Architectural Practice and Artificial Intelligence

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Digital transformation has characterized architectural practice for decades. In the 1990s, computer-aided architectural design (CAAD) and 3D programs fundamentally changed the practice of drawing. As a result, digital data exchange has successively extended the digital chain. Today, it is employed from the initial idea to the construction site, at least in some areas of the construction industry, particularly timber construction. In the upcoming third wave of digitalization, the autonomous viewing, evaluation, learning, and application of data based on AI is becoming the central focus.

If you listen to AI developers and reflect on the possibilities they suggest, you may find yourself fantasizing about the possibilities for using the myriads of planning tasks that have already been completed in order to deduce connections between outset, planning, and implementation by means of self-learning entities in the foreseeable future, rendering present day problems resolvable through planning. Thanks to AI, problems and challenges in architecture and urban planning could in future be recognized independently based on data and evidence, a multitude of solution approaches and implementation templates could be generated autonomously, the construction elements could be milled and printed, and implementation could be monitored and corrected if necessary. "Smarter, better cities" is the slogan.[1]

These forecasts also impact the future of architects. In politics as well as the construction and real estate industries themselves, the hope is growing that, with digitalization and AI, they will become completely independent from the architects' interpretative monopoly on "correct planning," which is

1 In the parametric area, such tools are already well advanced, but not yet self-learning and autonomous, cf. SUPat, "About," accessed January 16, 2025, https://archive.arch.ethz.ch/supat/about/index.html; LUUCY, accessed January 16, 2025, www.luucy.ch. See also Collage (February 2024), a magazine for spatial development on artificial intelligence.

merely understood as a limitation preventing development. "Evidence-based planning"—i.e., rational planning based on data (as supposed facts)—is the buzzword of the moment.[2] This hope is strengthened by the fact that the architects' visualizations can hardly be distinguished by laypeople from the images produced by evidence-based AI. Even an architectural theorist like Neil Leach arrives at the provocative conclusion in his lectures that 80 percent of architects will lose their jobs.[3]

This comparison and hypothesis are, among other things, also afforded to the image that architects, historians, and theorists have been conveying to the public regarding the work of architects. In their disciplinary debate they reduce the essence of buildings and cities to idea, structure, and form. The works, texts, and lectures of Aldo Rossi or Oswald Matthias Ungers, for instance, convey a clear outline of this process, subsumed under the demand for the "autonomy of architecture," which excludes non-architectural considerations from the examination of buildings and cities.[4] Thus architects are less inclined to explain their work verbally, but present it in the form of floor plans, sections, façades, 3D models, visualizations, and images instead.

As a result, architecture is increasingly perceived by outsiders as a system comparable to a construction kit—as a practice combining prefabricated floor plans and façades in order to generate images. Hence the developers' conclusion stands to reason: all you need is autonomous AI trained to reassemble digitized representations of such floor plans, sections, and façades. Formulate framework conditions. Generate floor plan. Generate façade. Generate image. Done.

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2 See Joris van Wezemael, "Innenentwicklung wird zur kooperativen Zukunftsgestaltung," *Forum Raumentwicklung*, no. 3 (2017): 4–8; Stefan Kurath, *Jetzt: die Architektur! Über Gegenwart und Zukunft der architektonischen Praxis* (Park Books, 2022), 46.

3 Neil Leach, "AI and the Future of Architecture," *INDESEM*, October 8, 2023, YouTube video, 1:05:32, https://www.youtube.com/watch?v=SZ3JOkQXRKo.

4 See Aldo Rossi, *The architecture of the city* (MIT Press, 1982); Oswald Mathias Ungers, "Berufungsvortrag zu den Prinzipien der Raumgestaltung gehalten an der TU Berlin 1963," *Arch+*, no. 181/182 (2006): 30–44. However, the exclusion of non-disciplinary content is not a development that only affects architecture. It can be found in all disciplines and has a lot to do with research practice. Gaining knowledge is only ever possible by reducing complexities. Since the beginning of the Enlightenment, this has led to a differentiation of the world into different areas of knowledge and practice, which have broken down the complexity of the world into specific disciplines and thus made it manageable. See also: Bruno Latour, *Die Hoffnung der Pandora*, (Suhrkamp 2000), 86.

