

Baking and Building: Reflections on Architecture and Artificial Intelligence

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Just as technology is always revealing nature from a new perspective, so also, as it impinges on human beings, it constantly makes for variations in their most primordial passions, fears, and images of longing.¹

Walter Benjamin

The following article addresses students and practitioners in the field of architecture who, in the future, will be dealing with particular technological questions in their profession. For this purpose, short “everyday scenarios” are designed to illustrate different relationships with *objects*, *things*, and “*automated*” *processes*. Examples labelled *Scenario B* illustrate these relationships with a simple object of comparison: baking bread. Those labelled *Scenario A* meanwhile translate these observations into the more complex field of architecture. The similarities in content between *B* and *A* can be conceptually related to each other. The aim of this contribution is, first, to describe our relationship to *objects* that appear to us as clear and comprehensible (i.e., *bread* and *architecture*), second, to distinguish conceptually that we name objects that we cannot grasp clearly and comprehensibly as *things*, and third, that the comprehensibility of objects is determined by our deep engagement in producing them which is affected by “*automated*” *processes*—understood as the division of labor through both human or machine work. The essay tries to show how our historically

1 Walter Benjamin, *The Arcades Project*, trans. Howard Eiland and Kevin McLaughlin (Harvard University Press, 2002), 392.

determined *concepts* and current *experiences* of objects, such as architecture or technology, are crucial for recognizing both the design of our environment and the technological possibilities and limitations—here, the automated processes of so-called “Artificial Intelligence” (“AI”).²

This short essay will not pursue a stringent differentiation of the individual philosophical concepts or an emphasis of their “adequate” scientific contextualization. Rather, it aims to set a few emphases that are as comprehensible as possible, using the designed scenarios to provide points of reference for a practice that can be used to develop independent thinking.

Currently, there are still no fully-applicable methods of AI for generating constructions for buildings. As interesting as the results of the various AI methods are, given the current debates and effects of AI, it seems more urgent to assume a critical perspective that counteracts its mythologization driven by tech companies and the adapted everyday language.³ However, a quote by the philosopher and sociologist Theodor W. Adorno should be prefaced to guide our endeavor. Although he probably never dealt with AI, he made a remarkably current statement about the computer in 1968:

It is likely with computers, as with numerous other phenomena, precisely because the disenchantment of the world is progressing as it is, institutions and things that are themselves part of the mechanism of demystification are then magicalized by the general consciousness, made into a fetish. [A]nd I would think that the less people seriously understand about this, and above all the less they are aware that these are highly enhanced calculating machines, the more they are prepared to trust these machines to be able to replace living, productive thinking.⁴

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- 2 The term “Artificial Intelligence” was coined in the course of a conference in Dartmouth in 1955: John McCarthy, Marvin L. Minsky, Nathaniel Rochester, and Claude E. Shannon, “A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence: August 31, 1955 [1955],” *AI Magazine* 27, no. 4 (2006): 12–14, <https://doi.org/10.1609/aimag.v27i4.1904>. In the following, the prefixes are omitted.
 - 3 For a socio-critical perspective on AI, see, for example, Matteo Pasquinelli, *The Eye of the Master: A Social History of Artificial Intelligence* (Verso, 2023). For a critical localization of AI in the context of architecture see, for example, Sandra Meireis, “Sinnliche und maschinelle Intelligenz. Zehn Thesen zu ‘KI’ in der Architektur,” in *Ästhetik und Architektur, Schriftenreihe des Weißenhof-Instituts zur Architektur- und Designtheorie*, ed. Daniel Martin Feige and Sandra Meireis (transcript, 2023), 269–89.
 - 4 This quote comes from an unpublished interview held in German that can be found in the Theodor W. Adorno Archive and will be published at the end of 2025 in my disserta-

Let's keep that in mind and focus on the scenarios now.

Scenario B₁ —We want to have some bread for dinner. We go to the bakery and name the bread we have in mind: “The wholegrain bread, please!” If the baker then gives us a pretzel, we will say, perhaps even pointing with our finger for a clearer understanding: “That was a misunderstanding, we would like that bread—there!” Our formal familiarity with the objects *bread* and *pretzel* helps us to get what we have in mind.

Scenario B₂ —Same scenario: We go to the bakery, order the wholegrain bread, pay for it, receive it, and enjoy it. In this scenario, we enjoy the “privilege” of the *division of labor*. The production of the bread appears to us as an “automatic” process, as the object is accessible to us without having to produce it ourselves.

