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Digital Architecture Teaching System at ETH Zurich

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Abstract:

The innovation of digital and information technology has spurred new thinking and new modes in various industries, which also makes architecture education tend to be digital in this context. In this paper, the construction of digital teaching system and teaching mode in Eidgenössische Technische Hochschule Zürich (ETH Zurich), renowned for its digital architecture teaching, guiding research and result transformation, is summarized, by means of presenting and analyzing course setting of digital architecture, basic laboratory research and teaching achievements in serving society on the basis of reviewing the development course of digitalization of architecture education, with a view to producing beneficial reference and significance for digital architecture education in China.

Keywords:*Digitization, Digital architecture education, Interdisciplinary, Teaching-research-production, Knowledge transfer.*

I. INTRODUCTION

Digital information technology innovation has promoted the rapid development of society, which on the one hand has accelerated the decline of traditional industries, on the other hand, has also spawned the rise of new disciplines. Over the past decades, digital technology has continuously influenced architectural practice and education in its unique way, its application in practice has improved engineering efficiency[1] and will make tremendous contribution to the sustainable development of society[2]; digitalization has changed the way of interaction, involving various fields of life in various forms, and has reshaped the scope of architecture

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discipline specialty[3,4], making the architecture discipline and education mode more diversified and complex, and having a profound and continuous impact on the development of architecture discipline and education and teaching methods[5]. In the field of architecture, the early criticism and conservative attitude towards digital education had changed to be more inclusive and positive [6,7], showing an important trend of interdisciplinary research between digital and architecture. New digital information technologies, such as the Internet of Things, big data, block chains, artificial intelligence and digital fabrication, are changing the traditional industry form imperceptibly. In this context, it is of great practical significance to discuss the impact of digitization on the application of construction education.

II. DIGTAL TECHNOLOGY INTERVENTION IN ARCHITECTURE EDUCATION

2.1 Development of Digital Architecture Education

Digital architecture education, referring to the education of architectural design adopting various digital knowledge and technology, plays a great role in promoting the construction of architectural discipline and practical production although it has only developed for less than half a century. From the early simple computer-aided design (CAD) to the computer-aided construction (CAM), there are roughly four development stages: In its infancy (1970-1990), the large-scale discussion and use of information technology from the 1970s to the 1990s mainly affected on the technical level[3], which is reflected in the fact that computer and computer-aided architectural design (CAAD) system has changed the way of thinking and mapping of practice and teaching design, and has generated positive thinking value in the discipline. In the rapid development stage (1990-2000), with the strong support of network and communication technology, it has greatly promoted the global popularization of digital education and the sharing and exchange of information[8], but it only stays at the conceptual level and cannot truly connect with the practical links. In the successful transition stage (2000-2010), with the further integration of digital technology and architectural practice, the large-scale popularization and use of computers and the opening of digital courses such as programming and design have laid the core position of digital technology in the future of architecture education[9]. At this time, the research of "generalized" digital architecture education still does not involve the core level of digitization. In its full bloom (2010 -), digital architecture education has made a big leap thanks to the breakthrough in fabrication. For example, the field of research continues to expand outward, and various emerging technologies at the practical level continue to emerge staggeringly in the future and real-life research[10]; the educational level has also shifted from traditional theoretical drive to digital technology-led

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drive[11], more and more digital technologies are incorporated into curriculum design, and the application of new technologies in information model construction and physical link analysis has become a key node in architectural teaching design, as shown in Fig 1.