Nobody would come to this conclusion if architects were to describe their arduous practice through words. Bruno Latour and Albena Yaneva address this in their critical examination of architects' work and their 3D CAD renderings. "When we picture a building, it is always as a fixed, stolid structure that appears in four colors in the glossy magazines that customers flip through in architects' waiting rooms."[5] However, these representations are missing some fundamental elements of architectural reality:

> Where do you place the angry clients and their sometimes conflicting demands? Where do you insert the legal and city planning constraints? Where do you locate the budgeting and the different budget opinions? Where do you put the logistics of the many successive models that you had to modify in order to absorb the continuous demands of so many conflicting stakeholders—users, communities of neighbors, preservationists, clients, representatives of the government and city authorities? Where do you incorporate the changing program specifics?[6]

They continue by pointing out that these influences and dynamics are part of the production conditions that apply to buildings and cities, rarely addressed or discussed. They perceive this as a significant shortcoming of architectural theory. Architectural theorist Jeremy Till sums up the problem, writing: "First, architecture is a dependent discipline. Second, architecture, as profession and practice, does everything to resist that very dependency."[7] This describes a peculiarity of architecture and urban planning that, in the general perception of architects' achievements, is increasingly becoming a boomerang with regard to the relevance of architecture, especially in connection with the increasing focus on AI.

Considering the real conditions under which buildings are created in all their complexity, architecture is not "only" about assembling building elements, but also about a multiverse of pluralities of concrete entities in constantly changing constellations that lead to constantly changing physical assemblies (with a spatial effect).[8]

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5 Bruno Latour and Albena Yaneva, "Give me a Gun and I will Make All Buildings Move: An ANT's View of Architecture," in *Explorations in Architecture: Teaching, Design, Research*, ed. Reto Geiser (Birkhäuser, 2008), 80.

6 Latour and Yaneva, "Give me a Gun," 81.

7 Jeremy Till, *Architecture Depends* (MIT Press 2009), 1.

8 Latour and Yaneva, "Give me a Gun," 82.

Buildings are therefore always unique and cannot be reproduced. Not because architects seek to realize themselves, but simply because the same clients, investors, spatial programs, building ground conditions, topographies, access, material conditions, use cases, available and required resources, and construction companies never match twice. In addition, the dynamics of social negotiation processes, economic developments, and geopolitical shifts lead to constantly changing interests and thus to constantly changing framework conditions.

Architects therefore never know in advance what a project will actually encompass and which conditions will prevail. Unpredictability, and thus uncertainty, are key parameters of architectural practice. In the majority of cases construction conditions are unpredictable and therefore incalculable. Constantly adapting unforeseeable developments without abandoning content and concepts that have already been developed (if you don't want to keep starting from scratch) is an essential element of architectural practice.

As a theory of action, design as the architect's craft therefore precisely aims at integrating the constantly emerging and changing interests and conditions, balancing them, relating them to original ideas and interests in order to maintain the network of entities, and constantly expanding it if necessary for the realization of buildings.[9] In architectural practice, this requires not only craftsmanship but also intellectual as well as political—i.e., strategic and tactical—skills, without which contradictions and breakdowns in negotiations between all players involved would constantly arise, repeatedly forcing fundamental restarts of the project.[10] Due to unpredictability and therefore uncertainty, nothing can be calculated here.

A clear transition reveals itself between the performance of artificial intelligence—processing what is already known in the form of existing data—and architectural intelligence—processing the unforeseeable in all conceivable forms such as changes in mood, lack of resources, economic crises, funding problems, legal changes, neighborhood disputes, contractors going out of business, misinterpreted plans, and construction machinery breakdowns.

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9 See Stefan Kurath, "Was tun Architektinnen und Architekten eigentlich?" in *Digitalisierung und Architektur in Lehre und Praxis*, ed. Patric Furrer, Andreas Jud, and Stefan Kurath (Triest Verlag, 2022), 17–27.

