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Dionysian Tendencies in Design
How references work in complex situations

Complexity

In the 1980s and 1990s, ordinary people in Iran frequently used a phrase, initially to encourage collective efforts in the face of wartime conditions and later to blame the unsuccessful projects in the post-war period. The phrase was: "We exhibit greater creativity in the midst of complexity." What people wanted to refer to was their general understanding of the relationship that they found between complexity and creativity. By 'complexity,' they meant situations with properties, behaviors, or patterns that are not directly predictable from the properties of their individual components. This was the case because the number of interacting components of every situation had dramatically increased during the war. The mental and psychological states of individuals – including people and soldiers, societal responses to incidents, domestic policies, developments on the war front, economic conditions, the policies of foreign nations, and numerous other variables – were added to a complex combination of existing factors, and changes in each of these variables had direct or indirect and sometimes disproportionately large effects on many other domains. As a result, the possibilities of unpredictable behavior and uncontrollable results in each project were increased. Therefore, even the problem figure was not very descriptive. The dimensions and characteristics of the problem could change at every moment, and it could create a more ambiguous face. Consequently, it

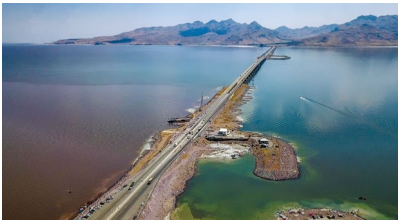
could not be framed or defined easily. And, by creativity, they meant a kind of fearless action that goes beyond the closed scope of norms and past solutions. To clarify the term 'creativity,' I refer here to Robert Franken, who defines it as a tendency to generate or recognize ideas, alternatives, or possibilities that could be useful in solving problems ... an ability to generate alternatives or to see things uniquely, which is linked to fundamental qualities of thinking, such as flexibility, tolerance of ambiguity or unpredictability, and the enjoyment of things heretofore unknown.[1]

In order to better explain the root of forming the above phrase, I compare two challenging projects which were both related to bridge construction; one of them was a project of providing a passageway to transport heavy military equipment, drinking water, and food from one side of the Arvand river to the other side in the heart of the battle in the 1980s. The other is related to the 1990s when the war was over, and connecting two sides of Lake Urmia in the west of Iran was needed to facilitate traveling between two cities. Due to intricate hydrological and environmental factors, geological conditions, and structural engineering challenges, bridge construction on a river is itself a complex problem. The war conditions impose a double challenge. The main difference in how people faced complex problems during and after the war was that, in the 1980s, there were still those who, like their ancestors, knew how to interact with the unknown and were not afraid of facing ambiguous and wicked problems. However, in the 1990s, the number of university graduates significantly multiplied,[2] and the prevailing belief in science as the sole credible authority for knowing and engaging with the world discredited reliance on other kinds of knowledges. Therefore, they increasingly leaned towards relying on scientific frameworks and university research results. They often sought paths that appeared scientifically secure and navigable and could provide tried-and-tested solutions to similar problems. With facilitated global communication, access to many of these solutions and ongoing projects – which served as a source of inspiration for addressing myriad post-war issues – became available. Nevertheless, there was always the possibility that these solutions might not be suitable for new conditions.

1 Robert E. Franken, *Human Motivation.* (Thomson Brooks/Cole, 1994), 396.
2 According to the statistics of the Ministry of Science, the rate of university education in Iran was twice as high in the 1990s as in the 1980s.

The river in the first example stands out from most rivers worldwide due to its unique behavior, experiencing two high tides and two low tides daily, resulting in a 3-meter water level fluctuation. Additionally, the water speeds of up to 70 kilometers per hour, irregular whirlpools, and a 900-meter width contribute to its wild and turbulent nature. Consequently, constructing a temporary wartime bridge over a river with unpredictable behavior posed many challenges. The process of building the bridge should remain hidden. It was not possible to carry heavy and huge equipment to the bridge site. The bridge's parts had to be assembled on-site with minimal facilities. The bridge must survive against tides, water pressure, and eddies. In typical wartime scenarios, temporary bridges over calm waters utilize floats or shallow-draft boats to support a continuous deck for pedestrian and vehicle travel. However, the conditions of the Arvand River made this type of bridge unfeasible. Nevertheless, over three years, multiple successful models of temporary bridges were constructed, each tailored to the specific circumstances.[3] The bridges were built by those who did not necessarily have an engineering education in a related field of study, but they knew how to interact with the ambiguity and complexity of the project, the unpredictable behavior of the river, and the existing challenging conditions. It can be said that for them scientific research and science in its academic sense was a side-issue. Essentially, the complexity and variability of conditions prevented them from scientifically testing soil, water, and other variables. As a result, the scientific approach was not welcomed from the beginning. Instead, they seem to have adopted "a model of dealing with the world that is not dependent on science."[4]

situation of Urmia Lake in 2023



Urmia Lake Bridge

3 Unfortunately, photos of the bridges are difficult to access, probably due to military reasons.

4 Andrew Pickering, "Acting with the World: Doing without Science." E-Cadernos CES, no. 38 (2022). accessed April 01, 2024, https://journals.openedition.org/eces/7894
"Science is part of the problem, and it is at most a side-issue in the poetic projects I've examined. It interests me a lot that there is a pattern of acting with the world that does not hinge on science and that is presently overshadowed by science. Part of my project is to foreground this strange pattern of 'doing without science.'"