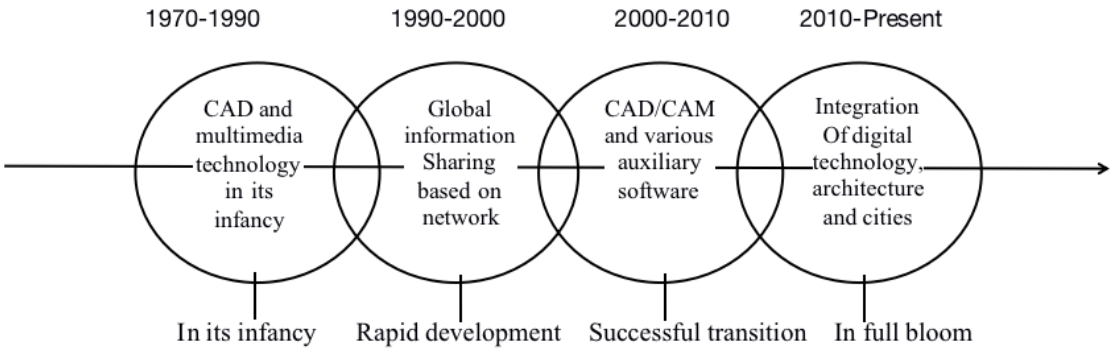

Fig 1: Evolution of Digital Architecture Education

Fig 1 shows that the role of digital technology in architecture teaching has evolved from a single assistant mapping tool in the early stage to a concept design based on interconnection, to a representation of virtual reality, and to today's multidisciplinary integration research dominated by interdisciplinary integration. Digital architecture will continue to expand its outer edge and connotation in the field of practice, and will reshape the overall curriculum structure of architecture education. At the same time, architecture education is also experiencing a transition from traditional static space teaching to dynamic space teaching which involves information explosion, interaction and challenge coexistence.

2.2 Shifting of Digital Architecture Education in ETH Zurich

The latestresearch in the field of digital fabrication shows that the development and use of digital technology in the construction process can greatly promote the transformation of the construction industry [12], and can achieve a new form of architectural expression, which will also affect or even change the way of architecture education in the future. As one of the world's top research architecture institutions, the Department of Architecture of Eidgenössische Technische Hochschule Zürich (ETH Zurich) has benefited from high-quality teaching and leading research results, featured by teaching and research method with close integration of architectural structure and design and a time-honored tradition. In the context of the rapid popularization of information society, ETH Zurich started early to explore digital architecture teaching, and initiated the national strategic digital architecture education program regulated

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nationally with National Center of Competence in Research (NCCR) in Switzerland in 2014, which integrated digital information technology into the research foundation of structure and design, explored a new path of modern architecture education under the digital environment, and reconsidered and defined the significance of digital technology for future architecture education.

The core of digital architecture research is to establish interdisciplinary research between different disciplines. The remarkable advantage of digital architecture education of ETH Zurich is to make full use of the potential of digital fabrication technology and create a strong interdisciplinary research department, typically integrating traditional independent disciplines such as architecture, computer science, material science, civil engineering and robotics technology. The digital architecture education of ETH Zurich is the integration of knowledge creation, processing, dissemination and application, which makes them penetrate and promote each other and produces a strong aggregation effect. Digital technology will completely change the teaching mode and practical technology of architecture. The talent training mode of ETH Zurich is redefining the seamless integration of architecture, digital technology and physical construction process in the future, paving the way for the realization of new design paradigm.

III. DIGITAL ARCHITECTURE EDUCATION SYSTEM OF ETH ZURICH

3.1 Three-Dimensional Organization Structure of Production, Learning and Research

At the beginning of 2000, relying on the strong strength and fruitful research achievements of the laboratory, ETH Zurich began to explore the application of digital technology in the architecture teaching process, providing research ideas and directions for the digital architecture education practice. Unlike the "plug-in" teaching mode of digital architecture in most colleges and universities, i.e. the setting of digital architecture course lacking systematic framework and course connection, ETH Zurich has collected all kinds of teaching resources in the school, integrates digital technology, human-machine intelligence and other disciplines into the teaching and research of architecture, and makes fundamental thinking in the new knowledge field of digital architecture. Not only are the research directions closely related, but also the logic among courses, courses and experimental research and output activities is strong, and the digital architecture education system featuring "Teaching Activities - Lab Research - Innovated Output" has been formed, as shown in Fig 2.

