

Exploration and Practice of a New Teaching Method based on BIM Technology and Intelligent Construction

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Abstract

Taking the digital pile foundation engineering information management system built by BIM Technology as the carrier, this paper explores a new method of cultivating emerging intelligent constructors in the industry under the background of intelligent manufacturing. Different from the traditional classroom teaching mode of only teaching and post employment practice, this paper proposes a new teaching mode of "wisdom + collaboration + practical training", which is based on the joint training of government, schools and enterprises, and adopts real-time synchronous simulation practical teaching. While the school's scientific and educational personnel and students jointly participate in the construction process of "smart construction" digital platform, Synchronously embedded in the super simulation training platform for teaching, trainees can synchronize the real management system data, information and operation in real time to obtain the most intuitive professional effect experience. Using the digital platform, we can effectively realize the linkage between government functional departments, construction engineering enterprises, it technology enterprises, digital information engineering and industry experts and scholars, so as to summarize a set of systematic new and effective digital platform "smart construction" and "smart construction career" closely combined senior talent teaching and training mode.

Keywords

Smart Construction; Smart Builder; Smart Pile Foundation; BIM; Teaching.

1. Introduction

The country's strength and prosperity has brought about vigorous urbanisation, and along with the sustained growth of the national economic level, China's construction engineering industry has long maintained a high rate of development. According to data published by the National Bureau of Statistics, in the first three quarters of 2021, the total output value of China's domestic construction industry reached RMB 1,912,837 billion [1], accounting for 23.24% of the gross domestic product, and despite the impact of the epidemic, the year-on-year growth still reached 13.9%. The construction industry continues to play a bottom-up and stable role in China's national economy. While the industry is developing rapidly, the traditional construction industry is becoming more and more exposed to problems such as sloppy production methods, low labour efficiency, high energy and resource consumption, and insufficient technological innovation. Through the continuous promotion of intelligent construction and construction industrialization synergistic development, with artificial intelligence, intelligent cloud, Internet of Things and other new technologies, the formation of intelligent construction industry system covering technical research, engineering design, production and processing, construction and assembly, operation and maintenance, the integration of the whole industry chain, cross-field, all-round new intensive high-quality "China Construction "is the inevitable trend of the

development of the construction industry. In July 2020, the Ministry of Housing and Urban-Rural Development, the National Development and Reform Commission, the Ministry of Science and Technology and other 13 departments jointly issued the "Guidance on Promoting Intelligent Construction and Building Industrialization". The Guidance on the Collaborative Development of Intelligent Construction and Building Industrialisation" specifies that by 2025, an industrial system for the collaborative development of intelligent construction and building industrialisation in China will be basically established, and by 2035, significant progress will be made in the collaborative development of intelligent construction and building industrialisation in China [2]. This move will greatly improve the status quo of the industry, which is characterised by fragmented management, low efficiency and poor information communication in the traditional construction industry.

2. Overview of Smart Building

In response to the development of science and technology, intelligent construction has been gradually upgraded from National Encouragement and promotion to the inevitable requirement of industrial development strategy. The current focus is building informatization, and intelligent building industrialization with coordinated development of intelligent construction and building industrialization will be realized within five to ten years. In terms of building informatization[6], design institutes, schools and R & D institutions mainly focus on the realization of engineering construction simulation technology. Each R & D team is committed to developing building intelligent platform software, which is compatible with BIM information model to realize project coordination and management. Such achievements include, for example, secondary development of Autodesk products, secondary development of Revit Set and add enterprise attribute information function and bim5d technology application on BIM model. Under these technical carriers, the realization of perfect building informatization takes the realization of the following aspects as the main indicators: engineering construction model simulation from extensive to detailed; The expression of design intent is clear and accurate, that is, "model: what you see is what you get"; All participants can realize data collaboration in the cloud, that is, "people are working and numbers are changing"; The civil engineering, water and electricity, wiring and equipment of different disciplines of the project can be calculated. They are maintained and updated throughout the project cycle, showing the ecology of intelligent buildings and their vitality.