The conditions of Lake Urmia, in the second example, were also very challenging compared to the other similar lakes due to the social, cultural and historical importance of this lake, geographical, and geological features and even the water's chemicals.[5] However, during the 1990s, despite the facilities and the removal of restrictions, and despite the fact that all of those involved in the project had academic education in the field of engineering and bridge construction design, and proceeded with scientific studies and experiments, the Urmia Lake Bridge became a failed project with many consequences for the environment and local residents. Therefore, people had come to believe that engineers' and designers' hands and minds were tied more tightly during this period. No traces of interaction with the ambiguity of the environment and complexity of the problem can be seen in this project. Instead a narrow focus on previous solutions resulted in building a typical bridge of the Tied-Arch type with very harsh consequences that many argue the bridge should be demolished as soon as possible. The effects of this decision include severe water blockages, the division of incoming water into two basins, and increased evaporation rates. This bridge has ultimately become a significant contributor to the environmental crisis in the region. Consequently, nearby cities now face the threat of salt storms, and the destruction of the lake's ecosystem looms on the horizon. As it was aptly stated, if, in the old science, it was possible to go into the laboratory, shut the door, and exclude the universe outside from consideration, the science of complex systems is not like this since it is not possible to separate their social and physical subsystems and study them in isolation. More generally, the subsystems of complex systems cannot be studied in isolation.[6] Complex systems often involve non-linear relationships, where small changes in one part of the system can lead to disproportionately large effects elsewhere. Therefore, seemingly minor decisions can have significant consequences. This feature is also seen in design. Brayan Lawson explains the complexity of design and states:

5 The lake's width at the place designated for the bridge was 1,270 meters. The lake's bed – up to a depth of more than 40 meters – comprises a mass of sludge with special compounds, which lacks the necessary resistance for loading. The amount of salt in water is at saturation level. It is the sixth-largest saltwater lake on Earth, and the water's chemicals make the bridge's construction and durability more difficult.

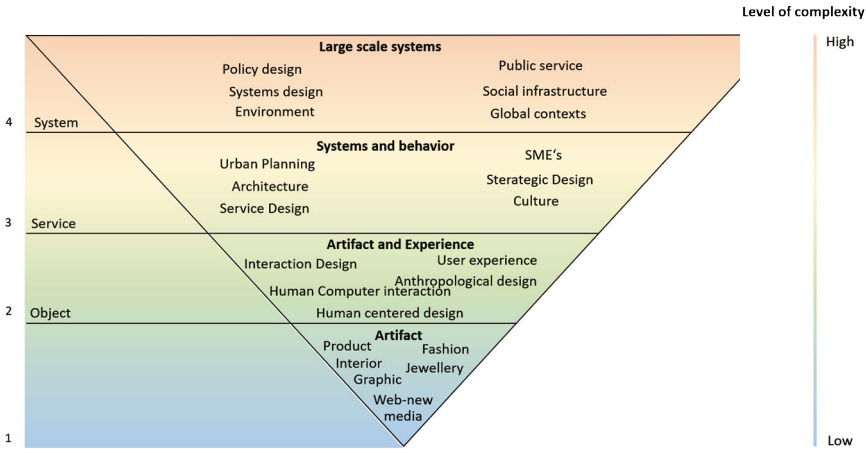
6 Katerina Alexiou, Jeffrey Johnson, and Theodore Zamenopoulos. *Embracing Complexity in Design,* (Routledge, 2009), 193.

> *Designers must be able to recognize and understand not just existing situations but ones that might exist if the design were to be constructed. In effect this means that a designer is potentially in some infinitely regressive world that shifts each time a change is made to the design.*[7]

Complexity is an essential feature of designing.[8] In other words, it inherently derives from the nature of the design. In the realm of design, we navigate through various domains, each with its unique set of attributes. Our decisions and actions have far-reaching implications that extend beyond a single domain. In fact, in the most extreme scenarios, a choice rooted in the intentions of one domain can ripple across all other interconnected domains, triggering a cascade of effects that reverberate throughout the entire design process. This interconnectedness underscores the intricate nature of design, where our choices are multi-dimensional and have consequences in all other domains.[9] Even if designers were able to define the problem considering all of the consequences and qualities across every domain, solving it would have appeared incredibly complex. This challenge is similar to finding a way through a vast and dense forest, where complexity and ambiguity abounds. At the time of beginning a project of any size, designers will usually feel overwhelmed by the amount of material they have to cover and dealing with the mass of ideas in their head. "However, wandering through that forest is an essential stage in any creative endeavor."[10]

Herbert Simon explains that "pure" science is the study of systems as they are, e.g. astronomy or the collection of biological specimens. By contrast, the science of complex socio-technical systems is usually concerned with systems as they ought to be.[11] The expansion of design thinking to other fields, such as management and sociology, has caused design to evolve into more complex environments. Obviously, the level of complexity in each design practice is different depending on the conditions of each project. Furthermore in general, different fields of design can be categorized based on the extent and complexity. The following table includes the design of tangible artifacts to the design of intangible ones and

7 Bryan Lawson, *What Designers Know,* (Routledge, 2012), 117.
8 Schön, D.A. "Designing as Reflective Conversation with the Materials of a Design Situation." Knowledge-Based Systems 5, no. 1 (March 1992): 3–14. https://doi.org/10.1016/0950-7051(92)90020-g.
9 Ibid.
10 Alec Nevala-Lee. "Surviving the German Forest,"accessed August 27, 2024. https://nevalalee.wordpress.com/2015/08/27/surviving-the-german-forest.
11 Herbert Alexander Simon, *The Sciences of the Artificial.* (MIT Press (MA), 1969).