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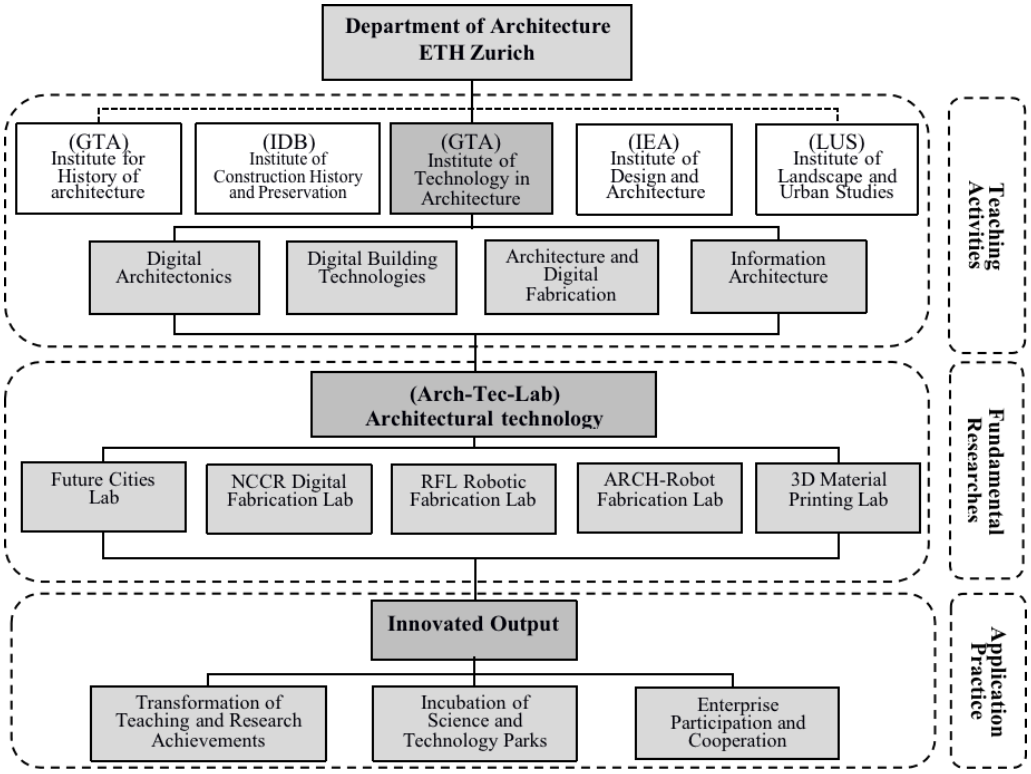

Fig 2: Structure of digital architecture education in ETH Zurich

As one of the five institutes under the Department of Architecture, the Institute for Technology in Architecture (ITA) is also the core institute for the education and research of digital architecture, where a teaching and development platform in the frontier field of digital architecture has been formed after years of exploration and practice. The platform consists of labs in four directions: digital architectonics, architecture and digital fabrication digital building technologies and architecture information, each of which is presided over by experienced professors who also undertake the teaching and research of digital technology courses. Finally, the teaching results are transformed in the Arch-Tec-Lab for the technical output driven by practical teaching and research. Next, the analysis will focus on three aspects: digital architecture teaching curriculum, laboratory research and output.

3.2 Analysis of Digital Architecture Education Model

3.2.1 Main Research Directions of Digital Architecture

The digital architecture teaching of ETH Zurich has a very distinct goal, where not only is

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the research direction clear, but also correlation among the research departments is strong, so as to jointly cultivate international talents with innovative integration of industry and education. Digital courses have been set up from undergraduate to postgraduate stages, covering the contents starting from the study of digital architecture theory at the architectural level, focusing on developing students' ability to apply digital concepts, then gradually transitioning to software training and practical operation, finally rising to the level of concrete and quantifiable urban information data, forming a complete teaching system chain, so as to realize the sustainable development of cities. The digital architectonics, architecture and digital fabrication, digital building technologies and information architecture together constitute the teaching foundation of digital architecture, as follows:

