaching System for Additive Manufacturing Based on the Integration of Production and Education

Zhu Wen [1,] Xiangcheng Cui [2], Yunzhuo Lu[2,*]

[1]School of Automation and Electrical Engineering, Dalian Jiaotong University, Dalian, China
[2] School of Materials Science and Engineering, Dalian Jiaotong University, Dalian, China

Abstract. Additive manufacturing, also known as 3D printing, is known as one of the subversive intelligent manufacturing technologies that can lead industrial transformation. It has significant advantages in personalized customization and preparation of complex structural components, and is having an important impact on traditional manufacturing process, factory production and processing mode and the entire manufacturing industry chain. At present, the talent gap of additive manufacturing and related specialties in China exceeds 10 million, of which the manufacturing industry has the largest demand for additive manufacturing application talents. It is estimated that the talent gap will be 8 million by 2025. The construction of scenario based teaching system of additive manufacturing integrated courses based on the integration of production and education. At present, it is urgent for universities and vocational education to fully integrate the "research" and "technology" of universities and vocational education institutions with the "production" of enterprises to build a scenario of production and education integration education that suits students. By creating real and vivid scenes for students, Help students get familiar with the background and business operation process of the integrated operation of additive manufacturing, strengthen students' ability to integrate theoretical knowledge, and apply what they have learned in combination with practice.

1 INTRODUCTION

China's higher education has always had the tradition of "Engineering" and the foundation of engineering talent training is deep. However, from the perspective of international standards, there are still obvious shortcomings in the training of engineering talents in China. This is highlighted by the weak foundation of Engineering Science, the disconnection between engineering technology and reality, the lack of engineering design ability and aesthetic ability, the lack of cross-cultural communication ability and integration ability, and the lack of engineering philosophy and engineering ethics. [7] Taking the application of 3D printing additive manufacturing technology as an example, based on the concept of integration of production and education, and according to the requirements of constructivist learning theory, it is key to build an integrated education scene suitable for students' 3D printing technology learning. On this basis, an education platform with "Technology Application Center + strategic cooperative enterprise alliance" as the core is built. At the same time, according to the requirements of the modern apprenticeship system, in the fields of joint training, collaborative cooperation In the direction of data exchange, it is effective to deepen collaboration, integrate the vocational education scenarios of schools and enterprises, explore the application of collaborative innovation in the training of technical skilled talents, and realize the research on the education mechanism of specific majors under the integration of industry and education in universities.[5]

2 BACKGROUND OF ADDITIVE MANUFACTURING INDUSTRY WITH INTEGRATION OF PRODUCTIONAN AND EDUCATION

The integration model of production and education can effectively solve the problem of insufficient supply of high-end applied talents in China. The cultivation of advanced design and intelligent manufacturing talents with additive thinking is an important way to realize the grand goal of "Made in China 2025", and the integration of industry and education has been the main development direction of higher education and vocational education since 2018.It is an irresistible trend to build a competency-based teaching system and solve the problem of the talent gap of high-end intelligent manufacturing in the form of the integration of production and education. Additive manufacturing needs talent:

*Corresponding author.Email: 13363296@qq.com
18340807307@163.com
*luyz@djtu.edu.cn (Yunzhuo Lu)

2.1 Research-oriented talents needed by upstream industrial chain technology R&D enterprises

Talents mainly engaged in the development and research of special materials for additive manufacturing, the improvement of technology, the research of printing materials and the development of printing equipment. 3D printing technology is the integration of mechanical engineering, computer technology, numerical control technology, material science, bioengineering and other multidisciplinary technologies.[1] At present, China's 3D printing technology mainly cultivates and promotes the improvement of additive manufacturing technology, mainly from the master's and doctor's degree students of relevant majors trained by universities, and fails to carry out undergraduate level talent training.

2.2 Applied talents needed by equipment development enterprises in the middle of the industrial chain

It refers to talents who have a solid professional foundation of a certain discipline and can fully integrate the professional foundation of this discipline with additive manufacturing technology. Application talents have a solid professional foundation of a certain discipline and can fully integrate the professional foundation of this discipline with 3D printing technology.[1] They are mainly engaged in the production and R & D of additive manufacturing equipment, generally in the field of machinery manufacturing and computer software programming. Because 3D printing has not been included in the*catalogue of undergraduate majors of ordinary colleges and universities*, [1] and because of the school running mechanism, teachers, experimental equipment and other reasons, few domestic colleges and universities have set up 3D printing majors at the undergraduate level, resulting in a shortage of 3D printing application-oriented talents.