Sub-disciplines of design practice operating on different levels of complexity, Table re-drawn from https://ithinkidesign.wordpress.com/wp-content/uploads/2014/07/typology-of-dt-inverted.jpg

from traditional design practice to the influence of design thinking in fields outside of design practice.[12]

"Complexity by itself is neither good nor bad: it is confusion that is bad."[13] Walking amidst a dense forest where, at first glance, all trees appear similar can be disorienting and dizzying. Time is needed for the paths among the trees to reveal themselves. "Complex things become simple after we have mastered them, after we understand how they operate and the rules for interaction."[14] Various researchers have proposed different methods to facilitate complexity in design. This article refers to three approaches: the transformation designer's co-evolutionary approach, Andrew Pickering's doing-without-science approach, and Donald Schön's interactive approach. Each one of their methods, assists designers in dealing with ambiguity, unpredictability and unknowns in complex situations. Once we understand the rules for dealing with complex situations, they become manageable and subject to communication. In all these methods, due to the impossibility of acquiring sufficient knowledge in all required areas, we are unable to consider all the potential consequences. Therefore, designers are compelled to initiate work on the project from a simple idea in a smaller domain, which Jane Darke calls it the "primary generator."[15] However, they can allow considerations from

12 Stefanie Di Russo, Understanding the Behaviour of Design Thinking in Complex Environments. Melbourne: Unpublished PhD thesis. (Melbourne: Swinburne University, 2016), 42.
13 Donald A. Norman, *Living with Complexity.* (MIT Press, 2016), 4.
14 Ibid. 222.
15 Jane Darke, "The Primary Generator and the Design Process." Design Studies 1, no. 1 (July 1979): 36–44, accessed April 15, 2024, https://doi.org/10.1016/0142-694x(79)90027-9

other domains to seep in gradually. This way, they uncover some unintended consequences of their actions during the work process. Since the process of design education cannot escape from explaining the first step in design, and design practice is tied to this step, and the primary generator directly impacts the entire design practice; it is essential to know what the primary generator can be. How can we achieve it, and what approach can lead designers to a more creative and satisfactory solution? The primary generator in design can be an idea taken from a topic outside the project, which may seem unrelated but familiar to the designer (reference), or an utterly related idea drawn from past solutions (precedent). In the following, I will provide a brief explanation for both. Despite acknowledging the differences between these two, many researchers in the field of design mistakenly use precedent for both of them. Whereas the term 'precedent' is less satisfactory than 'reference' as a generic description of this phenomenon in design. Goldschmidt prefers to see precedents as a subclass of the more general idea of reference.[16] Here we examine these two concepts independently and in relation to the concept of complexity and not knowing. Therefore, it remains faithful to their respective definitions and does not place either of them as a subset of the other.

Precedents

Kees Dorst and Nigel Cross discuss how a problem-solution pair is framed by designers, defining the design situation by considering the insight that a possible solution can provide. Such possible solutions are drawn from, or suggested by, the designer's storage of precedent knowledge.[17] According to Cross, design knowledge resides in designers and products in addition to the design process. Taking the first step based on the existing solutions or similar examples of a specific product, is the method generally followed by many designers. Cross elucidates that "much everyday design work entails the use of precedents or previous exemplars - not because of laziness by the designer but because the exemplars actually contain knowledge of what the product should be."[18] Put differently, they contain existing solutions. Precedent knowledge is a form of knowledge specific to the

16 Lawson, What Designers Know. 96.
17 Jason K. McDonald, and Richard E. West, *Design for Learning,* (2021), 5.4.4.
18 Ralf Michel, Design Research Now. (Walter de Gruyter, 2012), 47.

activities and goals of design, and you do have some, whether you realize it consciously or not. This kind of knowledge is also called episodic knowledge. Within the mind of each designer, precedent knowledge is structured over time into multiple schemata: "precedent stored in the form of episodic schemata is used by experts to recognize design situations for which gambits are available."[19] Lawson does not suggest that precedent knowledge should be turned into abstract knowledge through the creation of generalized principles. Instead, he explores schemata as patterns where the original experiential elements remain unchanged, serving as potential design actions that can be considered applicable to the current design context.

Many designed buildings, services, and products around us, from the simplest to the most complex, have preserved the legacy of their design. That is why we usually see not so many changes. For instance, the first typewriters were built in the early-1870s. Their (QWERTY) keyboard layout is still widely used today. It is not necessarily the most efficient or ergonomic keyboard layout for today's digital devices. Nonetheless, the widespread adaption of the QWERTY layout has been challenging to change due to its wide range of use and acceptance. Although Cross suggests that using precedents is not due to a designer's laziness, the reality is that, in practice, precedents are catalysts that expedite the design process and assist in bringing ideas and finding a more straightforward path to a solution. Precedents are often either whole or partial pieces of designs that the designer is aware of. They may be previously employed solutions by the same designer or other designers.[20] In the forest metaphor, precedents are like a path, a trampelpfad, constructed over time, allowing for a swift passage through the forest. Precedents usually play a crucial role in design education. In architecture education, building precedent knowledge has long been a highly structured activity, overtly and rigorously pursued by means of memorization.[21] In studio projects, students are expected to be able to identify precedents and analogies with their work, as a way to explain and justify it.[22]

19 Lawson, What Designers Know, 1.
20 Ibid. 96.
21 Bryan Lawson, *The Design Student's Journey.* (Routledge, 2018).
22 Eastman, Charles. "New Directions in Design Cognition: Studies of Representation and Recall ." Design Knowing and Learning: Cognition in Design Education, 2001, 147–98. https://www.researchgate.net/profile/Charles-Eastman/publication/246935473_New_Directions_in_Design_Cognition_Studies_of_Representation_and_Recall/links/54186d520cf2218008bf3ca0/New-Directions-in-Design-Cognition-Studies-of-Representation-and-Recall.pdf

Lawson recounts his time as an architecture student at the University of Oxford, where students were required to draw the designs of many famous historical buildings from memory.[23] A similar practice exists in product design, where students are encouraged to study and remember notable examples from renowned designers. Furthermore, each defined project commonly commences with a strong recommendation to research the precedents related to the problem and study existing solutions. As a student at the Faculty of Design at Sapienza University, benchmarking was necessary in the early stages of every design project. Through benchmarking, students were asked to find the best practices, creativity, and innovation in the field. The result should then be used as a starting point and source of inspiration for the students.