1) Digital architectonics, which emphasizes on the interaction between technologies and human, is aimed to expand the teaching content and solve all kinds of problems brought by urbanization through digital means. To this end, the lab, with specific learning content and clear research ideas to guide students to contact the frontier of the development of disciplines, has formulated a detailed teaching plan: first, to deal with the challenges faced by digital technology in the process of city reconstruction; second, to firmly grasp the working principle of digital field, excavate interest points in digital architecture learning and deepen research. Therefore, the design course is no longer a simple drawing representation (programming instead of drawing), its core teaching task is to enable students to master the parameter programming design with programming language as the core and generate diverse solutions in practice. The team of teachers from different countries, regions and disciplines continuously inject knowledge from relevant domain into the curriculum, which ensures the global perspective of basic teaching and lays a solid knowledge reserve for subsequent research on digital building technologies and fabrication.

2) Digital building technologies are designed to study new architectural technologies on the strength of advanced computational design methods, seamless integration of digital fabrication and new materials. Benjamin Dillenburger, the leading professor in this field, believes that digital technology will become the main driving force for the development of new materials and new fabrication methods, that the combination of new technology and new materials in this context will challenge the traditional architectural research ideas, and will achieve a short time, high efficiency and low cost construction strategy, and that additive manufacturing, including 3D printing, has great potential in the building field. Fundamentally, complex design solutions have been pioneered and innovated to make the construction process more rational and quality, and conceptual design has been transformed into a spanning construction entity.

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3) Architecture and digital fabrication. In order to conform to the development direction of digital intelligent construction in smart cities in the future, under the background of digital fabrication as the hot research topic in the world, the lab constructs teaching tasks around three topics: computer design, robot fabrication, and material and construction system, and actively explores the impact of digital fabrication technologies on the construction industry and the teaching mode of architectural design. In the process of learning digital fabrication, students can acquire the skills of building component making which integrates material function and aesthetic quality, non standardized digital construction ability of building components and comprehensive practice and teaching research methods, making it possible to use advanced digital construction methodology to achieve the interaction between design and material process.

4) Information architecture. Urban sustainable development is an important research direction and path for future cities. With the intensification of global urbanization process, cities will become the main living and working environment for most people, so the livability of cities becomes crucial. Gerhard Schmitt, a leading professor in the field of information architecture, believes that the communication between cities and residents should be two-way[13], and urban research should focus on the impact of digital and information on future urban development. Through the structure of a simulated urban information system, with data and digital information as the raw materials, students master a series of organic processing methods of overall planning and design by using digital visualization means, and create a simulated, visual and interactive platform for future urban research, ultimately realizing the quality management of large-scale urban space style and living environment. The research and discussion of information architecture has elevated the discussion of digital architecture from the construction level to the urban system level with a more integrated perspective, thus realizing the two-way communication between cities and residents.

3.2.2 Characteristics of Digital Architecture Teaching

1) Interdisciplinary general education system

An important trend of the development of modern higher education is to cultivate interdisciplinary talents, which is also an important measure of education reform. The teaching design of ETH Zurich has solved the practical problems of too fine classification of disciplines and specialties, split knowledge system and difficulty in meeting the needs of society. As the foundation and core element of digital architecture education, interdisciplinary thinking mode is permeated with general education concept constantly in the course teaching, focusing on

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cultivating students' comprehensive and design practical ability.

In the training program, which focuses on the integration of curriculum content from theory to practice and from abstract to concrete, a series of courses of Computer Aided Architecture Design (CAAD) are firstly constructed. Ludger Hovestadt, a course professor, argues that the core of digital architecture today is to apply the technological developments in other specialties to the construction industry, not to dwell on pure virtual reality technology experiments, but to find an anchor point that combines history with the present to demonstrate the specific uses of contemporary architectural practice. The courses are designed to guide students to think about computational models in architecture from frontier perspectives, attach importance to general knowledge cultivation in teaching methods and contents, and the knowledge system of different disciplines such as architecture, computer science, mechanical engineering, robotic technology, cognitive psychology and urban sociology jointly construct students' cognitive context. In this teaching concept, digital technology is emphasized to develop architectural design and theoretical research from the perspective of Internet of Things, big data and machine intelligence, and students are encouraged to use digital thinking to discover and solve various problems in the process of urbanization. In addition, there are abundant contents to supplement general education, such as after-class guidance, exercises, seminars, lectures and practice practice, to further expand the scope and vision of students' knowledge, to facilitate the transfer and development of knowledge and skills, and to focus on teaching complementation from static to dynamic.

