

Shift toward Emerging Engineering and Application-Oriented Education

—Taking Architecture Education in Huizhou University as an Example

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Abstract

Under the circumstances of shift toward emerging engineering and application-oriented education, the Undergraduate Architecture Program in Huizhou University has been exploring how to fit into the future-oriented, region-oriented and industries-oriented teaching. We strive for a breakthrough in teaching reform by innovation, integration, collaboration and practice to cultivate talents in architecture education. Since 2012, we have been committed to teaching approach exploration with a strong characteristic uniqueness, innovation and application. It proves to be a success that our teaching approach has nurtured graduates with uniqueness, innovation and application.

Keywords

Architecture Education, Emerging Engineering Education, Application-Oriented

1. Introduction and Background

The Undergraduate Architecture Program in Huizhou University was launched in 2003, following South China University of Technology, Shenzhen University, Guangzhou University and Guangdong University of Technology. Over 13 years' development, it was authorized as Provincial-level Specialty in 2016. Since 2012, we have been committed to teaching approach exploration with a strong characteristic of local and application-oriented (hereinafter A.O.) universities, nurturing graduates with uniqueness, innovation and application, engaging in engineering and research that has impact and practical value. After a seven-year'

exploration and transformation, an innovative teaching approach characterized by emerging engineering and application oriented, integration of greenization, digitalization and localization, has been established and been widely used in our teaching. We strive for a breakthrough in teaching reform by innovation, integration, collaboration and practice to cultivate talents in architecture education.

Guided by this approach, we have made remarkable achievements, such as more than 2000 high quality for talent, 15 collaboration of research, education and practice platform, 21 national and provincial research projects, a specialty construction success; that is, Architecture was authorized as Provincial-level Specialty in 2016 by the Department of Education of Guangdong Province Guangdong. According to Universities Ranking of China released by Chinese Universities Alumni Association (hereinafter CUAA), Huizhou University ranks fourth and is marked as regional first-class specialty among the twenty undergraduate architecture program from 2016 to 2018¹. Besides, due to its innovation and wide applicability, it has great value and potential for local universities and colleges. It paves way for the first-class architecture specialty construction and high-quality architectural innovators training.

2. Guiding Beliefs

Teaching approach transformation and innovation is not only a breakthrough to the undergraduate teaching reform, but also key to specialty construction and high-quality architectural innovators training. Under the circumstances of technological advancements and artificial intelligence, local traditional engineering education must shift toward emerging engineering and application-oriented education (hereinafter two shifts). To meet our vision and mission, the undergraduate architecture program in Huizhou University develops an innovative approach, adhering to the philosophy “Student-centeredness, Outcome-based Education and continuous improvement process (CIP). Thus, a new teaching approach, based on “Future, Region and Industry Orientated”, is implanted through innovation, integration, optimization and practice.

Huizhou University, located in Huizhou, one of the nine Pearl River Delta (PRD) municipalities, should take full advantage of the Outline Development Plan to develop the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area), enhancing collaboration and connectivity among industries in the Greater Bay Area. To accelerate the green transformation and upgrading of the manufacturing industry, emphasis the promotion of the green building, artificial intelligence building and upgrading of traditional building materials and building methods as well as the development of green products, and create a green supply chain. We have 55 staff members, including 3 professors, 12 senior engineers, 10 doctors, 5 doctoral candidates.

¹Chinese Universities Alumni Association. Universities Ranking of China , <http://class.cuaa.net/cur/2018/2018dxpm.shtml> [O/B] 2019-3-2.

3. Teaching Approach Innovation

3.1. Future-Oriented

According to Marc Prensky², Future-oriented Educating is educating with a firm eye on—in addition to the tests and the current curriculum—the real things our students need in their future lives, as we, their educators, perceive them. It means consciously re-balancing our teaching away from being only past-oriented to being far more future-oriented than it is today. It means adding a huge range of teaching contents we don't teach systematically today but that will be needed for tomorrow. Emerging engineering education (hereinafter 3E) requires institutions of higher education to expand the education reform of engineering professionals, take advantage of the close relationships between institutions and industries, become oriented to the current and future needs of industrial development, and expand the content and key development areas of engineering programs to vigorously train professionals who are involved in engineering technological and industrial innovations (Li et al., 2019). China's Emerging Engineering Education Construction and Action Guidelines (“Tianda Action”)³ clearly state the need to update and reform traditional disciplines and specialties, serve the transformation and upgrade of traditional industries, develop toward the middle and high ends of the value chain, provide an impetus to combine existing engineering disciplines and the integration of engineering disciplines and other disciplines, extend applied science disciplines to engineering disciplines, and cultivate new interdisciplinary specialties. Thus, the call of future-orientation education is essential. Building greenization (ecological building, green building and building conservation) and building digitalization (Auto CAD Architecture, Building Information Modeling, AI + Architecture, Virtual Reality, 3Dimension Printing, AI + Construction) will surely lead the frontier developments in the following decades. In order to meet the requirements of the 3E, the traditional teaching approach should integrate with the newest technology, such as greenization, digitalization, informatization and intelligentization, thus upgrade into Building plus (Building+) (Yuan & Zhao, 2017). School education should prepare students for the challenges of tomorrow. Students of today need new skills for the coming century that will make them ready to collaborate with others on a global level. Whatever they do, we can expect their work to include finding creative solutions to emerging challenges. Only by integration can we transform from traditional architecture education to emerging architecture education, which can bring about such changes as teaching contents and teaching methods (Wu et al., 2017).