Alongside its general meaning, the term precedent is commonly associated with its usage in the legal system. Extensive databases are available in the offices of all lawyers, and they are required to search for specific aspects of past cases to find potentially similar ones that can be used as legal precedents. By referring to the database of legal precedents in every country, some parts of the judicial decision-making processes can be delegated to artificial intelligence. Artificial intelligence can identify cases from the existing files with relatively similar conditions and, based on them, offer counsel, suggestions, and predictions. Doing so can streamline the judgment process, mitigating many instances of human error or biased viewpoints. A similar system exists for design, aided by machines, which is commonly employed today to expedite the design process, simplify the path for more complex projects, or reduce the cost of the process. Precedents in design and architecture have played a significant role in automating the design process. These precedents assist machines by enabling them to access design principles, aesthetics, and user preferences through analyzing and aggregating successful and influential designs. Artificial intelligence possesses data banks consisting of design precedents, which can generate new designs in user-preferred styles or provide design recommendations based on design precedents. For instance, in web design, it can propose layouts, color schemes, and typography choices by referring to successful websites with similar content or objectives. One of the best

23 Ibid. 101.

and most accessible examples in this regard is the platforms that assist graphic designers; for instance, Hatchful, Smashing Logo, and Looka are some of the many logo generator tools out there. They provide a wide range of logo templates categorized by industry and style. Clients[24] can customize these templates to create their desired logos while drawing inspiration from the provided designs.

Analyzing design precedents even helps artificial intelligence predict future design trends. By understanding designs that have gained popularity in the past, artificial intelligence can steer towards future design trends and incorporate these trends into new designs. It can also personalize designs based on individual preferences. Regardless of benefiting from precedents in enhancing artificial intelligence capabilities in the design process, the role of precedents in design compared to precedents in the legal system is entirely different. Each design process is defined with the goal of making even a minor change. It is yet expected to update and improve old solutions constantly. Wolfgang Jonas views this as an imperative and states: "Design must consciously generate variations and create differences, because the 'fits' dissolve, disappear, and become outdated" (translation by author).[25] Besides, Lawson believes that the nature of the design is such that "no two design situations are ever identical."[26] In other words, all design problems are unique. Therefore, unlike the lawyer, the designer is not aiming to showcase a direct match with the precedent; instead, they are leveraging something that shares sufficient similarity in certain aspects to serve as a valuable starting point.[27] In addition, while it is true that drawing inspiration from successful design works can provide valuable insights and create positive impressions, it is equally essential to uphold the intrinsic value of originality and uniqueness in the design process. Among the other points that designers should consider when relying on precedents is that they are whole or partial solutions. Accordingly, they demonstrate possible ways of doing things in design.[28] In fact, being precedent-focused in reaching a solution – much like being solution-focused – is seen in contrast to being problem-focused. The

24 Here, the presence of a human designer is no longer necessary.
25 Wolfgang Jonas, *Mind the Gap! - Über Wissen Und Nichtwissen Im Design,* (2006), 47.
Design muss bewusst Variationen herstellen, Differenzen schaffen, weil die „Passungen" sich auflösen, verschwinden, altmodisch werden."
26 Lawson, What Designers Know, 96.
27 Ibid. 96.
28 Ibid. 98.

term solution-based precedent goes back to when designers and architects used pattern books. Lawson describes the use of patterns book and its relation to the solution and problem as follows: "If the pattern of the problems could only be seen as it is and not as the bromide image of a previous solution conveniently at hand in the catalog or magazine around the corner." He continues with this explanation: "stop being solution-focused and become problem-focused!" Using precedents in the first steps of the design process means starting with the previous solutions, which in a complex system limits the domains of creativity from the first point. Staying within the realm of tried-and-tested solutions keeps us away from exploring new horizons. While focusing on the problem at the beginning of the design process means focusing on the context from which the solution is expected to emerge. Here, according to Alexander, "form is the solution to the problem; the Context defines the problem."[29] He explains in his book "Notes on the Synthesis of Form" that the designer never really understands the context fully. He may know piecemeal what the context demands of the form, although he does not see the context as a single pattern – a unitary field of forces.[30] Furthermore, since the context is so vast and each person understands only a part of it, each solution will necessarily have a personal flavor, so we may have different solutions based on the number of designers because it is unclear from the perspective of each designer which part of the context is considered a problem and which part needs attention.

References

In contrast to designers who place emphasis on precedent, the second category includes those who initially look to references. References draw upon the designer's own knowledge and experiences, which are not necessarily related to the context but could also include "personal precedents."[31] According to Cross, "design knowledge resides firstly in people: in designers especially."[32] On this basis, it can be said that Cross also believed that the designer's knowledge holds greater importance than product knowledge. Socrates

29 Christopher Alexander, *Notes on the Synthesis of Form.* (Harvard University Press, 1964), 15.
30 Ibid. 90.
31 What I mean by "personal precedents" is the precedents that the designer probably created in previous projects.
32 Michel, *Design Research Now,* 47.