Scenario B₃ —We have a problem: The bakery is closed, and so we want to bake bread for the first time in our lives. Suddenly, from this perspective, bread no longer seems as self-evident as before. The production of bread now seems distant or unclear.

To approach the matter, we will gather *information*. We never start from scratch; we can rely on historical accounts that describe this process to us: the recipe lists the ingredients as well as the procedure. The recipe contains the idea of production. This process is thus reproducible; with the same ingredients and the same process, we get “the same” bread every time. The production process is no longer a “thing” to us, but a tangible “object” that we have been able to differentiate through our engagement. The object *bread* is now even more familiar, even “closer” to us than it appeared before our own attempts.

Scenario B₄ —Through our experience, we have noticed qualitative differences between the purchased and homemade bread. As we delve deeper into the matter, we will distinguish which ingredients or steps need to be changed to make

tion, which gives more theoretical context to Adorno's theory. Michael Mieskes, “Technologische Bildlichkeiten. Digitalität und Mimesis nach Adorno” (PhD diss., Goethe University Frankfurt/M., forthcoming end-2025). See Theodor W. Adorno und [Peter?] Beike, “Zeitalter des Computers”, Theodor W. Adorno Archiv, Frankfurt am Main, SK 63/2, <https://archiv.adk.de/objekt/3285076>. All subsequent translations are by the author, except where otherwise stated.

the bread tastier. We will begin to adjust the recipe—the reproducible process—based on our experience. If we succeed, we will have developed not only a more differentiated relationship with our object, *bread*, but also with our object of *production*. We possess an experience that has brought us closer to these objects.

Scenario B₅ —We didn't have time for baking and after a long time, we go back to our old bakery. We try our favorite "wholegrain bread" and notice: it doesn't taste as good anymore! This is because our understanding of bread has become more differentiated through our closer engagement. We draw on our experience and realize: Not all bread tastes the same, not all bread has the same qualities. The object, *bread*, is familiar to us in a special way, so we can see that we will not get this object—in the way we understand it—if we continue to go to that bakery.

—How should we now locate our relationship to the "wholegrain bread" in Scenario B₃? Did we have a "blind spot"—a "thing-side"—on our supposedly concrete object?

Scenario B₆ —We visit different bakeries and notice qualitative differences. We can identify that this is due to the production process, which we understand better through our new experiences. We can locate the "automated" processes because we have experience with our object, *bread*. We can differentiate: "This may formally look like a rustic loaf of bread, but its substance is like that of spongy toast. Its production process is reduced to cost optimization, profit, and the design of a desirable appearance." Or: "That small loaf over there looks modest, but it is tasty, and two small slices are filling." Even if the homemade bread still tastes better, we can better navigate within the various "automations."

A brief interlude —What can we take from this everyday relationship between thing, object, and automation for our consideration of architecture and AI? Obviously, we need to have a certain nearness to be able to understand an object as such. Of course, with architecture and AI, we are dealing with more complex objects, and we would hardly claim that we could do without the division of labor to explore and implement everything ourselves. However, we can proceed methodically, similar to baking bread, by dealing with historical circumstances on the one hand and collecting our own experiences with the production process on the other. We turn to the given circumstances, engage with the expe-

riences of others, but we are also ready not to rely solely on their information, instead mobilizing and adapting our own approach through our own experience. Such an engagement could lead to the ability to differentiate the object *architecture* even though we have not performed every task ourselves or determined and shaped every material. Such an engagement would bring us closer to the object *architecture* in a way that allows us to differentiate the qualities it possesses and how it could be realized.

Scenario A₁ —We stroll through an unfamiliar city and see a particularly striking silhouette in the distance, a structure that stands out from its surroundings due to its shape. Advancing a few steps closer, we identify it as a magnificent building, and say: “Look at that architecture!”

Scenario A₂ —During our walk through the streets, we don’t encounter a baker, but an architect, who responds to our statement as follows: “Architecture is a *gesture*. Not every purposive movement of the human body is a gesture. Just as not every purposive building is architecture.”⁵ We need to think about that for a moment, but we have already learned: not every object that looks like a delicious, substantial loaf of bread is actually such.

Scenario A₃ —Let’s take this architect’s statement seriously and ask ourselves: what is a “purposive movement”? And accordingly, what could a “purposive building” be?

(We scratch our heads.) It must be related to the everyday movements of our body. We need to ask ourselves what needs we can satisfy with it, what technical–functional actions can be performed in it, and what goals can be achieved with it. We need to start dealing with how we can create such a building. Let’s use existing reports of experiences for this!