3.2. Region-Oriented

Well located in the Greater Bay Area, adjacent to Hong Kong, Macao, Guangzhou and Shenzhen, Huizhou boasts for its ecological conservation, natural re-

²Marc Prensky. <http://marcprensky.com/> [O/B] 2019-3-2.

³Emerging Engineering Education Construction and Action Guidelines. http://www.tju.edu.cn/english/news/latest/201904/t20190417_313009.htm [O/B], 2019-03-12.

sources, marine resources and pleasant living environment, surrounded by mountains and lakes. From year 2000 up till now, Huizhou has been honored as National Forest City, National Clean City, China's First Urban Green Lighting Demonstration Project City, 4th Place among Top 10 Livable Cities in China, 2018 National Water Ecological Conservation City, the first batch of China's Beautiful Landscape Cities, National Famous Historical and Cultural Cities, which offers lots of potential for the building industry⁴. In October 2015, Ministry of Education, Ministry of Finance and National Development and Reform Commission (NDRC) jointly issued Guidance for Encouraging Regular Local Undergraduate Institutions Shift their Focus toward Application-Orientated Education⁵, which states that provincial Department of Education should encourage and guide local institutions shift their focus toward providing application-orientated education (Lin, 2017). In October 2016, Department of Education of Guangdong Province enlisted Huizhou University as one of the 14 universities transforming to applied universities.

Given such favorable circumstances, our program should take full advantage of these policies and follow the new trends, hoping to find a distinctive approach for architecture specialty development through innovation, integration, optimization and practice. Obviously, this approach finds its vitality in Huizhou and the Greater Bay Area, which is applicable to the local universities having similar opportunities.

3.3. Industries-Oriented

According to 2019 Engineering and Construction Industry Outlook⁶ and 10 construction industry trends in 2018, we highlight greenization, digitalization informatization and intelligentization. Green construction is a growing field in construction. More and more buildings and plans are incorporating green technology into the construction process. Green construction is a way of building projects in an environmentally responsible and resource-efficient way. It covers from planning to design, to construction, maintenance, and demolition. Digital is transforming the industry itself and helping us imagine, create, and build the spaces, structures, and cities of tomorrow. Internally, digital technologies like robotic process automation (RPA) have the ability to make significant impacts on back-office operations for engineering and construction firms (Zhao, 2019). In addition, building information modeling (BIM) systems that allow contractors to create 3D models and make immediate changes to designs today are evolving quickly. With the inclusion of cost and project scheduling to add two more dimensions, 5D BIM systems can help bring projects in on time and on

⁴Huizhou.

<http://www1.huizhou.gov.cn/pages/cms/huizhou/html/mlhz/bba17c651b254848011b46035f9904e8.html?cataId=b> [O/B], 2019-03-21.

⁵Ministry of Education.

http://www.moe.edu.cn/srcsite/A03/moe_1892/moe_630/201511/t20151113_218942.html [O/B], 2019-03-21.

⁶Engineering and Construction Industry Outlook.

<https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-2019-engineering-and-construction-industry-outlook.pdf> [O/B]. 2019-03-22.

budget, ensuring no overruns—a key to driving operational efficiencies with large construction projects. Look for potential further maturity of BIM in the coming months into offerings that incorporate 7D, adding energy efficiency and facility management for comprehensive life cycle project management. Prefabricated and modular construction is a rising trend because of the amount of material, time, and flexibility of it. Modular construction has the ability to save companies a lot of time and money. Because units are built off campus in a factory, companies do not have to worry about the weather. The units also recycle material they don't end up using or even excess material. This helps cut back on waste which is currently undergoing a big push at the moment. And they can build units that meet your exact specifications quickly and easily (Yuan & Hu, 2015).