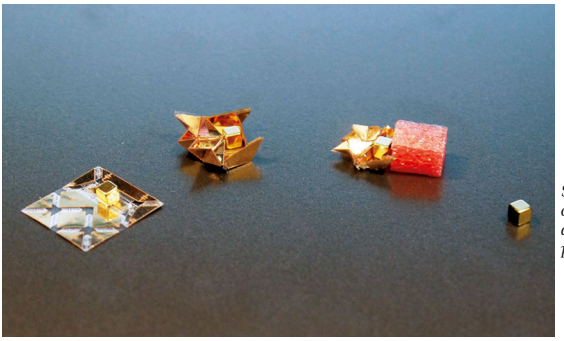
expressed in Theaetetus that although always regarded as the most direct way, it is not the nearest way but a meandering and twisted path that the journey of knowledge takes. While using precedents is seen as a shortcut, choosing references over precedents means opting for a longer, more twisted path. References explore the vast unknown, while precedents stick to the well-marked roads. References reflect a designer's personal experience, whereas precedents are the experiences of others, which we only have a general understanding of, making them impossible to fully grasp. Elizabeth Boling, who also works on precedents and references, argues that "each designer's store of experiences is unique to that designer. Even when multiple designers share the same experiences, they do not necessarily pay attention to the same aspects of those experiences, or recall them later in the same way."[33] However, professional designers delve not only into solutions but also into meaning, and for this purpose, they turn to references beyond the scope of the subject. For instance, although there is no clear connection between a squid and a lemon squeezer, it is said that the design reference for the lemon squeezer of Philippe Starck was a calamari squid plate at a restaurant. Alberto Alessi, president of the Italian design company of the same name, explained the way he received the sketches and said;

> *I received a napkin from Starck, on it among some incomprehensible marks (tomato sauce, in all likelihood) there were some sketches. Sketches of squid. They started on the left, and as they worked their way over to the right, they took on the unmistakable shape of what was to become the juicy salif. While eating a dish of squid and squeezing a lemon over it, Starck drew on the napkin his famous lemon squeezer.*[34]

The napkin with sketches by Starck, Reference: https://hivemodern.com/pages/product36/juicy-salif-juicer-starck-alessi.

33 McDonald and West. Design for Learning, 5.4.1.
34 hivemodern.com. "Juicy Salif by Philippe Starck for Alessi | Hive, accessed " June 10, 2024, https://hivemodern.com/pages/product36/juicy-salif-juicer-starck-alessi

Lawson asks: “Why can some designers sometimes draw on references from apparently remote situations and use them in quite novel ways that not only surprise us but also seem entirely relevant to us?” Then he answers: “Perhaps this is at the very heart of what we mean by creative production.” There are many such examples. Due to their deep cultural familiarity with a concept, certain designers can excel in advocating for entirely unrelated ideas. For instance, consider miniaturized robots that draw inspiration from origami. These robots possess the capability to autonomously transform into intricate 3D structures by leveraging origami principles adjusting their folding and unfolding techniques to match various tasks at hand. The folding patterns dictate the robot’s functionalities; otherwise, a plain sheet would remain stationary. Typically, these origami-inspired mini-robots are crafted by individuals who have cultivated their understanding of this art or originate in cultures that place a strong emphasis on origami, like Japanese and Chinese traditions.



Self folding origami robots, Photo credit: CSAIL, Reference: https://danielarus.csail.mit.edu/index.php/2015/09/lorem-ipsum-2/

Design knowledge and using references

This property, which involves drawing references from an experience, memory, or an emotional or mental state, can indeed make the process of shaping a potential solution ambiguous and complex. It means that many qualities and dimensions of the final product, including materials, plans, colors, form, dimensions, functionality, internal and external relationships, environmental impacts, cultural, social, and other potential influences, may remain obscure. This feature often leads only professional designers to dare to use references as primary generators. Novice designers and design students often face challenges when using reference as the primary generator. It is not easy to visualize ideas that have not been realized before.

They are imaginary pictures that manifest themselves vaguely in the designer's mind. To have a clearer shot, one must reduce the density of fog. They must learn how to transform a vague mental image or a memory into a tangible product or service. However, design education systems usually prefer to use more concrete methods like utilizing precedents instead of finding ways to convey and reflect abstract concepts such as intuition and imagination in the design process, which are difficult to express and convey. Therefore, due to the ambiguity present in this approach, education needs to redefine theoretical and practical methods for students.

For this purpose, strengthening non-formal intelligence will assist designers. Techniques at this level are typically taught by generalizing examples and are pursued intuitively without resorting to rules. According to Hubert Dreyfus's classification of intelligent activities,[35] design knowledge[36] is included in the category of non-formal behavior (Area IV), which emerges in an undefined and shifting set of situations. The area of non-formal behavior encompasses "all those everyday activities in our human world which are regular but not rule-governed."[37] Besides design, games in which the rules are not definite – such as guessing riddles and disambiguation of natural languages – are also included. To explain the characteristics of this group, Dreyfus says:

> *Area IV differs from Area III (which is called complex formal behavior) simply by introducing a further level of complexity, whereas Area IV is of an entirely different order than Area III. Far from being more complex, it is really more primitive, being evolutionarily, ontogenetically, and phenomenologically prior to mathematics.*[38]

Non-formal intelligent behavior helps designers not only to visually register information but also to form its meaning or, as Schön states it, they identify patterns and give them meanings beyond themselves.[39] Pattern recognition in this domain is based on the recognition of the generic or typical knowledge and the number of

35 According to Hubert Dreyfus, classification of intelligent activities are Area (I) Associationistic, Area (II) Simple Formal, Area (III) Complex Formal, and Area (IV) Nonformal.