2.3 Commercial talents needed by downstream service providers in the industrial chain

As the aggregator of additive manufacturing technology and market ability, commercial talents are management talents in the additive manufacturing industry in the production and service fields. They have certain industrial design, additive manufacturing equipment operation, commodity sales and other capabilities, provide additive manufacturing services, and can use their own technology and ability to carry out practical operation, maintenance, service and other work. We need to have a comprehensive understanding of the additive manufacturing industry chain. Such talents generally come from the specialties related to additive manufacturing technology in Higher Vocational Colleges and secondary vocational schools.

3 INTEGRATION OF PRODUCTION AND EDUCATION: AN URGENT PROBLEM TO BE SOLVED IN TRAINING ADDITIVE MANUFACTURING TECHNICAL TALENTS

The education mechanism under the integration of industry and education needs the support of a more intelligent industrial mutual benefit network information platform. It is urgent to establish a big data platform support based on the intelligent industrial Internet that can realize the unified interface of a variety of practical training equipment and teaching platforms. With project data and teaching data as the core, it organically integrates project cases, production equipment, teaching resources, practical training equipment and other resources inside and outside the school to form a more smooth The interactive process of intelligent industry and educational resources.[5]

3D printing technology is a new industry. Most colleges and universities have insufficient understanding of it, and leaders do not attach importance to the construction of relevant majors and talent training. Due to the shortage of teaching funds and the relatively high price of 3D printing equipment, many colleges and universities are unable to introduce relevant 3D printing equipment, which makes it impossible to build teaching resources related to 3D printing technology, and the knowledge and skills obtained by students in schools cannot be quickly qualified for practical jobs.[1]3D printing and other technologies are constantly upgraded and innovated, but the teaching content seriously lags behind the actual job skill standards, and students can not master the application of cutting-edge technologies so as to meet the needs of modern enterprises.[7]

The training mode of master and doctoral students led by scientific research projects based on the tutorial system lacks continuity in the training of additive manufacturing technology talents. In addition, the commercial talents in the additive manufacturing industry trained based on the modern apprenticeship system lack complete policy details, such as improving the restrictions on the scope of schools and teaching venues, increasing the support for the establishment of enterprise industry education integration teaching scenarios, and ensuring the interests of the community of interests in the implementation of the strategic cooperative education mechanism of enterprises and schools, so as to facilitate the full realization of the industry education integration professionalization scenario.[5]

The school enterprise linkage mechanism is not perfect. The close cooperation between schools and enterprises can effectively promote the sustainable and healthy development of vocational education. At present, the cooperation between colleges and companies is very frequent. However, a solid and systematic long-term school enterprise cooperation has not yet been established. During the internship, most students will perform simple repetitive tasks, lack initiative, and cannot adapt to actual work well.[7]

4 DESIGN OF TEACHING SCENE OF ADDITIVE MANUFACTURING BASED ON INTEGRATION OF PRODUCTION AND EDUCATION

At present, colleges and universities lack a comprehensive scene and talent training mode integration in cultivating laser additive manufacturing technology talents. It is urgent to fully integrate the "research" and "technology" of colleges and universities with the "production" of enterprises, build a production education integration education scene suitable for students, and realize a new education mechanism based on the integration of production and education. [5]It is necessary to transform the "teaching" in professional learning into the "teaching" in work, which is a combination of enterprise production Education and teaching, scientific and technological research and development, skill improvement, quality cultivation, operation and management and social services are integrated, which can enable students to learn professional knowledge at school, create a pleasant teaching environment, make full use of Internet Education Technology and scene teaching experience, so that students can learn "professional" professional skills and obtain maximum educational value. Specifically:

4.1 Cultivating students' professional practical ability through practical situational teaching

In combination with the needs of the industry, formulate training plans and models. The professional talent training model should meet the needs of both the post structure and the modern manufacturing industry. Therefore, to integrate the requirements of the industry into the disciplinary knowledge system of practical teaching in Colleges and universities, it is necessary to carry out Research-oriented education, starting from the practical problems that the industry or the enterprise really cares about, so that the industry has enthusiasm, There is a long-term sustainable motivation to participate in teaching and training. Take the cultivation of professional post skills as the core of strengthening the construction of professional curriculum system, adjust teaching contents according to technological development, build a curriculum system based on professional ability, improve the education of intelligent technology, digital technology and information technology, and set curriculum modules in line with the ability requirements of posts. We should teach students according to their aptitude according to their characteristics, encourage students to actively participate in the innovative design competition by building a platform, so as to improve their innovative consciousness, thinking and ability, and actively develop the modern apprenticeship education mode. Pay attention to the combination of practice and teaching, make professional courses and basic courses overlap, increase practice class hours, and increase discussion in practice courses. Enterprises, schools and students should discuss specific problems together, and summarize these investigations, trials and errors and discussions into courses to achieve the training of practical talents.[7]