4. Teaching Approach Application

4.1. Innovation

Innovation contains two aspects, namely theoretical and practice innovation (seen **Figure 1**). We closely follow the new trends of emerging technologies, artificial intelligence and teaching approach. Literally, a coupling is a technical term from physics, referring to a device used to connect two shafts together at their ends for the purpose of transmitting power. The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. By careful selection, installation and maintenance of couplings, substantial savings can be made in reduced maintenance costs and downtime. In this context, coupled system is metaphorized, referring to a more advanced and efficient matching. Under the guidelines of system optimization, we integrate the teaching procedure of *Architecture Design* and *Architecture History*, show the evolution mechanism from integration to optimization to innovation as to as make it a model for demonstration. Thanks to our innovative teaching approach, we yield to a satisfactory outcome (see chapter five).

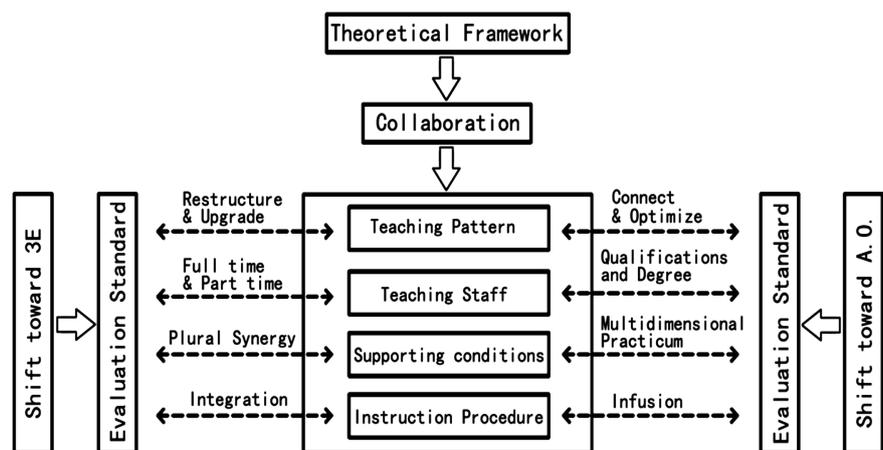


Figure 1. A Roadmap for teaching approach innovation.

4.2. Integration

Guided by the Coupling System, integration means that specialty instruction syllabus & contents should have an influx of philosophy, emerging technologies, moral education, professional ethics and our glorious achievements in construction engineering, which are essential elements for their personality molding and career development (Li, 2018). School education should prepare students with moral standards, professional ethics so that they can better fit into society and meet the requirements of construction industry. There is a successful combination of moral education with specialty instruction. Taking the course *Architecture History* for example, Dialectical and Historical Materialism is well integrated with course syllabus and contents to help students develop a scientific world outlook towards human history, society and individual (Li & Lai, 2017).

Apart from an emphasis on moral and ethical education, emerging technologies help students keep track of the newest trends. Integration of green, digital and regional architecture is a breakthrough point, which helps change our teaching syllabus & contents, instruction pattern and teaching methods (Gu, 2016). For example, the course *Architecture History* takes regional architecture an emphasis with the aid of virtual reality, while *Architecture Design* takes digital architecture an emphasis with the aid of BIM, AutoCAD and 3 Dimensional Printing. What's more, *Architecture Technology* emphasizes green architecture integrating Big Data and AI.

4.3. Collaboration

Learning through collaboration is one of the most effective forms of learning. Teaching and learning in isolation are very restrictive and hinder progress. Learning in groups enhances the scope of learning and develops critical thinking. Collaborative learning activities include collaborative writing, group projects, joint problem solving, debates and more. Collaborative learning redefines traditional student-teacher relationship in the classroom. In order to combine theory and practice, school instruction, research, internship and service learning & community engagement all in one, we have more than 30 long-term partners, including NGOs, institutions, government departments, universities, enterprises. We have various kinds of synergic instruction, such as class room instruction, research, teaching, community engagement and internship. For one thing, industry-oriented short term trainings are held to help students get the emerging technologies. In the past three years, a cooperative training on BIM with Zhiye Information Consultation Shenzhen Co., Ltd., on prefabricated construction and AI construction with China State Construction Steel Structure (one of the subsidiaries of CSEEC) and on green construction with State Key Laboratory of Subtropical Building Science, which helps to foster creativity and innovation. For another thing, a synergy of classroom instruction is adopted. We have an alliance more than ten universities or colleges participating in Cre-Architecture Inter-University Design Competition for sophomores to

help promote teaching and students' design competence. Besides, famous architects are invited to give lecture or design CRIT committee for undergraduate graduation design project.