We follow some philosophical wisdom from a book published in 1570 called *The Four Books on Architecture*. In the first chapter, it states that certain things “must be considered and prepared before building can start.” Besides “usefulness or convenience,” “durability” also plays a central role in the construction of “every building.”⁶

5 Ludwig Wittgenstein, *Vermischte Bemerkungen*, ed. Georg Henrik von Wright (Suhrkamp, 1977), 86.

6 Andrea Palladio, *The Four Books on Architecture*, trans. Robert Taverno and Richard Schofield (MIT Press, 1997), 6.

First, we set a purpose. “Convenience will be provided for when each member [*membro*] is given its appropriate position”⁷—for our purpose, an exemplary fragment: an apartment. We must therefore consider that objects and actions required for cooking, baking, eating, washing up, sleeping, etc., must be contained or take place in it. Through these conditions and individual elements, the *volume* required for the purpose of an “apartment” can be determined. How can we now construct the building that defines this volume and is characterized by a certain “durability”?

Durability will be guaranteed when all the walls are plumb vertical, thicker below than above, and have sound and strong foundations; and further, when the columns above stand vertically over those below and all the openings, such as doors and windows, are one above the other: so that solid is above solid and void above void.⁸

A building constructed in this way would be a purposeful one!

Scenario A₄ —It seems, therefore, that purposefulness can be determined by clear rules. For “durable construction,” we can also rely on “recipes” based on existing experiences. For example, material properties such as hardness, density, flexibility, tensile strength, load-bearing capacity, etc., are based on *measurements*. Through these measurements, we can *quantify* the materials and derive the necessary construction dimensions based on them: we can determine through formulas how material information relates to formal dimensions. This numerical, formalizing activity gives us certainty that our planning approach and the subsequent implementation are physically sound. In a way, we create a formalizing principle based on data that provides us with stable components.

Put very simply: By stacking and lining up these components, we achieve an order that ensures the structure holds together. This order can be derived through formalizing activity because it must also take physical numerical values into account. If we can rely on this order, it is a process that enables the reproduction of our object. The process could be described as an “algorithm”: because this process can be broken down into small, numerical basic operations (“Elementarity”), because it is determined by compliance with their clearly defined sequence (“Determinacy”), because it is available in a general

7 Palladio, *The Four Books on Architecture*, 7.

8 Palladio, *The Four Books on Architecture*, 7.

form and can be executed as such (“Generality”), and finally, because there is a completed result that can be achieved again by the same procedure (“Finiteness”).⁹ With algorithmic operations, we can thus determine our purposeful, technical–functional structure for a building.

Scenario A_5 —Algorithmic operations, as is well known, can be solved not only by human activity but also by computing machines.¹⁰ For *Scenario A_4* , however, a parametric system would suffice;¹¹ there is no need for an AI system. AI systems are characterized by their ability to determine their computational paths in a self-learning manner. Through various clever programming methods, they can respond flexibly to tasks and represent complex issues accordingly.¹² However, all AI methods are fundamentally based on algorithms, meaning they rely on familiar, rule-based mathematical forms:

Formal thinking ... is based on the possibility of replacing the operation with thoughts by the operation with patterns of signs, so that the rules according to which the construction and alteration of the patterns of signs take place no longer refer to the content of the thoughts, but only to the structures of the patterns themselves.¹³

A rule-based following of signs, which delivers a correct result without human thought (and therefore without thinking!), as generative systems adopt and even adapt, suggests reliability—but we know from our experience with bread that we must relate these general “patterns” back to our physical world.

9 See also the “intuitive” (since not mathematically provable) concept of algorithm by the philosopher Sybille Krämer, *Symbolische Maschinen, Die Idee der Formalisierung in geschichtlichem Abriss* (Wissenschaftliche Buchgesellschaft, 1988), 159.

10 Krämer, *Symbolische Maschinen*, 3.

11 For example, Autodesk’s software, Fusion 360. See Bryce Heventhal, “Generative Design in Autodesk Fusion: Revolutionizing Design with AI,” Autodesk, September 30, 2024, <https://www.autodesk.com/products/fusion-360/blog/generative-design-in-autodesk-fusion-revolutionizing-design-with-ai/>.

12 There are various AI methods, each with its own strengths and weaknesses. For example, one distinguishes between Machine Learning, Neural Networks, and Deep Learning. For a general technical overview, see Clemens Heitzinger and Stefan Woltran, “A Short Introduction to Artificial Intelligence: Methods, Success Stories, and Current Limitations,” in *Introduction to Digital Humanism: A Textbook*, ed. Hannes Werthner (Springer, 2024), 135–49, <https://link.springer.com/book/10.1007/978-3-031-45304-5>.