36 Different names and descriptions have been attributed to the knowledge of design, such as intuitive knowledge, practical knowledge, or tacit knowledge. The distinguishing feature of design knowledge is that the type of reasoning and dealing with phenomena in design differs from the type of reasoning in other sciences, such as mathematics, philosophy, or physics.

37 Hubert L. Dreyfus, *What Computers Still Can't Do.* (MIT Press, 1992), 206.

38 Ibid. 206.

39 Schön, "Designing as Reflective Conversation with the Materials of a Design Situation." 3–14.

individual experiences. Problems on this level are open-structured, requiring determining what is relevant and insight into which operations are essential before the problem can be attacked. Techniques on this level are usually taught by generalizing from examples and are followed intuitively without appeal to rules.[40] In fact, "some essential knowledge needed to perform the task lies outside the problem itself but in knowledge of situations in which the problem may arise."[41] For instance, focus on meaningfully translating the homonyms in the following sentences.

Stone is under the nail.
The match did not work.
Box is in the pen.
Someone is in the bark.

In understanding the meaning of such phrases, human intelligence seeks clues within and beyond the text. To understand the sentence "box is in the pen," we need information outside the sentence itself. For instance, we need information about the pen size compared to the box. This is something that is not explained within the sentence. Therefore, it explores a contextual interpretation of pen that can accommodate the box. Our past experiences come into play to help us comprehend the contextual meaning. In English, pen has the following two meanings: a certain writing utensil and an enclosure where small children can play. Here, our information about the children's playground and its size is also helpful. Therefore, instead of a writing instrument, we refer to a playpen that can hold a toy box. Design knowledge typically aligns in a similar manner in this situation. This means that the information needed to arrive at an interpretation for any given problem lies outside of that problem itself. Essentially, "design solutions have a rather curious and complex relationship with design problems."[42] References also invite the designer to contemplate a broader spectrum of possibilities. Goldschmidt elaborates on this point by comparing it to precedents:

40 Dreyfus, What Computers Still Can't Do, 206.
41 Lawson, What Designers Know, 117.
42 Ibid. 8.

> *Research on analogy distinguishes between within-domain source analogs and between-domain ones, and it is generally believed that good between-domains source analogs are potentially more potent aids in creative problem-solving ... Likewise, we believe that precedents, which are within-domain visual design aids, maybe less powerful triggers for creative designing than are other between-domain forms and images that designers can read off various.*[43]

As an example, Goldschmidt points to architecture and explains that precedents in architecture only include buildings, and this means limiting ourselves to within-domain sources, which are a restricted source of stimulants. However, referring to images and objects other than buildings and unrelated experiences to the buildings (between-domain sources) evokes more creative ideas for an architect. Each design project beckons the designer to meditative thinking. This helps to discern subtle relations and patterns that are not easily readable. Calculative thinking should be avoided, especially in the early stages of any design process. With their relatively ambiguous and unknown nature, references cannot be obtained by calculative thinking. As "calculative thinking is not meditative thinking, not thinking which contemplates the meaning which reigns in everything that is."[44] By contrast, "meditative thinking demands of us that we engage ourselves with what at first sight does not go together at all."[45] There are no constraints for something to merit being a reference, except that it evokes an implicit meaningful connection for the designer, a connection that relates to their project in a way only they can understand. For instance, although, many viewed it as a shard of glass nestled in the heart of London, the connection that Renzo Piano saw between the design idea of the Shard Tower and the city of London was based on his repeated experience of observing tall-masted ships on the Thames. Goldschmidt states: "To be valuable, a reference must carry meaning and a designer must therefore have sufficient intimacy with it. It also has to relate to concerns that are on a designer's agenda, which may undergo frequent changes. Collections of references are therefore a rather personal matter."[46] References are typically simple clues that seem to come to the designer's mind almost accidentally but are, in fact, connections forged through the designer's experiences with

43 Goldschmidt, Gabriela. "CREATIVE ARCHITECTURAL DESIGN: REFERENCE VERSUS PRECEDENCE." Journal of Architectural and Planning Research 15, no. 3 (1998): 258–270. http://www.jstor.org/stable/43030466
44 Martin Heidegger, *Discourse on Thinking,* (1966), 46.
45 Ibid. 53.
46 Goldschmidt, "CREATIVE ARCHITECTURAL DESIGN," 258–270.

meaningful ties to the project. This very openness of the nature of references – coupled with their inherent ambiguity – places them among experiences that seem elusive, occasionally reminding us of them.
References can be derived from a vague image of a memory, a natural phenomenon, a fantasy, or a seemingly related or unrelated imaginary scene. It means, even a designer's imagination can be used as a reference. John Zeisel argues that one of the key features of the design process is working with heuristic information. He sees this type of information as a catalyst for imagination.[47] Philipp Oswalt also considers the logic followed by design as a different, imagination-based logic. According to him, this is the very reason why not knowing plays a productive role in it.[48] Based on this, the greater challenge in designing is letting go of accumulated knowledge. He abandons classified information and scientific logic and, for solving a complex, multi-layered problem, relies on non-formal problem-solving intelligence. Non-formal intelligence helps designers picture new and unfamiliar patterns and imagine meanings beyond what scientific reasoning suggests. In sciences such as mathematics, philosophy or physics, we usually deal with inductive and deductive reasoning. While the type of reasoning and dealing with phenomena in design is different. Lionel March considers abductive thinking as the key element of design reasoning, although his preferred name for this type of reasoning for design knowledge is productive reasoning. This type of reasoning is also called intuitive. Some, like John Kolko, introduce abductive reasoning as the 'best guess' leaps;[49] others consider it envisioning and anticipation. According to Kolko's definition, abduction is "the hypothesis that makes the most sense given observed phenomenon or data and based on prior experience."[50] Therefore, the richness of the designer's experiences can facilitate abductive thinking. Charles Sanders Peirce articulates abduction as "that type of argument that starts from a surprising experience, that is, from an experience that contradicts an active or passive belief. This takes the form of a perceptual judgment or a proposition relating to such a judgment,