In terms of the coordinated development of intelligent construction and building industrialization, the overall goal is to increase the application of intelligent construction in all links of engineering construction and form an intelligent construction industrial system integrating the whole industrial chain including scientific research, design, production and processing, construction assembly and operation. Among them, research on Key Technologies of intelligent construction, development of basic software and hardware, development of intelligent systems and equipment, project application demonstration and cultivation of intelligent construction talents are the core contents. The Internet platform for the construction industry built for the industrialization, digitization and intellectualization of buildings has been preliminarily established, and the industrial foundation, technical equipment, scientific and technological innovation ability and construction quality and safety level have been comprehensively improved. Through such new scientific and technological means, labor productivity has been significantly improved and energy and resource consumption and pollution emissions have been greatly reduced, The macro strategic goal of effective environmental protection, create and realize the world's leading core competition of "built in China", and fully realize the industrialization of intelligent buildings [2].

3. Training of Intelligent Builders based on BIM Technology

3.1. Intelligent Constructor

In this context, the intelligent construction profession was born and is widely welcomed by the construction industry. They are highly integrated professionals who can integrate engineering construction with digitalisation, intelligence and information technology, use digital management platforms and integrate construction, management and implementation of construction projects as one. What distinguishes a construction engineer from other engineers is that he or she knows how to build and aims to build projects. From the perspective of the enterprise, how much of the actual production problems can BIM information technology currently solve? How much production value can be created for the enterprise? What is the urgent need for enterprises to solve the problem? What enterprises need is to bring new methods, new materials and new models around engineering and construction to ensure quality, energy efficiency and efficiency. Therefore, whatever new technology, new materials and new methods should be based on engineering construction, with engineering construction as the core.

3.2. BIM is a Teaching and Training Platform based on the Application of Wenzhou Smart Pile Foundation System

The volume of construction projects is complex and the content is various. The professional knowledge required to establish such an all inclusive and effective correlation system of content information is very complex and the workload is huge. This paper aims to start with a part of the construction project - the digital project of pile foundation engineering information management in Wenzhou, support the pile foundation information system under construction, establish a teaching professional training platform at the same time, explore the effective training mode of intelligent builders in the professional field of pile foundation engineering, and fill and meet the needs of government functional departments, construction enterprises, professional design. At the same time, we will cultivate talents who can fully adapt to and master this new type of "intelligent constructor" based on digital information system.

On the training platform, trainees can register on the information platform and enjoy corresponding permissions according to their own roles, and realize on-site operation and application equivalent to the real application platform in the training subsystem synchronized with regional construction information in real time. Through this simulation and training teaching, an effective model of joint training of intelligent builders by government, schools and industry enterprises based on digital education is established. This new model is summarized as "wisdom + interconnection + collaboration" teaching. This teaching method enables the teaching and research team and students to deeply participate in the construction of "smart site" pile foundation engineering data platform, and build an information-based pile foundation construction management service system covering "government, enterprise and project" by using Internet technology and information means, Improve the "smart site" management platform and comprehensively improve the refinement, informatization and digitization level of pile foundation construction management and supervision; On the other hand, in the process of implementing the talent training scheme of intelligent builders, the project is introduced into professional teaching, and vocational and technical talents with more market competitiveness are trained through well-designed systematic simulation on-site teaching means; On the other hand, it can feed back the construction and optimization of the data platform by feeding back the problems in the process of practical operation, so as to promote each other and create a win-win situation!

Building a digital platform, see Figure 1. which shows the real-time data information of regional construction projects. Supporting the information platform, explore the establishment of

synchronous training sub platform, and copy all the information of the platform in real time. At the same time, it is added as a special teaching tool for teaching, and establish a series of systematic training courses and methods in the form of simulation, Complete the teaching practice of corresponding intelligent constructor.