10 Stefan Kurath, jetzt: die Architektur! Über Gegenwart und Zukunft der architetkonischen Praxis (Park Books, 2022), 216.

So, when talking about AI and architecture, it is imperative to first establish a theory of architectural practice that links the representations of architecture with the production conditions as well as the required intellectual, technical, and political achievements.[11] Then we need to weave in artificial intelligence as a separate entity applied in order to extend architectural intelligence. Such a theory of architecture and AI is enriched with a corresponding realism regarding architectural practice, in the context of which the significance of AI within architecture as well as the effects on its forms of representation must be addressed.

There is no doubt that AI tools will become an essential part of architectural practice. It is, however, not yet possible to predict the final result of this process, especially considering the significant discrepancy between the forecasts and the actual current possibilities that AI offers. Nonetheless, we need to try to find out, step by step.

Experience reports were discussed in the context of an event on AI in professional practice at the BDA in Munich in June 2024. In the first presentation, Jacob von Rijs from architecture firm MVRDV shared insights into their experiences, primarily with the deployment of image-generating AI tools. Gheyath Mohammed from Henning Larsen spoke about his experiences with using AI tools for generating and analyzing structures. Stefan Höffgen from Tegel Projekt GmbH spoke about AI applied in neighborhood development, particularly for the self-learning analysis of aerial images with vehicle and plant recognition. What all three had in common was their curiosity and interest in the new AI tools.

All three recognized a great potential in the future application of AI. At the same time, the tools evidently do not yet provide the desired added value in everyday practice. This is attributed to the fact that the tools have not been developed for architecture-specific applications, and most tools rely on generic

11 The German architectural theorist Stephan Trüby also points out that buildings can hardly be traced back to individual figures alone, but rather to complex framework conditions. He speaks of architecture as a maximally complex cultural technique. Against this background, an architectural theory that only refers to architecture would greatly underestimate architecture. Stephan Trüby, *Absolute Architekturbeginner. Schriften 2004–2014* (Wilhelm Fink Verlag, 2017), 19. Architectural theorist Bart Lootsma already sees improvement here, and points to a paradigm shift. Architectural theory is now "not only concerned with an elite and canonized part of the built environment, but with spatial practices in general": see Bart Lootsma, *Reality Bytes: Selected Essays 1995–2015* (Birkhäuser, 2016), 31.

data collections sourced from the internet. The lesson learnt is that architects urgently need to participate in the development of AI-related tools and must create their own (controllable) data collections.

ZAHA Hadid Architects are very advanced in this respect. They command a vast data pool derived from their own projects, and develop their own AI tools. A presentation by Christoph Geiger and Clemens Lindner at an ideas workshop on Munich North in November 2024 impressively demonstrated great potential in this regard. Their text contribution merits discussion here.

The experiment, which encompassed a hands-on AI event organized by metris / Plan:kooperativ and moderated by Matthias Burgbacher, yielded interesting insights. The task was to generate a live visualization using AI in dialogue with the public and the planning teams participating in the ideas workshop. The regulations of the City of Munich served as a basis for the visualization, as well as various expert opinions on Munich North and text prompts from the planning teams on specific spatial situations contained in their designs. Image-generating AI was employed in order to create images in real time, which were then discussed, criticized, and adapted by residents from the northern districts of Munich—also in real time.

It was interesting to experience how this workshop yielded insights to non-planners regarding the challenging practice of architects. Initially, the sum of contradictory ideas and comments did not yield any result. Moreover, all demands needed to be balanced constantly and negotiated anew in order to proceed to the next step. In their discussion with the planners as well as architects Geiger and Lindner, all participants demonstrated the aforementioned intellectual and technical capabilities of architectural practice: registering concerns, translating them into language, translating them into realization suggestions, and constantly reprocessing them. Such insights into the reality of architectural practice are rarely offered to non-architects, although they help substantially to convey what it is that architects actually do. Therein lay the great value of the event. The AI was but the means to this end.

The history of science reveals that new technologies and tools always lead to new insights. The invention of the telescope is a vivid example of how magnifications of the universe enabled completely new insights and provided evidence for the heliocentric view of the world. When seeking to make progress in architecture and urban planning, a proactive, affirmative, and critical approach to AI developments in architectural practice is therefore of great importance. However, this does not merely apply to application, but also to the question regarding how to deal with new technologies and the discoveries they yield.

