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Teaching Architecture: The New Challenges

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Abstract
The teaching of Architecture presents new challenges. The constantly changing world leaves, in the same classroom, generations with different skills in terms of mastering the digital tools and technologies. Teachers from the "analog era" teach students from the "digital era". The need to cross these two worlds – in the teaching and in the practice of the profession - generates structuring questions for the planning of the courses (from degree to doctorate) that need to respond to how we can reconcile different interests without forget the need to explore manual skills and the need to implement a "real thinking" about concepts like: place, space, function, etc. – which we cannot allow that could be replaced by "artificial thinkings".
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1. Introduction

The evolution of technological capacities and their implications in the construction of Artificial Intelligence (AI) have had a significant impact on our daily lives and, consequently, on the way we teach architecture today. These advancements, which occur almost daily, have enabled progress in areas such as 3D modeling, simulation of environments, analysis of urban data, virtual and augmented reality, among others. These tools are increasingly being used in the teaching and practice of architecture, offering students more interactive, collaborative and practical learning opportunities. This prepares them better for the challenges of the job market and provides them with the necessary tools to design innovative and sustainable environments and spaces. Many architectural studios around the world already use these tools for the development and communication of their work. These "advantages" lend favor to the argument of using new technologies in the teaching and practice of architecture and other areas of action.

Currently, AI interferes in our daily lives in such a natural way that we often do not realize its existence. When we think about its advantages, however, we often approach it with a "suspicious eye", as we witness the enormous technological leap that has occurred. With regards to teaching architecture, the majority of practicing teachers learned with the support of long-used and experienced pedagogical methodologies that value the techniques of hand sketching, technical drawing, or manual model creation. Only in the late 1980s did computer-aided drawing and virtual three-dimensional modelling emerge and, in the early 21st century, these tools began to become more commonplace.

Despite this slow adoption of technology, the implementation of more technologically advanced tools has become common in architecture programs in schools around the world. Specific courses now include insights into:

(i) 3D Modeling and the use of different design software: Tools like AutoCAD, Revit, SketchUp or Rhino are widely used to create digital three-dimensional models and technical drawings - however, these must be used as representation tools, not conception (thinking) tools.

(ii) Virtual Reality (VR) and Augmented Reality (AR): Allow students to explore architectural projects in virtual environments, providing an immersive and interactive experience - allowing sensory experimentation with space virtually.

(iii) 3D Printing: Allows students to create physical models of their architectural projects quickly and accurately, facilitating the prototyping process.

(iv) Data analysis and simulations: These tools could be used for analyzing energy performance, natural lighting, ventilation and acoustics help students better understand the impact of their projects on the environment and the community and contribute to promote more sustainability proposals.

(v) Artificial Intelligence (AI): AI algorithms are beginning to be applied in various areas, such as the automatic generation of architectural layouts, space optimization and design trend analysis - it is currently possible to construct a project by providing coordinates that can be extracted from a program to be implemented (building typologies, use, volume, height, etc.).

These technologies naturally transform the way students learn architecture, offering new opportunities for experimentation, collaboration and innovation during the design process. We know that due to ease of access, it may be extremely "appealing" for a student to resort to AI to obtain a response to the program proposed by the teacher. It is possible to have applications on the phone that generate almost unlimited space organization in plan and its transposition to elevations and sections and convert it into a three-dimensional model in seconds.

With the realization of this reality, numerous questions arise, for which we still do not have answers: Does the use of these technologies and tools negate the need to learn to think with our hands? The need to feel and live the place? The need to construct an abstract thinking, that allows the construction/materialization of a perception

about space, using (also) “manual skills”? The need to experience spaces and places in order to build an “internal library" of sensations and knowledge, that can subsequently be transposed to new places? Among many others!

2. From manual skills to Artificial Intelligence

If we understand "manual skills" as "thinking with hands," which Baeza (2011) presented as the need to reconcile architecture with sensory experience, exposing how architects should express their ideas not only through drawing or words but also through physical contact with materials and the valorization of the relation between light, space and form - in other words, about the need to experience different places and the importance of a tactile and sensory approach to be able to create emotional spaces. The author speaks about the importance of touch, simplicity and harmony with the surroundings to create space (built or not built), where his main ideas are still explored today in different classrooms where architecture design and drawing are taught, namely:

(i) The importance of touch in architecture: The sense of touch plays a crucial role in understanding architecture, where the need to feel and touch built spaces is the only way to truly comprehend them.