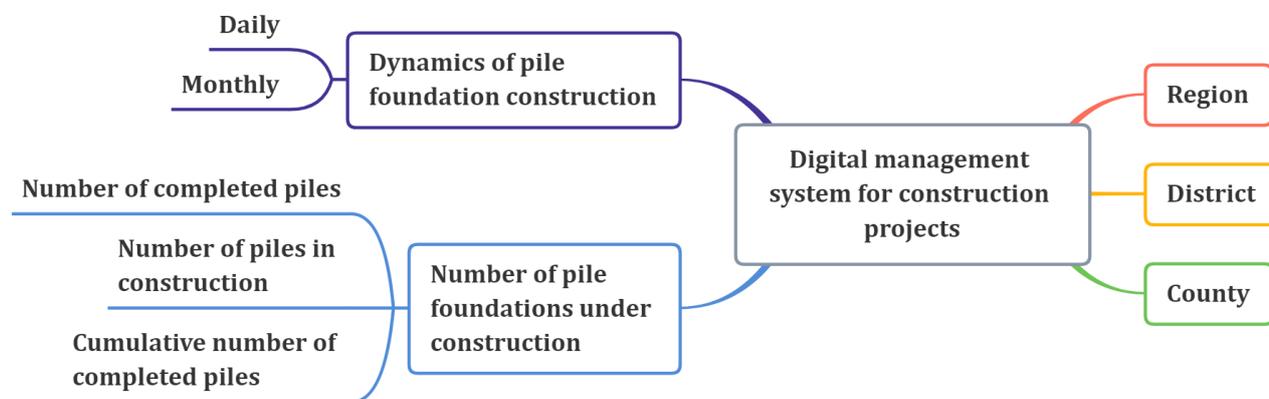


Figure 1. Building a digital platform

On the smart pile foundation platform, there are three portals. One portal can manage the registration information of the construction unit. The administrators of all engineering units under construction record the unit information by filling in the "project file". Establish government monitoring. After the pile foundation information is registered on the supervision platform, the display screen and real-time updated pile foundation information big data can be seen in the control room of relevant government departments to realize monitoring. On the smart platform, the second portal is to use the production platform. Mainly for construction and production, the project manager module is configured on the smart pile foundation platform, and the project manager can realize the function of smart command and management on the construction and production platform. Under this portal, construction managers can also enter and manage processes and procedures. The third portal of the smart pile foundation platform is a mobile applet, which is compatible with wechat and flexible to use. It is suitable for the on-site management of constructors and supervisors and is not limited by site conditions. It can update the process construction registration, inspection, verification and audit at any time.

Figure 2 and figure 3 are the architecture of big data application of digital platform and the architecture of digital construction management. The training and teaching of intelligent constructor is also carried out based on this framework. The trained constructors implement simulation operation according to their roles, experience and get the real feedback of the simulation brought by the operation through the internal digital process, so as to make the teaching immersive, and its effect is far better than boring classroom teaching and rote learning. Through the system's comprehensive application of interactive data, production data and other interactive contents of various main units, it provides different dimensions and contents of business needs to construction, construction, material manufacturers and other units to realize the whole life cycle service function of platform sharing and sharing; it provides government departments with a series of data such as summary and early warning analysis of construction market related industries to provide relevant data for the development planning and risk control of construction market.