4.2 Cultivating students' social ability through the real environment of enterprises

Actively explore joint research and teaching projects between schools and enterprises, set up comprehensive mechanical manufacturing courses and intelligent design and manufacturing experiments with rich practical colors according to technological development and production requirements, develop experimental teaching projects that help cultivate students' job adaptability and innovation ability, explore practical and effective school enterprise cooperation modes, and strengthen substantive and in-depth cooperation with enterprises. Practical teaching projects are conducive to students' experimental teaching and skills improvement, and also conducive to providing powerful technical services for enterprises. Excellent enterprises and high-level technical talents are invited as industry instructors to jointly establish talent training goals, truly achieve "combination of work and learning" through a large number of work examples, cooperate to develop courses and explain advanced technical knowledge. At the same time, let professional teachers and students enter the enterprise to contact and practice the advanced technology on the production line, clarify their own post ability needs, and truly realize the organic combination of "teaching, learning and doing" through practice.[7]

4.3 Cultivate innovative talents for additive manufacturing industry through creative work

Innovative engineering science and technology talents are an important force to promote China's engineering science and technology innovation and industrial development, and play a key role in implementing the innovation driven development strategy and building an innovative country. Innovative engineering science and technology talents refer to compound leading talents with distinctive professional characteristics, interdisciplinary knowledge base, innovation and entrepreneurship ability and good comprehensive quality that adapt to and meet the needs of emerging industries and new economy in the future. They should not only specialize in their own fields, but also have cross-border integration capabilities based on cross industry and cross discipline knowledge and capabilities. By changing the education mode to strengthen the general education part, changing the previous emphasis on professional knowledge over comprehensive quality, integrating practical innovation with student growth and ability training, and achieving the talent training program of integrating traditional and modern technology, student practical activities with teacher scientific research activities, internal and external practice, engineering quality with humanistic quality, and student common and individual development, the education chain, talent chain The industrial chain and innovation chain are organically linked to train students to learn how to study, work, cooperate and survive, so as to meet the challenges brought

by future uncertainty. In the case of designing modules and doing a good job in curriculum planning, students should be given the right to choose courses freely, expand their freedom to choose courses, and meet their personalized needs. The curriculum content should be diverse, diversified and multi-layered, so as to stimulate students' interest in learning, speculative ability, critical spirit and creative ability, encourage students to explore new knowledge and things, and ensure their comprehensive development and personalized development, Closely integrate the special requirements of innovative engineering science and technology talents.[9]

5 RESEARCH ON THE CONSTRUCTION PATH OF "ADDITIVE MANUFACTURING LABORATORY+ENTERPRISE SYRATEGIC COOPERATION" EDUCATION PLATFORM

5.1 Establish the common value pursuit of school enterprise cooperative education under the background of industry education integration

First, focus on the value source of college education, not only train talents with professional skills for the society, but also promote the realization and all-round development of students' self-worth. By mining the value implication of the curriculum, implement the education goal into classroom teaching, and realize the unity of ontology value and tool value; Return to the original intention of education, take the classroom as the main channel, and transform discipline resources, academic resources, teacher resources, social resources, etc. into educational resources, so as to achieve the unity of education and talent cultivation, and thus promote the free and all-round development of people. Second, through the establishment of a teaching team with a multi-disciplinary background of "Ideological and political teachers + professional teachers + counselors + enterprise instructors" and other measures, we should build a team of teachers with self-conscious moral awareness and strong moral ability, take the initiative to study in curriculum teaching, and strengthen ideological and political education. School teachers and enterprise engineers formulate professional curriculum standards according to job requirements, organically integrate value orientation with knowledge teaching and ability training, and run ideological value orientation through the whole process of education and teaching such as curriculum scheme, curriculum standard, teaching plan, syllabus, lesson preparation implementation and teaching evaluation.[8]

According to the nature and characteristics of different professional courses, grasp the key points to be excavated and expanded. To publicize the successful deeds of the leaders or entrepreneurs of the equipment enterprises to the students, highlight the cultivation of the craftsman spirit of seeking truth and pragmatism, practical innovation and excellence, train the students to be practical and rigorous, patient and focused, hard-working, and pursue excellence, and grow into technical talents who care about the society and have the responsibility of the times.