To sum up, the interdisciplinary training system of digital architecture education of ETH Zurich is based on the integration of teacher resources and multidisciplinary knowledge with different disciplines background, which can widen students' disciplines perspective and promote disciplines exchange so that they have the ability to constantly adapt to social needs and solve complex problems, and that it can complete the organic connection between enterprise needs and talent cultivation in industrial transformation and upgrading.

2）Online and offline blended teaching model

The teaching of theory and practice design is often limited by the site and equipment [14], resulting in the inability to interact and discuss effectively with students [15]. ETH Zurich and a number of Swiss universities have collaborated to create Swiss MOOC Service, which provides courses to ordinary people outside the "Ivory Tower" on a virtual platform and is an important source of advanced knowledge for students of ETH Zurich. For example, the teaching mode of information architecture direction is set to take quantifiable data as the core. The mixed

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teaching mode is used in future urban thematic courses, actively focusing on and discussing urban environmental issues. Four versions of courses have been continuously updated and upgraded since 2013.

Online courses are offered in a virtual design studio, with self-study as the main line, and students from different disciplines backgrounds are encouraged to form learning groups freely. The course aims at high-density urban areas, planning four online learning modules of future cities, livable cities, smart cities and response cities to fully understand the city as an "organism", quantitatively simulate the city's "metabolism", and explore data-driven urban issues based on crowdsourcing and perception. In addition, hard requirements for submitting course assignments and teaching links for final exams are also designed for online courses. Links such as simultaneous training, attending related lectures and interactive discussions are also designed to facilitate the supplementation and exchange of interdisciplinary knowledge.

Offline teaching is centered on the processing of data and digital information and a series of special courses entitled "Data Mining-Information Architecture-Digital Analog-Urban Response" are set up with the research of urban environmental problems as the theme to effectively link up with the online courses. Studio teaching can be used to evaluate, discuss and consolidate the content, and to solve problems in an interactive way. At the same time, under the guidance of teachers, field survey and analysis activities such as data collection, processing and analysis, assessment of urban systems and quantitative analysis are completed. Finally, the concept of citizen design science is put forward, which advocates the public and experts to participate in urban planning and design.

The online and offline blended teaching method is developed on an interconnected and shared network platform, which is characterized by the use of data visualization resources and the establishment of more diverse teaching methods, breaking the limitations of student participation and learning motivation. The combination of digital technology and architecture education has realized the interconnection of different disciplines and greatly enriched the traditional learning methods. More class time is allocated to students who have difficulties in understanding knowledge points, so that they can master the key points of learning and understand the difficulties of knowledge in a more in-depth way, and more innovative experimental teaching methods can be carried out, realizing the concept of combining online course autonomous learning, offline teaching guidance and team cooperation, overcoming the blindness brought by a single way, so that the whole teaching process reflects a clear teaching goal, and adapts to the trend of future subject integration and diversified development.

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3) Course cluster oriented by social needs

The particularity of architecture discipline makes architecture education a life-long system, and the concept of architecture education should keep pace with the times. In response to the trend of digital fabrication in the future, ETH Zurich has launched a cluster of architecture education courses based on digital research for different levels of people, such as undergraduates, postgraduates and professionals in the construction field, to improve new skills to meet the path and practical needs of professional development. With competency-based learning, the representative cluster courses are MAS ETH DFAB, CAS ETH ARC and continuing education of 3D MIT ArcGis.