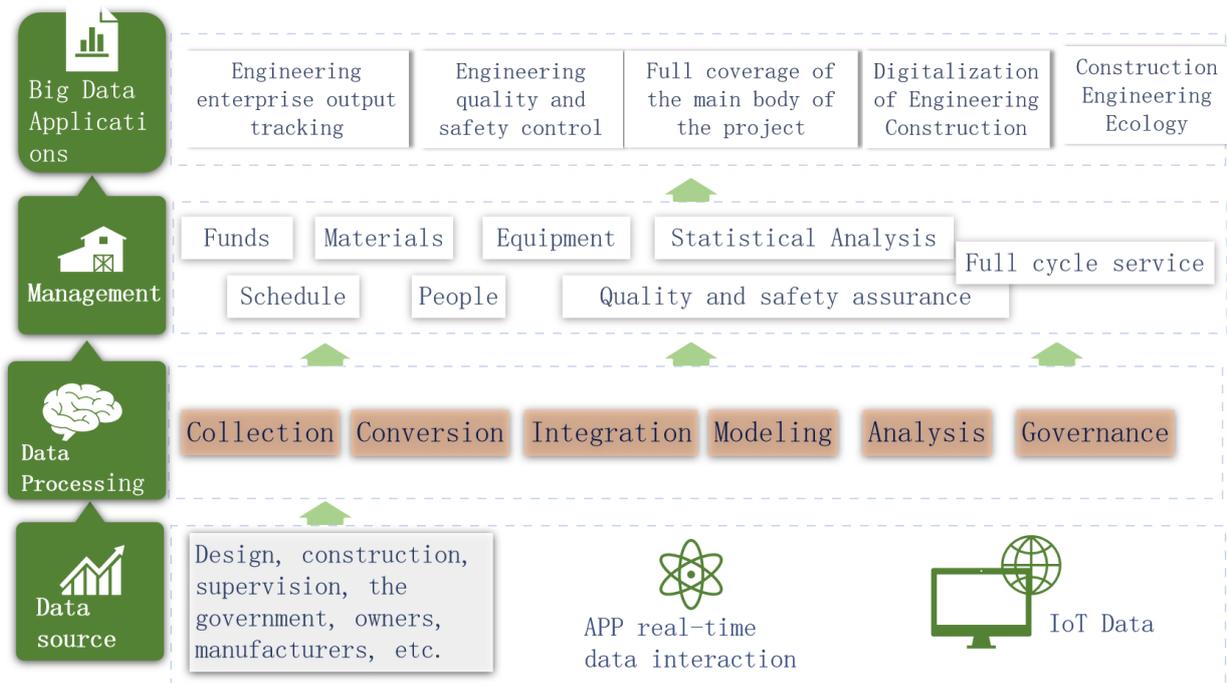


Figure 2. Architecture of digital platform big data application

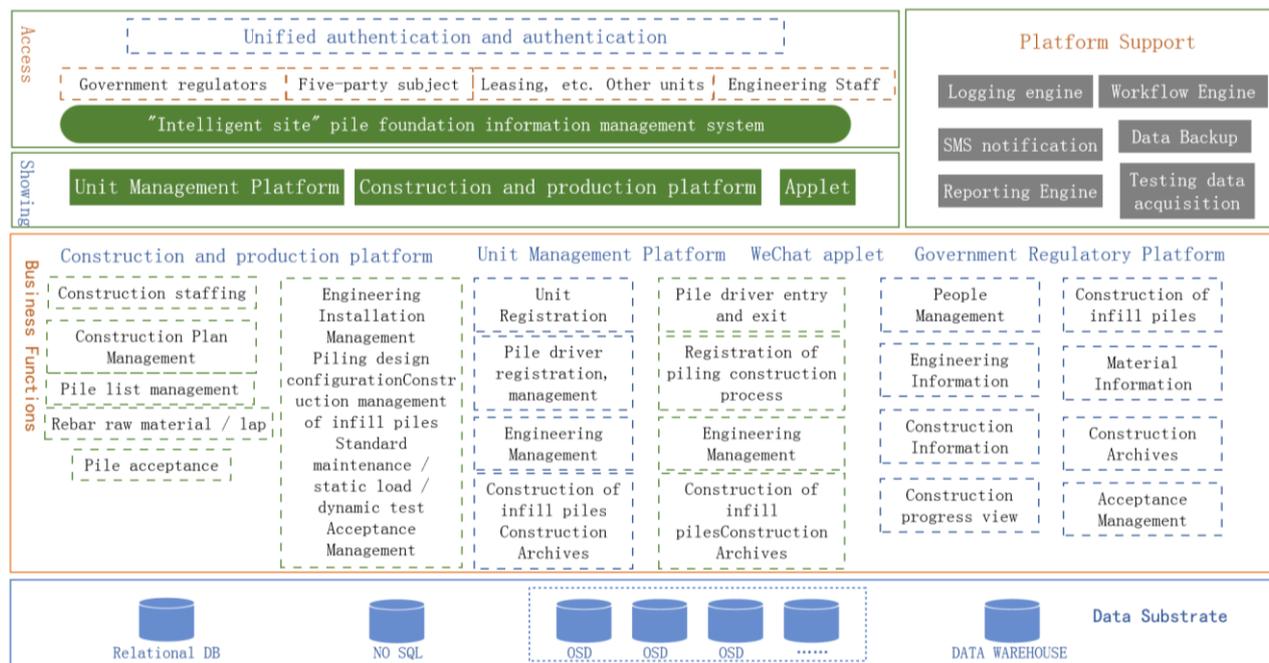


Figure 3. Digital management structure for pile foundation construction

Digitisation includes not only the collection and collation and analysis of big data-type data in the general sense, but also the simulation of figuration into data. The current development of BIM technology in this field provides the necessary support for this. Firstly, it presents the formerly linear components in the form of three-dimensional physical drawings and enables interactive and feedback visualisation between the components. In the Building Information Model, all processes are visualised, and its visualisation is not only used for effects presentation and production reports, but more importantly for communication, discussion and decision making during the design, construction and operation of the project, which can be built on the basis of visualisation[6]. Secondly, BIM building information model can co-ordinate the

collision problems of various professions in the pre-construction stage of the building, help designers to make modifications and achieve a good solution to professional design collision problems before construction. Thirdly, BIM technology can not only simulate building models, but also scenarios that are difficult to operate in a real environment. In the design stage, energy saving simulation, emergency evacuation simulation, sunlight simulation and heat conduction simulation can be carried out; in the tendering and construction stage, 4D or even 5D multi-dimensional and multi-element simulation can be carried out; in the operation stage, simulation of daily emergencies and handling methods can be carried out. Fourth, the use of BIM technology can also be used to optimise design, construction and operation. Because BIM technology makes good use of information, logical analysis and rapid judgement, it can help users to develop a variety of optimisation