13 Krämer, *Symbolische Maschinen*, 102.

Nevertheless, we maintain, it is very likely that certain AI methods can adapt and support the constructive, planning approach (A_4) of humans, as they can determine formalizing processes based on data that represent material properties or a physical environment, and thus ultimately generate technical–functional forms.¹⁴ Furthermore, they could carry out formalizing procedures that exceed the computational capacity of humans in their complexity and information density, and potentially offer technical–functional optimizations that also consider the scope of ecological aspects, for example. In summary, we can say: Machines seem able to serve our required technical–functional purposes, which we achieve through formalization, even if we have to pursue them critically!

Scenario A_6 —We now know that machines can support us in the realization of our desired, purpose-built objects. We know that we need to understand this object—the technical–functional building construction—so that the manufacturing process also turns out as desired. For all problems that can be solved by a rule-based procedure, there are ways to develop corresponding formalizing procedures. We can also call this a “program.” Programs can be created and followed by both humans and machines. But what happens outside of this problem-solving area, outside of formalization? “The limits of formalizability are the limits of a mechanical, unimaginative mind.”¹⁵

Scenario A_7 —Let’s look beyond these limits. The building fulfills a purpose, but not every building is architecture, it was said. Architecture is a “gesture.” We are familiar with this word from our everyday lives: the friendly wave of a person greeting us expresses the gesture of welcoming. It is a physical movement that follows the purpose of the greeting, but adds a certain “warmth” to it—one could say that the movement is filled with a vivid expression that not only greets the newcomer in a matter-of-fact way, but welcomes them warmly. We recognize the purposefulness of the greeting movement, but *it shows* that it is *more* than a purposeful movement, more than a transmission of information. How could this be transferred to architecture?

14 One possible approach here could be Reinforcement Learning, a category of Machine Learning in which a so-called Agent learns based on a Rich Environment. See, for example, Richard S. Sutton and Andrew G. Barto, *Reinforcement Learning: An Introduction* (MIT Press, 2018).

15 Krämer, *Symbolische Maschinen*, 181.

An architectural gesture could be characterized by possessing a similarly “vivid expression” that is familiar to us through that physical gesture of our body. This would be the case if architecture succeeded in enriching the *volumes* of purpose with “more” in developing a vivid *space*. Since it has neither an organic body nor a language of words, it is faced with the challenging task of realizing this “more” through form and material¹⁶—for example, a gesture of welcoming as a reception. We would have to use our experience to find out which gesture—measured against its purpose—would be considered a more exuberant or appropriate expression in architecture; we would have to find a contemporary measure of form and material to do so. This measure is not found through formalization or quantification, but through our physical experience that takes part in our environment.

We conclude: the gestural entrance fulfills its purpose with expression. The entrance of a building therefore differs from that of architecture in that it has no gesture, but we can still walk into the building. We can now grasp our object, *architecture*, a little more clearly than before.

Scenario A₈ —A great friend of *architecture*—as his expression, the “art of master builders” (“*baumeisterliche Kunst*”¹⁷), reveals—was the composer and philosopher Theodor W. Adorno, who recorded his experiences with such art forms in a number of notes. Among other things, he was concerned with constructive procedures that were limited to technical–formal correctness and deducible order. He also verified such procedures based on existing objects—in one of his notebooks, it says that “in the architecture of the eighteenth century” one encounters “similar circumstances [of a supposedly systematic necessity of compositional logic], where ‘compelling’ symmetrical relationships prevail *without* constructive necessity in the strictest sense. My suspicion: that contingency increases the more rigid the regularity becomes, i.e., the more it dispenses the subject from experience.”¹⁸ If we depend on formal regularity, the quality of our object can suffer under certain circumstances, which we only notice when we have come closer to it through experience (i.e., B₅). But the first

16 Here I allude to Theodor W. Adorno, “Funktionalismus heute”, in *Gesammelte Schriften, Band 10.1, Kulturkritik und Gesellschaft I / II*, ed. Rolf Tiedemann (Suhrkamp, 1977), 388.