Taking MAS ETH DFAB as an example, the prominent feature is the 1-2 year part-time study mode, which is divided into 7 independent modules for teaching. Each module is closely connected with workshops and laboratories and taught in the form of special discussion. First, expand the teaching horizon. First, expand teaching horizons. Experts from academia and industry regularly interact with students to teach advanced methods and technologies based on the cutting edge of digital fabrication. Second, improve students' digital literacy. In order to meet the demand of digital fabrication in construction industry, teaching focuses more on the cultivation of practical ability of digital application. Thirdly, the cultivation of core element ability is to cultivate team cooperation ability. Students of architecture and computer science, robotics, control system engineering and other specialties form learning groups, use advanced robotic construction equipment and printing technology to implement the 1:1 prototype of conceptual scheme, and collaborate to complete real project cases. Meantime, CAS ETH ARC and 3D MIT ArcGis courses are offered to professionals in the construction industry, and their essential differences from Master's courses are in the depth and breadth of course learning. On the basis of practical work experience, students accept digital construction courses and experimental teaching which are more in line with the current work situation, master the whole process design method of digital and assembly design, and make it a career leap-forward development path through the post learning mode of "practice-theory-re-practice".

Students experience and expand the creative power of digital fabrication process through a series of effective teaching training. Guided by social needs, knowledge in the field of digital architecture has been successfully transformed into practice. Individual creativity and self-assessment thinking ability have been greatly improved, enabling them to take the lead in future design, development or management positions. To a large extent, the open curriculum for all members of the society promotes the development of digital fabrication in the whole construction industry, and shows the integrity, continuity and innovation of the digital

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architecture education system of ETH Zurich.

3.3 Basic Laboratory Research

As a practical platform to show the students' ability to apply, innovate and create the knowledge they have learnt, the digital architecture education of ETH Zurich is characterized by cultivating the students' practical ability, with the goal of high-quality research teaching, and focuses on the education mode of "teaching-practice-output" combining the technical knowledge with the ability to use, and actively discusses the impact of digitalization and automation on the construction education and industry. Under the continuous promotion and integration of the project, a number of representative and leading characteristic laboratories within the discipline have been generated.

3.3.1 Robotic Fabrication Lab

The development of computer-aided architecture design and robotic fabrication has created conditions for seamless connection between design and fabrication, which, together with the robotic fabrication lab, has helped ETH Zurich take an important step towards digital fabrication. The renowned Robot Fabrication Laboratory (RFL), in which four industrial robots can work together in a huge space of 43m×16m×8m, allows experts and students in the field of digital fabrication to conduct unprecedented large-scale experiments and master the procedures for automated construction of robotic processes. Furthermore, the lab supports 1:1 scale 3D printing of buildings, and the operation links can enhance the innovative creation of design and construction. In this way, students can actively participate in the docking process of social practice and commercial manufacturing services, and can also manually produce design finished products such as building components, city sculptures, landscape installations, and participate in some large-scale design exhibitions and art festivals to turn concept works into physical exhibitions. In addition, the lab provides a variety of internship opportunities for students of this or related disciplines to choose from, to meet and participate in real project cases, to work closely with architects, materials scientists and structural engineers as members of an interdisciplinary team to explore technical and material solutions.

3.3.2 Future Cities Laboratory

The architectural technology laboratory is the result of the interdisciplinary cooperation and the application of new technologies in digital architecture education, which demonstrates the impact of digitalization on the efficient and intensive, energy-saving and non emission of architectural design. Here, the traditional boundaries of different disciplines are weakened, and

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the continuous "digital chain" process links all steps from design to construction. The "fabrication gap" between design and reality is bridged by digital fabrication, which provides a powerful guarantee for future urban sustainable development.