strategies in situations where construction design is becoming increasingly complex and exceeds the limits of the capabilities of those involved themselves. Fifthly, it provides users with the various reports and diagrams required and generated during the design and analysis process, such as integrated pipeline diagrams, integrated structural left-hole diagrams, collision check reports and improvement reports.

4. Wenzhou Vocational Education is of Great Importance to the Cultivation of Intelligent Construction Talents and Educational Reform and Innovation

On November 8, 2021, Zhejiang Provincial Department of education and other eight departments jointly issued the action plan for improving the quality and excellence of Vocational Education in Zhejiang Province (2021-2023). Article 11 of the plan specifies that it is necessary to speed up the digital reform of vocational education. A two-way docking mechanism between production and education supply and demand involving government functional departments, industry organizations, research institutes, vocational colleges, etc. shall be established. "Promote the accurate connection between vocational education and industrial talent demand." And Article 12 "build an integrated education model of" unity of knowledge and practice and combination of public schools "[3].

On December 6, 2021, Wenzhou Municipal Bureau of housing and urban rural development issued the notice on the full application of the information management system of the main project of "smart construction site" in Wenzhou, requiring to establish the digital management concept of "wisdom + interconnection + coordination", build an information construction management service system covering "government, enterprise and project", and improve the management platform of "smart construction site", Comprehensively improve the refinement, informatization and digitization level of construction management and supervision of foundation and foundation works and main structure works [4].