47 John Zeisel, *Inquiry by Design*. (CUP Archive, 1984), 6.
48 Haare Hören - Strukturen Wissen - Räume Agieren, 2015 , 150.
49 Jon Kolko, "Abductive Thinking and Sensemaking: The Drivers of Design Synthesis." Design Issues 26, no. 1 (January 2010): 15–28. https://doi.org/10.1162/desi.2010.26.1.15.
It is also called "intelligent guessing" by some others.
50 Ibid. 15–28.

and a new form of belief becomes necessary to generalize the experience."[51] According to most empirical findings, intuition is also based on a large amount of practice and accumulative experience.[52] The connection between references and abductive-intuitive reasoning is interesting. Both using references and abductive-intuitive thinking are dependent on experience, and both operate without dependence on rational reasoning. Intuition is also described as the apprehension of an object by the mind without the intervention of any reasoning process.[53] The same is true for reaching a reference. Any phenomenon can be a reference without any logical connection. In design practice, finding a reference is generally intuitive, at the core of abductive reasoning. Relying on references can be seen as turning to Dionysian tendencies instead of Apollonian tendencies. They are not like precedents to be archived or stored in databases. Essentially, they operate outside the realm of rules and are independent of any formula or theories. Furthermore, they are typically not easily formalizable, explained, or shared. Intuitive and abductive reasoning are essential tools of the design practice to create references as primary generators. Abductive thinking "is particularly evident at early design stages when synthesis must be carried out with only intangible intents and incomplete information."[54] In a study about the behavior of designers in complex environments, the researcher explains that:

> *Abductive reasoning proved to be a major force behind the navigation around complex and ambiguous project briefs... The complex, ambiguous project brief significantly influenced the attitude, mindset and approach that both design teams took towards the design process. Intuitive and abductive reasoning was observed as a fundamental driver for both design teams when faced with complex and ambiguous environments.*[55]

Even where user-centered design has been prioritized, this research shows that designers rely more on intuition, especially in unknown, ill-determined, and ambiguous conditions. "Where there was a crossroad between relying on user feedback or intuition to fill in for gaps in knowledge, the design teams often chose

51 Charles Sanders Peirce, Philosophical Writings of Peirce, (1955). http://books.google.ie/books?id=YHjcAQAACAAJ&dq=Philosophical+writings+of+Peirce&hl=&cd=2&source=gbs_api

52 Trent Ling, Y. G. Xiao and Petra Badke-Schaub. "HOW INTUITION AFFECTS DESIGNERS' DECISION MAKING: AN INTERVIEW STUDY." (2014). https://www.designsociety.org/download-publication/35199/how_intuition_affects_designers%E2%80%99_decision_making_an_interview_study

53 Ibid.

54 Lu, Stephen C.-Y., and Ang Liu. "Abductive Reasoning for Design Synthesis." CIRP Annals 61, no. 1 (2012): 143–46, accessed April 15, 2024, https://doi.org/10.1016/j.cirp.2012.03.062.

55 Di Russo, *Understanding the Behaviour of Design*, 113.

to trust their own ideas and instincts. Designers 'filled in' for missing information using intuition and gut instinct."[56] On the other hand, precedents are chosen quite logically. Using precedents as primary generators puts the design train on a pre-set rail from the beginning and makes the subsequent movements not limited but faithful to the precedents. Essentially, using precedents means continuing the path that has been taken up to that moment and showing the direction of movement in the future. This is while complex situations are generally in a constant flux of transformation. Therefore, it is better not to build a strong foundation for a primary generator and not to make a concrete and clear idea. "Attempts to frame a problem solution early in the process could not adequately account for all of the necessary number of variables that would impact the project."[57] The primary generators can be completely unrelated, unclear, unknown, and unimaginable, and just like a floating shapeless piece of wood detached from a tree, constantly changing direction with the flow of water, forms a shape by joining and separating other pieces. These pieces are the same as references that help designers in the first steps, when no horizon can be seen in the distance, and the problem is still ambiguous and unknown. The designer gives the pieces of the unformed idea into the design flow and cautiously tries to keep up with the unknown currents.