17 Arnim Regenbogen and Uwe Meyer, eds., *Wörterbuch der philosophischen Begriffe* (Meiner, 1998), 63.

18 Theodor W. Adorno, “Graeculus (I), Musikalische Notizen,” in *Frankfurter Adorno Blätter VII*, ed. Rolf Tiedemann (edition text + kritik, 1992), 21. Emphasis by Adorno.

sentence of this quote initially sounds paradoxical: “compelling’ symmetrical relationships ... without constructive necessity in the strictest sense?” So, construction here must be understood as something different from what we have worked out in scenario *A*₄. Adorno seems to be referring to a form of experience through which we can make constructive decisions that cannot be derived in a technical–functional sense. It is an experience that does not provide retrievable knowledge, let alone allow one to enrich formal rules. So, we need to be more precise here: The gesture that we experience through our body is a form shaped by our senses, it is determined by our aesthetic perception. The task of such an architectural construction would therefore be to translate these gestural experiences into the (“wordless”) language of architecture—through form and material.¹⁹ As in our everyday gestures, organic, asymmetrical moments would creep into the technical–functional construction or systematic order. These—in an aesthetic sense—constructive “irregularities” could be experienced as gestures.

Let us specify this experience, which is *essential for the construction of architecture*: aesthetic experience needs a body. It enriches our small, purposeful everyday situations with vividness. It opens up a realm that we cannot summon in a controlled manner, but which happens to us involuntarily and immediately: we are momentarily distracted and disrupted from our everyday, purposeful courses of action because we are somewhere in between fascinated and shocked. In this, we experience a participation in our environment. The term we use to outline such “small” or “large” phenomena of an object is “beautiful.”²⁰

We conclude: “Construction” in architecture does not only mean serving purposes, but also mobilizing its purpose-bound order according to the experience of the living body. Construction is therefore not a purely rule-based, dominant activity, but rather also needs non-intended impulses to flow into itself through aesthetic experience. We can thus distinguish that there is both technically-functional and vividly-gestural construction, which do not stand in opposition to each other but go hand in hand. Such a construction would be called “supra-functional” by Adorno.²¹ Supra-functional constructions need a

19 Adorno, “Funktionalismus heute,” 377.

20 On the concept of the “beautiful” in Adorno, see Theodor W. Adorno, “Ästhetik (1958/59),” in *Nachgelassene Schriften, Abteilung IV: Vorlesungen, Band 3*, ed. Eberhard Ortland (Suhrkamp, 2009), 157; Theodor W. Adorno, *Aesthetic Theory*, ed. and trans. Robert Hullot-Kentor (continuum, 2002), 44 and 61.

21 Adorno, *Aesthetic Theory*, 44.

body. With a nod towards AI, a technical formulation: the body as an aesthetic measuring tool.

Scenario A₉ —What does this mean in conclusion for a current architectural practice that will deal with the future developments of AI?

We can localize the answer. The potential of such technologies lies not only in making our lives easier by taking over or accelerating work but also in expanding the realms of experience. In the worst case, automated processes can lead to us losing sight of our objects without realizing it. This turns objects into things in a bad sense. The simple abundance of our shaped environment also suffers as a result: Our functional forms without the quality of gesture would be sober and dead, “gesture” without purposeful orientation would become an empty play with material and form. An alternative scenario would be if we were to embark on an “excessive,” friction-generating exploration between thinking and perceiving, between conceptual apperception and liberating, aesthetic experience. This could give us a refreshing perspective on architecture and technology, if we were to allow ourselves to be driven to our limits, to free ourselves from “classical” design processes in order to open our perception to the qualities of architectural space, however this may be technically produced. This would place the architectural object at the center: It would differentiate the purposes up to ecological questions, would interlock it with “nature,” and pleasantly remove the so-called “creative subject” from its center, without forgetting that it corresponds with man in its language-like form.²² If we could gather unexpected, unintended experiences in the new technologies, and if these could help us to realize a living habitat that is characterized by numerous constellations that create an equivalent, gestural vessel for our everyday life in any modes and ways of existence—that would be an urban, architectural habitat for man and nature.

Outlook —With this openness to experience, equipped with a rich concept of our object—architecture—we could re-engage with its obscured, distant “thing-side”: “to produce what is blind, expression, by way of reflection, that

22 Adorno, “Funktionalismus heute,” 376.

is, through form; not to rationalize the blind but to produce it aesthetically, “To make things of which we do not know what they are.”²³

23 Adorno, “Funktionalismus heute,” 114. Here Adorno quotes himself: Theodor W. Adorno, “Vers une musique informelle,” in *Quasi una Fantasia, Essays on Modern Music*, trans. Rodney Livingstone (Verso, 2002), 322.