5.2 Improve relevant systems and mechanisms to stimulate innovation vitality

According to the actual needs of aerospace, railway locomotive and other enterprises for additive manufacturing technology and talents, build additive manufacturing laboratories, take this as the basis, take scientific research projects as the link, carry out strategic cooperation with enterprises, jointly solve the technical problems faced by enterprises, and study how to achieve the integration of "production and education" in this process; Explore how to implant enterprise workflow models such as "project-based scientific research content, professional scientific research methods, professional scientific research environment, process oriented scientific research, and enterprise oriented scientific research management" into the laboratory. The goal of laboratory construction is to promote the combination and optimization of resources in a wider range by integrating cross-border resource elements, extending the industrial chain, innovation chain, talent chain and education chain, and driving the development of regional additive manufacturing industry and academic disciplines. The construction of the innovation platform has received strong support from the local government, and has won 12 national and provincial longitudinal scientific research projects. It has maintained close cooperation with CRRC Dalian Locomotive and rolling stock Co., Ltd., Anshan Iron and Steel Group Co., Ltd., AVIC Shenfei Co., Ltd., Dalian Sanlei science and Technology Co., Ltd. and other well-known enterprises at home and abroad for a long time, forming a collaborative construction among schools, enterprises and local governments. At present, the project has built a fixed scientific research team and a multi-functional 3D printing comprehensive training room. Mainly engaged in:

Starting from the composition design of amorphous alloys, combined with the characteristics of long-range disorder and short-range atomic structure of amorphous alloys, the composition of special amorphous alloys and their composites suitable for laser additive manufacturing technology is obtained by using the cluster plus linked atom model method; On this basis, using laser additive manufacturing technology, amorphous alloy rail transit equipment parts can be prepared without size restrictions, breaking through the size and shape restrictions of amorphous alloy.

It is proposed that the microstructure of amorphous alloy composites can be controlled in situ by using laser additive manufacturing technology. By controlling the cooling rate of each layer of materials in the process of laser additive manufacturing, the microstructure can be controlled, and then the amorphous alloy composites with gradient change in dendritic phase volume fraction can be successfully obtained. The gradient amorphous alloy composite shows a perfect combination of high yield strength (> 1.3gpa) and high tensile ductility (~ 13%). This increase in strength and toughness is due to

the synergistic strengthening caused by the interaction between adjacent layers and the asynchronous deformation caused by the heterogeneous microstructure.

5.3 Build an education system with "additive manufacturing laboratory + enterprise strategic cooperation alliance" as the core

Since 2014, our university has established a laser additive manufacturing laboratory for special metal components to engage in research work on laser additive manufacturing of metal materials, including the research foundation of additive manufacturing process and the research foundation of metal material composition design. In recent years, we have established a strategic cooperation alliance in laser additive manufacturing technology and talent training. In the process of undergraduate training, gradually complete undergraduate quality education, receive systematic engineering practice education throughout the four years, establish and improve "additive manufacturing laboratory", whose core function is to integrate the application and innovation of additive manufacturing technology and the promotion of new additive manufacturing technology into a scientific research practice teaching base. The total value of the existing equipment is nearly 8 million yuan. According to the layout of process flow such as additive manufacturing model design, three-dimensional scanning, additive manufacturing printing, and product post-processing, it simulates the actual manufacturing process of the enterprise and the atmosphere of the manufacturing enterprise. Improve students' engineering practice ability and cultivate high-quality application-oriented professionals.

5.3.1 Fixed scientific research workstation.

As an incubator for the promotion of advanced technology and the improvement of teachers, it provides all-round support for the scientific research and teaching ability of college teachers and the technological research and development of enterprises. On this basis, the college has successively set up an academician working platform, a doctor's scientific research workstation for new materials of metal 3D printing and a chief technician workstation for Yantai manufacturing industry. The college has hired 9 flexible experts to participate in the platform and professional construction, and is striving to build a national first-class industrial metal 3D printing + Advanced Manufacturing Technology Innovation Incubation Platform. We have implemented a teacher building model of leading by famous teachers, part-time jobs for each other, and temporary posts for enterprises. The flexible expert team undertakes the theoretical training task of professional teachers of the college, comprehensively and systematically improving the professional theoretical level of additive manufacturing of professional teachers. Professional teachers and enterprise technicians have two-way exchanges, working part-time in each other's units, and learning from each other's strong points to complement each other's weaknesses around the construction of professional teachers. On the one hand, when teachers participate in some technical work of enterprises, they can understand the actual production of enterprises and improve professional and technical skills; On the other hand, in the process of part-time work in the school, technicians can master the actual situation of students and improve the teaching level. Have at least 2 months of temporary training in the production line, be familiar with the production operation and equipment operation of the enterprise, enhance quality awareness, process awareness and safety awareness, and improve professional and technical skills.[2]