The Ministry of Education and the Ministry of Housing and Construction organized an industry resource survey report (2019): industry development and talent demand in the next 10 years in China's construction industry employees in technical and managerial personnel - the shortage of intelligent construction technicians will be greater than 1 million people / year smart construction technology talent shortage is highlighted in the intelligent design, intelligent equipment and construction, intelligent operation and maintenance and management of professional fields from 9% to 20%.

The training of intelligent constructors based on BIM Technology conforms to the national and industrial needs and is on the hot spot of industry training. In response to policy guidance, in order to promote the scientific and technological progress of enterprises, accelerate the industrialization of scientific and technological achievements in Colleges and universities, promote the combination of production, learning and research, explore and form a new teaching system with the joint construction of "construction engineering R & D center" by

schools and enterprises as the teaching base, establish and open the virtual simulation training base and double qualified teacher training base as the core, The implementation of training operation projects in the base provides important guarantee and support for cooperation in technical R & D, technical support, project support and other fields. The intelligent construction simulation classroom, which focuses on training intelligent constructors, will be built into a new curriculum with vocational education characteristics.

In the practice of realizing new education, the training teaching introduces the joint training mode of government, school and enterprise, and the industry education integration R & D institution cooperated by the government, school, system developer and construction party puts forward key research plans and schemes for key cutting-edge technologies related to wisdom construction. All parties involved jointly formulate technological development plans and carry out various scientific research projects. The University focuses on teaching the basic and cutting-edge technical knowledge of pile foundation information management, and arranges to participate in the training plan and practical courses of big data platform. The research topics of the teaching and research team mainly include how to test, train, operate teaching and embed teaching tools on the platform. Enterprises pay more attention to the digitization and intelligent practical application of knowledge and information and result feedback. Through such tripartite linkage between government, school and enterprise, the implementation steps of education reform will keep pace with the progress of scientific research achievements of the R & D platform, and all parties have their own needs, so as to actively and timely embed the fundamental contents required by vocational education into the implementation process of the whole large project.

The core organization principle of information management in pile foundation construction is to classify according to the main unit of the project, according to the specialty, formation time and process of the data, from shallow to deep, from coarse to fine. The training of intelligent engineering is also carried out according to this principle. The course not only strives to achieve the goal of cultivating high-end talents, but also attaches importance to cultivating students' basic working skills and craftsman spirit of excellence. Its essence lies in, first, teaching cases are decomposed and abstracted from real cases of enterprises. Second, the training platform is based on school enterprise cooperation, so it can establish independently managed online training projects relying on the "smart construction platform". Third, the project acceptance data are directly connected to the centralized units on the platform, such as urban construction archives, research institution databases, etc. Taking pile foundation engineering as an example, different roles such as government, construction unit, construction unit, supervision unit and supplier are designed by using digital technology multimedia interactive platform. Students carry out teaching and training through rich teaching and training contents. The advantage of online management function is that the operator is convenient and fast, and can input information timely and accurately, including image information, so as to avoid problems such as data loss or omission.

For example, in the pile foundation information management, construction equipment management is one of the important guarantees of project safety and quality, such as. The information of various pile foundation engineering personnel of the construction and supervision units shall be registered and managed online, and the data shall be called at any time. The two-dimensional code information management is implemented for mechanical equipment such as cast-in-place pile machine, which makes the operation simple and easy, and the operator can quickly complete it through the mobile phone. The system platform can record the basic information and construction process information of cast-in-place pile in real time with multiple interfaces. The production status of pile foundation engineering is tracked and counted in real time, and all data can be traced. The results of concrete test block detection, reinforcement raw material detection and reinforcement joint welding detection of cast-in-

place pile are recorded completely online, so as to realize the functions of material inspection, detection and real-time correlation, statistics and early warning of specific pile foundation. The static load detection and pile integrity detection of cast-in-place pile are randomly selected and recorded online, and the deviation acceptance of cast-in-place pile is selected, accepted and recorded online. The engineering data is complete and has the function of error reporting. The big data, digitization and intelligence of these information have a huge workload and are very error prone in the era of manual recording. Through new information technology, they have become a powerful assistant to intelligent engineers.