Cornelia Diethelm, an expert in digital ethics, points out: "Employing AI tools responsibly means that employees and managers need to know how to use these new possibilities correctly and in compliance with the law, and that they must always view the results critically."[12] This also includes an awareness of what AI actually does, as Diethelm continues: "AI-generated content is only spawned through probability calculations and chance based on the training data. Therefore results can be outdated, misleading, or even wrong."[13]

This has different implications for different applications of AI. Analytical AI, which analyzes existing objects broken down to data based on questions, can still be controlled to a certain extent, even if it is not always possible to comprehend exactly what is occurring and how, especially regarding self-learning processes. Therefore it is crucial to take a particularly critical look. With regard to the surge of information that is increasingly flooding architectural practice, great added value is generated nonetheless. In fact, the available data on space, utilization, and motion has assumed a new quality. Analytical AI in particular will contribute significantly to the immediate identification of shortcomings and development opportunities in existing urban structures by categorizing patterns, rules, and comparisons of cities, and comparing them with empirical knowledge from the fields of architecture and urban planning. In medicine, such procedures are already being applied in diagnostics in order to compare and analyze imaging procedures—for instance, to attain cancer diagnoses in a much faster and accurate manner.

However, while clinical data from studies are published and therefore accessible to researchers, the greatest challenge within architecture and urban planning lies in making access to corresponding data sets on movement and spatial behavior available. They are collected by the big tech companies in the background, for example through app usage or location tracking on mobile phones. The companies retain these data sets for themselves as data gold in order to utilize them commercially. An open-source strategy for research purposes needs to be demanded from tech companies under state law.

12 Cornelia Diethelm, interviewed in Isabelle Amschwand, Brigitte Maranghino Singer, Reto Savoia, Michael Grampp, and Daniel Laude, "Generative künstliche Intelligenz – neue Horizonte für Verwaltungsräte" (swissVR Monitor II/2024, August 2024), 21. Author's translation.

13 Diethelm, interviewed in Amschwand et al., "Generative künstliche Intelligenz," 21. Author's translation.

With regard to generative AI in connection with architectural practice, there are clear limits concerning the quality and usability of existing data. Such data are always related to the past. Using them carelessly reproduces the status quo. This can be seen impressively in the careless use of today's image-generating AI for visualizations of future city concepts. Here, too, AI proves to be a "stochastic parrot" that calculates probabilities based on what is already known.[14]

But architectural practice is always future-oriented. It is precisely about the unknown. It is precisely about improving an existing situation in the context of constant change and unknown framework conditions. Especially in the context of the global warming, biodiversity, resource, and housing crises, a change in thinking and planning with regard to architecture and urban development is urgently required. If newly-generated most probable rows of letters and image pixels produced by AI are based on data from developments that have actually caused the crises themselves, the benefits for architecture and urban planning remain extremely limited. Thus, probability calculations referring to the past generated by text-, image-, and structure-generative AI cannot simply be applied in their current form. Instead, they may serve as a starting point for further enhancements, corrections, improvements, and additions. As mentioned above, design as the architect's craft—adapting the unforeseeable in real time—will retain a central role in the disciplines of architecture and urban planning.

AI will therefore not replace architectural practice, but rather add value. Nevertheless, there will be displacement movements. The future of architects will depend on the extent to which they succeed in making themselves indispensable again in the social negotiation processes surrounding spatial development. In order to re-establish this connectivity, architects must engage with the possibilities presented by AI. They must do so not only in order to work in a more evidence-based manner and restore trust in politics, but also to free up time for what lies at the core of an architect's work: to invest great effort and passion into connecting their reflections on space and their sustainable and resilient spatial concepts with society on a day-to-day basis in order to realize them in the material world and translate them into physical space.

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14 See Emily Bender, Timnit Gebru, Angelina McMillan-Major, and Shmargaret Shmitchell, "On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?" in *FAccT '21: Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (FAccT '21, 2021), 610–23.