4.4. Practice

Aligns with the University Vision and Mission, developing students' knowledge, communication skills and professional competence, promotes critical and innovation thinking and problem-solving abilities, embeds practical experience, and is informed and underpinned by research and competition. Encourage students to participate actively in research and competition. To ensure that mandatory practical, research, work-integrated and service learning experience is included within each program, and that each program curriculum is fit for purpose, relevant, academically validated to international standards. Various platforms are used to boost students' profession ethnics, operational ability, creativity and innovation.

5. Achievements and Implications

5.1. Achievements in Talent-Nurturing

Build a high-quality talent pool. After several years' practice, students' practical and innovative abilities improve greatly. In the recent three years, enrollment numbers in architecture program continue to climb and scores soar year by year. In 2015, the lowest enrollment score for Architecture Program in Huizhou University is 550, compared with the lowest score for provincial standard 519, while enrollment scores in 2018 are 464 and 376 respectively, a margin of 31 to 88. According to data released by education consulting firm MyCOS in 2018, 78% of undergraduates work in the construction industry, and 92.82% in Guangdong province and 80.1% in Guangzhou, Shenzhen, Huizhou, Dongguan (Pearl River Delta Cities) etc. It has a constant employment rate 95.35% and a low job-hopping rate 19%, 8 percentages lower than average. Employment satisfaction rate is 76%, ranking the top Five among 50 programs. Besides, for those working more than two to three years, 83% students get a high monthly salary more than 5000 yuan and 81% students get promotion and technical titles Assistant Engineer or Senior Engineer. The number of students pursuing postgraduate study sees a steady rise, from three to 12 then to 23 in year 2016-2018. The number of prize winners in provincial-level and national competition exceeds 200, accounting for 65% of the participants. Awards cover various aspects, such as Creative Award in National Green Architecture Design, third Prize in National "Challenge Cup" Competition of Science and Technology, third Prize in China College Students' Energy Conservation and Emission Reduction Competition, first Prize in Guangdong "Challenge Cup" Competition of Science and Technology, first Prize in Guangdong College Students' Entrepreneurship Plan Competition and so on. From the awards, it is obvious that students get an all-round development in the fields of management, social science, energy source, science and technology.

They are a window to show Chinese college students' creativity, innovation and experiment skills.

5.2. Achievements in Specialty Construction

Backed by national and provincial teaching and experiment platforms—Architecture Virtual Reality Lab, Green Architecture and Virtual Reality Lab, Guangdong Provincial Architecture Experiment Teaching Model Center, Guangdong Provincial Architectural Engineering Virtual Reality Experiment Teaching Model Center, Guangdong Provincial Architecture Specialty, Guangdong Provincial *Architecture History* and Design Teaching Team, the undergraduate program enjoys favorable financing and facilities, reaching a total of 12 million yuan. Four provincial and nine university-level projects under Teaching Quality and Teaching Reform Program for Higher Education have been approved and three have been deemed qualified upon check. As for excellent course construction, *Story of Old House* has been authorized as provincial Open Courseware in 2018 and *China Architecture History* as university-level open course. Over the past three years, we have been undertaking 17 national and provincial Higher Education Teaching Reform Project and Guangdong Teaching Quality and Teaching Reform Project, finished 4 projects. In addition, it yields to 11 university-level teaching reform projects and 13 essays on teaching reform.

5.3. Implications for Other Local Universities and Colleges

From the above achievements, implications of the teaching approach are as followed. First, seminars and proceedings are effective ways to promote our program. Up until, the number of academic participants is more than 200, including international architecture education conference, the 16th International Conference of Architecture and Culture, National IHEs Conference on Architectural Education Deans and Department Heads Meeting. Second, more than 30 scholars or architects, including cademician of the Chinese Academy of Science and Engineering such as HE Jingtang, WU Xianshuo, RONG Baisheng, ZHOU Fulin, WANG Fuming have been invited to deliver lectures, which is beneficial to our teaching, research and promotion. Third, we cooperate with more than 20 colleges and universities in or out of Guangdong Province, just name a few, South China University of Science and Technology, Kunming University of Science and Technology, Guangzhou University, Guangdong University of Technology, Changchun Institute of Technology etc. The Cre Architecture Inter-Universities Design Competition has attracted ten universities more than 900 participants. These are effective ways to improve teaching.

6. Conclusion

Thanks to our continuing exploration, we constantly make modifications on our teaching curriculum, teaching methodology and experiments through innovation, integration, collaboration and practice. An innovative teaching approach,

characterized by emerging engineering and application-oriented education, upholding future-oriented, region-oriented and industry-oriented, proves to be a success with fruitful accomplishments. Additionally, it is of great value for local universities and colleges.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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