5.3.2 Laser additive manufacturing laboratory

The laser additive manufacturing laboratory for special metal components has the equipment and analytical instruments for the research of this project. Such as metal laser additive manufacturing system with 6kwipg fiber laser as the core, MTS810 fatigue testing machine, jem2100f transmission electron microscope, supra55 field emission scanning electron microscope, empyreanx-ray diffractometer, keyencevhx-1000e three-dimensional video microscope, netzschstsa449 synchronous thermal analyzer, ICP full spectrum direct reading plasma emission spectrometer, parstat2273 electrochemical comprehensive analysis system, wire cutting machine, bending fatigue testing machine Universal testing machine, precision balance, high vacuum sintering furnace, optical dilatometer, high-precision resistance measurement system with 7081 digital voltmeter as the core, fm-700 microhardness tester, various heat treatments, etc. The laser additive manufacturing laboratory for special metal components has the equipment and analytical instruments for project research. Such as metal laser additive manufacturing system with 6kwipg fiber laser as the core, MTS810 fatigue testing machine, jem2100f transmission electron microscope, supra55 field emission scanning electron microscope, empyreanx-ray diffractometer, keyencevhx-1000e three-dimensional video microscope, netzschstsa449 synchronous thermal analyzer, ICP full spectrum direct reading plasma emission spectrometer, parstat2273 electrochemical comprehensive analysis system, wire cutting machine, bending fatigue testing machine Universal testing machine, precision balance, high vacuum sintering furnace, optical dilatometer, high-precision resistance measurement system with 7081 digital voltmeter as the core, fm-700 microhardness tester, various heat treatments, etc. In terms of mechanical property measurement, it has MTS810 electro-hydraulic servo universal testing machine, impact testing machine and fatigue testing machine, which can carry out routine mechanical property testing.

5.3.3 Multi function 3D printing comprehensive training room

Take scientific research projects as the link, carry out strategic cooperation with enterprises, jointly solve the technical problems faced by enterprises, and realize the integration of "production and education" in this process through project development; Enterprise workflow mod-

els such as "project-based scientific research content, professional scientific research methods, professional scientific research environment, process-based scientific research, and enterprise based scientific research management" are implanted into the training process of student training.

6 CONCLUSIONS

Professional construction is always on the way. The college's innovation platform for integration of production and education is still under construction and improvement, and the construction of new majors is only one example of the construction of new majors in many vocational colleges. However, its construction mode, the coordination of schools, enterprises and local governments, and the construction goal of "driving one industry and serving one economy" through professional development have specific and good reference value for similar colleges.[2]

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REFERENCES

1. P.J.X, (2017)3D printing application talents training mechanism under the background of "new engineering". Educational modernization, Education modernization media brand:6-8.
2. G.S, (2022) Practice and exploration of additive manufacturing technology specialty jointly built by universities, enterprises and local governments. occupation, Professional construction:73-75.
3. J.Y.Z,(2009)Exploration and practice of scene construction and modular teaching reform.Journal of Beijing Institute of Technology (SOCIAL SCIENCE EDITION),Vol.11 No.6:38-40.
4. C.P,S.L.L,J.H.D,Z.B.T,H.L.L,(2020)Exploration and Practice on the construction of new engineering specialty with multi-disciplinary intersection——Take the construction of additive manufacturing as an example. Educational modernization, Education modernization media brand:80-82.
5. F.L,J.Y.W,(2020) Research on the mechanism of integrating production and education in Higher Vocational Education——Take the application of 3D printing additive manufacturing technology as an example. Cultural vision:401-402.
6. C.Y.W, (2020)The integration mechanism of industry and education in Vocational Colleges Based on the pilot practice of modern apprenticeship system Exploration and research. Educational modernization. February 2020 issue 12:71-73.
7. Z.G.Y,X.H.W,Y.P.S,S.T.C,S.T(2020)Research and Practice on the training scheme of mechanical manufacturing and automation talents in Higher Vocational Colleges Based on additive manufacturing (3D printing).Strait science and technology and Industry.
8. L.Y.W,J.C,G.N.Q,(2019)Build a new engineering talent training ecosystem oriented to "the Belt and Road". Journal of Higher education management, Volume 3, issue 13:61-69
9. X.J.G,P.J.Z,(2021)Research on general education training of innovative engineering talents under the background of new engineering. Journal of College of adult education, Hebei University, Volume 23, issue 2:92-98.