(ii) Minimalism and purity: Simplicity and purity in architectural forms and a minimalist approach to construction, where each element is carefully considered, allows for the creation of spaces that inspire and elevate.

(iii) Light and shadow: The interaction between light and shadow in architecture as the primary "material" for the construction and transformation of space.

(iv) Connection with the surroundings: The importance of designing buildings that harmonize with their surroundings, integrating naturally with the surrounding environment, respecting the landscape and local culture.

(v) Simplicity and complexity: The duality between simplicity and complexity in architecture - where often, true beauty lies in the simplicity of forms, but complexity can be skillfully used to create captivating and intriguing spaces.

Most programmes of architecture courses, in Europe, reserve for the early years the implementation of pedagogical practices with a strong focus on the need to "think with hands" and leave the implementation of different technological tools for the final years of education. The teaching in design studio classrooms maintains the character of an experimental and exploratory workshop - which is intended to be dynamic and engaging - where teachers apply pedagogical methodologies supported by the paradigmatic "learning by doing" through the simulation of practice, developing architectural projects (in a simulation of reality). The way it is developed can vary depending on the level of studies and the pedagogy implemented by the school and/or the professor. Our reflection leads us to the fact that the development of a project (or the act of designing) can either consider only "manual skills" - using simple sketching, producing models, or technical drawing - or resort to available technologies. At this point, we have two considerations: technologies as a support or tool for representing an idea or as the only resource to create and represent a response to a design problem.

3. Pedagogy of Experience and Natural Intelligence

Bernard Tschumi, an architect and educator renowned for his bold theories and innovative pedagogies applied to architectural education, introduced the idea that architecture is more than just form and function. It is about events and emphasizes the importance of designing spaces that allow for a variety of experiences and activities, where movement and interaction have a central role. Similar to Fernando Távora, who advocated for the significance of movement and the factor of time in the way we understand and live in architectural spaces, as detailed in his book "The Organization of Space" (1962), these are insights that we gain only through our perception and experience, that is, our Natural Intelligence (NI).

Tschumi advocates for a conceptual approach to architectural design and encourages students to explore abstract ideas and theories related to philosophy as a starting point for developing the inherent concept of the project, believing that in this way, they can obtain more structured, innovative and creative solutions. Challenging more traditional teaching conventions, he questions pre-established notions of form and function, teaching students to push the boundaries of architectural thinking. He believes in the importance of integrating theory and practice in architectural education, encouraging students to explore theoretical concepts in parallel with the development of practical design skills, aiming to create a deeper and more holistic understanding of the discipline.

Tschumi encourages experimentation and provocation in the design process, challenging students to question the status quo and seek radical architectural solutions that defy expectations and inspire critical thinking.

In summary, Tschumi's pedagogies in architectural education emphasize the importance of the event, concept, deconstruction, integration of theory and practice, as well as experimentation and provocation as essential elements for the development of relevant and innovative architectural practice. And it is through knowledge of pedagogical models like Tschumi's, Tavora, or Baeza that we find it difficult to replace the sensory experience of “Natural Intelligence” with “Artificial Intelligence.”

In a nearly unanimous consensus, and valuing the results of the implementation of different pedagogical methodologies that let the students question the process of thinking and learning, different European schools implement the development of the following in design studio classrooms:

(i) Collaborative projects: Fostering a collaborative environment where students work together on projects. The aim is to enhance not only their technical skills but also teach them to collaborate effectively with others. This model is applied both internally and through international experiences, such as workshops and exchange programs.
(ii) Project-based learning: With a teaching model centered around simulating projects that require students to apply what they have learned. This approach helps them see the relevance of their learning.
(iii) Individualized learning: Recognizing that students may have different learning styles and paces, personalized instruction and structured support can be developed to help each student succeed. This process can help students develop critical thinking about their work and consequently improve their learning trajectory.
(iv) Peer learning: Where students are encouraged to learn from each other by sharing their knowledge and experiences. This can be done through group discussions, peer reviews, or collaborative problem-solving activities.
(v) Integration of theory and practice: Where students are encouraged to apply theoretical concepts to practical applications. Grounding the project in construction systems, history, theory and criticism of architecture.
(vi) Valuing the place: Architecture remains connected to the place. At this point, the school has the obligation to encourage students to know the places for which they design and also to know other places that allow them to build an individual knowledge of the world and the architecture that constructs it.
In this teaching process, the flexibility and adaptability of the professors become essential. Students change every year, they are all different and technological leaps are increasingly significant and respect shorter and shorter timeframes. Flexibility allows the adaptation of pedagogical practices to maximize learning outcomes, meeting current needs and students' abilities.
By incorporating these teaching methodologies into a design studio classroom environment, it is possible to create an engaging learning experience that values students' education, where different knowledge intersect (theoretical and practical). However, today we face new challenges. We know that computer programs organize space automatically, minimizing long days of work and thought. So, what is the role of the architect of the future and of architectural education? Should we continue to value "learning by doing" in our classes? Simulating the development of projects that, possibly, in the future will be done by computers that cross information in seconds that takes a lifetime for us to know?