This laboratory is a research institution based on the achievements of previous digital fabrication, driven by digital technology, to explore strategies for improving urban environment and generate design schemes. As an interdisciplinary research center, ETH Zurich Future Cities Laboratory in Singapore is an important part of the globalization strategy of its scientific research projects. Urban sustainable development as a major project, guided by the pioneers in the field of digital construction, Professors Fabio Gramazio and Matthias Kohler, has carried out teaching research around the three themes of "computer design, robotic fabrication and material structure system" in the form of joint teaching with the teachers and students of National University of Singapore and Nanyang Technological University. By means of investigation and observation, the urban stock and flow resources are mastered, and the interdisciplinary research methods of architecture, structural materials, robotics and computer science are integrated in the practice process, and the strategies and methods of digital technology in modular manufacturing of high-rise buildings are explored. Laboratory project research catalyzes major changes in urban production conditions and creates a new dimension for the diversity of automation through creative dialogue with industrial production logic and paradigms[16]. Student achievements are displayed in the form of lectures, seminars, publications and exhibitions of conference papers, and achieved expected results through exchanges and discussions among experts, scholars and the public.

3.4 Research Output and Application Practice

Basic research is the source of the entire science and technology system and the driving force of innovation-driven development. Although achievements and papers in scientific research have always been an important reference to measure the level of education in colleges and universities, ETH Zurich pays more attention to the value of technology transfer on this issue, and hopes to build a complete and innovative education ecosystem in a multi direction approach. It has become the primary teaching and research goal of ETH Zurich to directly transform the research results into industry and deliver them to industry in time, which is especially valued in the traditional strong discipline of architecture in the university. Digital fabrication provides synergy and opportunities for a large number of achievements transformation and innovation, forming an innovative digital architecture education ecosystem.

(1) Focusing on the transformation of teaching and research achievements. At the graduation stage, the seamless combination of papers, practical research and achievement transformation is

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an important reflection of the teaching results of the college, which enables students to integrate the research results of the laboratory and graduation works, with an attempt to cooperate with local construction enterprises. The entity fabrication is completed through a series of digitized processes such as analog form, automated analysis, transmission and printing, which makes the conceptual concept come true and is conducive to the training of students' innovation and cooperation ability, and helps the enterprises in technology and products updating in this process.

In the university, practicality-oriented basic research is advocated, and teachers and students play a key role in innovation and entrepreneurship. Besides, a pioneer scholar program is set up to promote their entrepreneurship to encourage teachers and students to innovate and release vitality from various levels, such as technology, capital, social practice and value-oriented, in order to push research results to the market and obtain their own benefits in the transfer of results. On this basis, the university actively cooperates with practical R&D institutions. For example, the prospects of digital technology combined with sustainable research of wood materials are shown in the digital assembly project of shaped roof structure. After pushing the research into application and practice, a large number of start-ups and new potential of industrial cooperation emerged, thus realizing the original intention of digital architecture education of the university.

(2) "Incubation" of innovation and technology park. As one of the important R&D and technology transfer centers in Zurich, Zurich Science and Technology Park relying on universities such as ETH Zurich and a number of scientific and technological innovative enterprises and scientific research institutions, jointly builds a service platform for college students' innovation and entrepreneurship, where students can continue their research in the university, with the university providing entrepreneurship guidance and comprehensive follow-up evaluation. Finally, hundreds of international patents will be born each year, which contributes greatly to the improvement of national innovation ability. This has become a new way of transforming university teaching and research achievements, and an important platform for the combination of industry, university and research.

(3) Strengthening the cooperation of teaching, research and production. Enterprises have signed cooperation agreements, strategic alliances, and jointly established laboratories and R & D centers with colleges and universities. For example, ABB, a partner of the robotics fabrication laboratory in Sweden, as a sponsor of robots and their control systems, has been working closely with ETH Zurich on knowledge transfer between teaching research and industrial production. Here, the lab no longer only has a single experimental function, but also uses

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innovation as the driving force to realize teaching, practice, design and fabrication in the same space, from design to construction to building entities. The continuous digitizing process also enables ABB to see the huge prospects of digitization and automation in the construction field.