5. Prospect and Prospect of Intelligent Construction and Intelligent Constructor

Intelligent construction is a concept that is very broad and dynamic. It will be constantly updated and improved in line with the development of science, technology and management concepts in human society. In general, the expected prospects for intelligent construction are summarised in the following areas.

1). Digitisation. The digital information internet platform for the construction industry is the main way to promote the digital and intelligent upgrading of the industry. This paper also aims to embed the training of effective BIM-based "intelligent builders" in this segment.

2). Industrialisation. The deep integration of the construction industry with the industrialisation of information technology is complementary to the development of assembled buildings [5]. When the smart building construction enters a mature stage, the building process will be composed of several smart modules, with each zero component of each module being able to add attributes at any time and be able to self-check and warn to correct errors. In the intelligent building management centre (intelligent brain) all kinds of most scientific and reasonable standard data of components are stored. The product design is generalised, serialised and modularised to achieve an efficient standardised engineering and construction system with big data aiding scientific decision-making. The maturity of the development of assembled buildings represents the establishment of a specialised, large-scale and information-based production system based on standard components and the realisation of a model and industrialisation of building production.

3). The widespread use of intelligent construction robots. Construction robots are the ideal assistant for intelligent builders. At present, China has made breakthroughs in intelligent equipment such as excavators, building machines and bridge erectors. These construction robots can not only effectively improve production efficiency, guarantee safe operations and achieve precise production, but in the future, with the rapid progress of science and technology, a new generation of robots capable of independent learning and human-machine interaction will assist intelligent builders to complete more. In the future, as science and technology advance, a new generation of robots capable of independent learning and human-machine interaction will assist intelligent builders in completing more precise manufacturing and difficult construction projects, truly realising intelligent construction.

4). New construction talent training in a smart environment. The changing environment and the expanding knowledge space have put forward more requirements for construction talents, and talents limited to a certain field or even certain fields can no longer meet the needs of the digital, industrialised and networked intelligent construction industry. One of the most important issues in achieving the goal of intelligent construction is how to train more complex vocational and technical personnel who can adapt to the requirements of the times and the social environment within a limited period of time. After practice, the new teaching model of "intelligence + collaboration + practical training" discussed in this paper is an effective attempt to make use of professional knowledge and deep involvement in the construction of intelligent

construction management platforms, while creating digital training bases and platforms, and being able to imitate real training based on real cases. Through this new teaching model, intelligent builders and intelligent construction robots work together to analyse and solve problems based on big data in the cloud, and the resulting new technologies, methods and work patterns will certainly achieve satisfactory results in terms of safety, quality, schedule and cost[7].

5).The intelligent building will definitely be upgraded and improved continuously, aiming at low-carbon ecology, achieving green building standards, harmonization of internal and external environment, and harmony between human and nature[8].

6. Conclusion

To sum up, learning for application is the foundation of talent training. Adopting the new teaching mode of "wisdom + collaboration + practical training", supplemented by more flexible three terminal teaching, can not only effectively improve the professional skills of employees, make them faster adapt to the work needs of the new digital era, provide more professional technical services, but also provide a solid foundation for "smart construction", digital life and cloud services. This teaching method with a high degree of combination of theory and practice can effectively bridge the relationship between education, enterprises and the government, simulate and strengthen the training of the elements represented by "people" in the core element group of "man-machine, material, law and environment", from the actual development trend of the construction industry, the management needs of government functional departments The actual needs of enterprises in the industry and the professional ability of employees are of practical significance. It is an innovative attempt to directly connect school students with enterprises, industries and government management.

Acknowledgments

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