4. The impact of artificial intelligence on the construction of an architectural idea

> "The world of forms is of infinite and progressive richness for mankind and its study becomes increasingly captivating and necessary with the growing awareness of the importance that form holds in relation to human existence (...)."
>
> Fernando Távora (1962)[1]

In this "human existence," technology may reveal its "fragility." Regardless of the pedagogical methodologies adopted, architectural education, particularly in the development of architectural design, is strongly based on the ability to create spaces capable of evoking sensations in their users. These sensations are recognized through our own experiences.
Is AI capable of understanding a place and of conceiving a space (built or empty) suitable for that place and capable of evoking sensations in its users? Or can it only construct an infinite intersection of images and algorithms that generate plans, sections and elevations capable of conceiving a balanced nice space?
We know that AI is "shaping" the construction of architectural ideas in different ways. From automated project construction to data analysis informing project decisions, AI influences how architects conceive and execute their projects in our daily lives. It presents itself as an essential tool for optimizing spaces, predicting design trends and even creating more sustainable and efficient structures.
The significant contrast between AI and “manual skills” in the process of constructing an architectural idea lies in creativity and intuition. While AI can generate efficient and optimized projects and spaces based on an infinite knowledge of different data and algorithms, the manual approach adds human sensitivity/existence - as referred to by Távora, Baeza, or Tschumi (among others) - allowing for the incorporation of cultural and emotional elements. Furthermore, human experience enables flexible adaptation to complex challenges and specific contexts that may not be as easily captured by algorithms.
In this perspective, it is possible to start getting the idea that the impact of AI on the construction of an architectural idea/concept is profound and multifaceted. AI technologies are revolutionizing the architectural design process by providing architects with powerful tools for generating analyzing and optimizing design solutions. However, it's essential to recognize that AI also has its limitations. While it can process vast amounts of data and generate solutions based on predefined parameters, it may lack the nuanced understanding of human experience, cultural context and emotional resonance that are crucial aspects of architectural design. Additionally,

[1] TÁVORA, Fernado (1962). Da organização do espaço. FAUP, 7ªed (2007)

AI-driven development of design solutions may sometimes lack the creativity, spontaneity, and intuition that arise from human thought processes.
Moreover, we cannot minimize the fact that the use of AI in the architectural design process raises ethical questions regarding issues such as privacy, data ownership and the role of automation in creative processes. Architects must navigate these ethical considerations carefully to ensure that AI is used responsibly and ethically in the pursuit of architectural excellence, and these processes of awareness must start in schools.

5. [Partial] Conclusions

We're still in the midst of an ongoing process and rushing to conclusions can be risky. The emergence of AI technology in architecture presents both opportunities and challenges that we are still navigating. Students, who have grown up in the digital era, often possess excellent skills in using these tools, although they may sometimes rely on them to expedite their work due to the natural inclinations of student life. It's up to educators, who come from the analogical era, to adapt to this evolution and effectively integrate both natural and artificial intelligence into their teaching methods. While AI offers exciting possibilities for enhancing the architectural design process, it should be viewed as a complementary tool rather than a replacement for human creativity and intuition. By integrating AI with manual skills and human expertise, architects and students can leverage the strengths of both approaches to create innovative and sustainable architectural solutions.
It's crucial that the integration of AI does not overshadow the importance of human creativity and critical thinking in architectural education and practice. The synergy between manual skills, conceptual thinking, and the integration of theory and practice should continue to underpin architectural projects and the discipline as a whole. It is essential to strike a balance between embracing technological advancements and preserving the essence of architectural education and practice. By harnessing the strengths of both natural and artificial intelligence, we can ensure that architecture remains a vibrant and relevant field that continues to enrich human experience and the built environment.

Conflict of Interests

The Author(s) declare(s) that there is no conflict of interest.

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