IV. ENLIGHTENMENT TO ARCHITECTURE EDUCATION IN CHINA

With the rapid transition of the mode of production from mechanization to digitalization, emerging industries such as the digital economy are booming, which has a huge and far-reaching impact on the society. With the promotion of digital strategic decision-making to national level in China, digital economy has been written into the Government Work Report for many times and is considered as a new variable to improve quality and efficiency and a new blue sea for transformation and growth. However, the construction industry is not well prepared for this change and its investment and innovation lag far behind other industries, so it is imperative to transform the digital architecture education in the context of the urgent need for transformation and upgrading in the construction industry. Starting from the digital architecture education in ETH Zurich, this paper actively explores and studies the digital architecture education mode adapted to the development of the times, which provides a strong guarantee for the transformation and development of the construction industry, and also points out the development path and direction for the future digital architecture education in China, for serving the national strategy, and training digital skilled personnel, in the following aspects:

4.1 Establishing a Digitalization-Oriented Architecture Teaching System to Meet the Needs of the Society

In order to realize the digital transformation of teaching knowledge, ETH Zurich attaches great importance to the rational use of digital technology in the teaching process, updates the teaching infrastructure and actively constructs the digital architecture teaching system. Modern digital education enables students to learn independently according to individual differences, which optimizes the flexibility of teaching methods, improves students' interest and enthusiasm in learning, and achieves deep personalized learning customization along with online and offline blended teaching mode that changes the classroom experience on campus. In the process of practice, the in-depth application of various types of digital technology intelligently improves the training of students' hands-on operation ability and collaboration ability. Thus it is clear that digitalization will completely change the "teaching" and "learning" of architectural education in the future. At present, most teaching links in China still remain in the traditional teaching form, and it is necessary to actively think about how to adapt the design studio to the digital trend, apply new equipment, new technologies and new models to seek new ways of teaching process.

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The digital teaching system constructed by ETH Zurich is worthy of active attempt and promotion in China's construction colleges and universities.

4.2 Promoting Collaboration and Research among Different Domains in the Face of Industrial Demand

The digital architecture education in ETH Zurich has broken the traditional "academy-discipline" setting mode, with the training goal of students' interest and ability to participate in interdisciplinary research activities, master professional cutting-edge knowledge and skills under a strong multi-disciplinary background, and treat architecture education as an interdisciplinary "ecology" research rather than a separate discipline, providing students with tools that can continuously adapt to social development, as well as skills to transform expertise into results. Due to the late start of domestic architecture education, most of which grew up in the environment of engineering colleges and universities, it is necessary to pay more attention to the personalized training of students and continuously expand the multi-disciplinary knowledge stock of students. ETH Zurich has been continuously promoting interdisciplinary integration, forming a multi-disciplinary cooperation mode of "science and engineering", "engineering and engineering " and "arts and engineering" to effectively connect vocational education and training with architectural quality education, which has played a beneficial enlightenment for the continuous improvement of architecture teaching quality in China.

4.3 Stimulating Social Energy and Promoting the Exploration of Multiple Cooperation Models

As an important function of modern universities, teaching, research and production is both a systematic project and a social work, with a necessity to integrate the common will of universities, scientific research institutions, enterprises and the state to form social responsibility. Teaching and research should continue to promote social practice. In view of the current "split" relationship among architecture teaching, research and social practice, ETH Zurich and the NCCR have jointly established a digital architecture teaching platform based on professional training of industry standards, which provides a reference model for the architecture education in China in accelerating the research and in-depth exploration in the field of digital architecture, providing synergies and opportunities for the substantial transfer of knowledge and innovation, continuously balancing the supply-demand relationship between schools and society, and achieving the goal of "going out of class" with the new industry-university-research system of mutual benefit and collaborative development. At the same time, outstanding achievements in teaching, research and knowledge and technology transfer continue to enhance the competitiveness of schools and countries as an innovation engine and contribute to social

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development.

V. CONCLUSION

Architect Hopkins said, "Architects in the post-digital age will design in code, and robots will build our buildings." In the digital information age, the scope of traditional architecture education has been continuously expanded, and the space of digital simulation has expanded the connotation and extension of the inherent architectural concept, and the architectural elements have been more abundant in the digital space. The combination of digital and architectural education has brought a new development space and opportunity for architecture education, but as the experience and technology of the complete design process, it still lags behind the accumulation of traditional architectural education and practice, and needs more social attention, construction investment and educational forces to promote its continuous development.

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