Not knowing and dealing with complexity

Science usually uses precedents. As in other areas of inquiry, science (through the scientific method) can build on previous knowledge and develop a more sophisticated understanding of its topics of study over time. Although it is very likely that references also help scientists, usually, most of the scientific progress is based on previous results. German sociologist Dirk Baecker refers to the book Die Fabrikation von Erkenntnis to describe the way in which science works and says: "Science does not observe the world, but rather calculates possible statements based on experiences with previous statements. What she actually knows is thanks to her

56 Ibid. 113.
57 Ibid. 107.

skill, including cheating, in producing variations in dealing with her own experiences and reacting to them."[58] The problem with using the scientific method is that science cannot easily resolve complex situations with open and evolving variables. The rigidity of science fails when attacking and resolving 'wicked,' ambiguous problems,[59] because, according to Rittel & Webber, science is exclusively capable of dealing with 'tame' problems. There is no room for trial and error when dealing with wicked problems.[60] They remark: "The problems that scientists and engineers have usually focused upon are mostly "tame" or "benign" ones...Wicked problems, in contrast, have neither of these clarifying traits."[61] Since the 1980s, complexity has been recognized as an important part of design practice and design thinking. Complex situations generally contain "wicked" problems, which are "unique" and "ill-defined."[62] Realizing complex situations is not so easy. Despite its wide use, the term "complexity" is ''notoriously difficult to define.'' According to John Flach, there is an explicit connection between complexity and uncertainty...Thus, coping with complexity is synonymous with coping with uncertainty![63] Ambiguity, uncertainty, and the impossibility of knowing all of the fields involved are among the most important characteristics of complex problems. Navigation in this situation is not so easy. The designers must make their way through a dense forest and over a swampy ground, trying to find a path that is constantly changing direction. Stefanie Di Russo, in her study, introduces the language used between designers as containing a sense of uncertainty:

> *Both design teams had to navigate their way through complex and ambiguous terrain, working towards an outcome for a brief that is subject to change. A key indicator of the sense of uncertainty experienced throughout the project was observed in the language used between designers during sensemaking, synthesis and brainstorming sessions. The language expressed amongst the design team was often undeveloped and rarely definitive. Repetitive comments such as "might be this" and "I don't know" reflected the uncertainty both design teams felt throughout the process of the project.*[64]

58 Die Wissenschaft beobachtet nicht die Welt, sondern sie errechnet mögliche Aussagen aus den Erfahrungen mit bisherigen Aussagen. Was sie tatsächlich weiß, verdankt sie der Kunstfertigkeit, Mogeleien eingeschlossen, im Umgang mit den eigenen Erfahrungen Variationen zu produzieren und darauf wiederum zu reagieren. Knorr-Cetina, Karin. Die Fabrikation von Erkenntnis, 1984. http://books.google.ie/books?id=MisTAAAACAAJ&dq=Die+Fabrikation+von+Erkenntnis:+Zur+Anthropologie+der+Naturwissenschaft.&hl=&cd=1&source=gbs_api.

59 Horst W. J. Rittel, and Melvin M. Webber. "Dilemmas in a General Theory of Planning." Policy Sciences 4, no. 2 (June 1973): 155–169. https://doi.org/10.1007/bf01405730.

60,61,62 Ibid.

63 John M. Flach, "Complexity: Learning to Muddle Through." Cognition, Technology & Work 14, no. 3 (December 24, 2011): 187–97. https://doi.org/10.1007/s10111-011-0201-8.

64 Di Russo, *Understanding the Behaviour of Design,* 107.

She explain that: "Surrendering to the unknown amidst uncertainty was an attitude both design teams expressed."[65] Surrendering to the unknown means relinquish control. It is almost impossible to quickly choose a solution among the ways that have been tried in the past, which can lead us to a good end in this situation. "Part of the art of dealing with wicked problems is the art of not knowing too early which type of solution to apply."[66] The way in which we start the process should also be in accordance with the nature of the problem. It means that the primary generator is better to be indeterminate, uncertain, or even inexpressible. Therefore, enframed ideas cannot be considered a suitable solution due to the clarity and certainty they give to the design process from the beginning. Referring to the swampy lowlands that he uses to express the situation of uncertainty in design, Wolfgang Jonas explains that:

> *'Design through research' assumes that the 'swampy lowlands' of uncertainty will be subsequently replaced by well-grounded knowledge. But exclusively scientific research is unable fully to recognise the implications of acting in a space of imagination and projection. The 'knowledge base position' needs to be complemented by the 'unknowledge base position' or by the competencies to deal with not-knowing. It is not science as a method, but science as a guiding paradigm for design, which is being called into question.*[67]

'Unknowledge base position' shows the approach of the designer. In fact, a person who is faced with a wicked or complex problem is faced with not knowing. That is, the essence of the problem is so obscure and unknown that designers or even design teams simply cannot have all of the knowledge needed to face the problem. They cannot define and describe the problem or identify and categorize all of the variables that affect the project. Sometimes, they cannot even find specific precedents for the brief. The way of dealing with the problem is formed from this point. Designers begin with not knowing. This also includes not knowing the problem itself. The wider the spaces of not knowing, the more possibilities are available for movement. Not knowing lies in the essence of design knowledge and helps the designer. Sometimes, relying on existing limited knowledge can only be misleading or prevent you from seeing other

65 Ibid. 108.
66 Rittel, "Dilemmas in a General Theory of Planning." 155–169.
67 Michel, *Design Research Now.* 202.

ways. Therefore, there will be a need for an epistemic break.[68] The concept of not knowing should not be equated with ignorance. In the ideation phase, not knowing implies the absence of reliance on and return to the existing knowledge base concerning a specific subject. I refer to this knowledge as labeled knowledge. Knowledge of the construction of churches refers to a collection of knowledge derived from various architectural styles and construction methods applied to churches worldwide. Knowledge of designing eyeglasses pertains to the insights gained from studying, designing, or making existing eyewear. Knowledge of public transportation apps is the name we can give to the knowledge obtained from studying, designing, or using all kinds of applications that connect a transportation system to passengers to check the timeline, book a seat, or buy a ticket. There are infinite types of labeled knowledge that either we gained before or need to study and research about them to achieve. Precedents, including all types of existing knowledge and information around a particular case, are labeled knowledge. Instead, references generally contain unlabeled knowledge. However, why is it important to refer to unlabeled knowledge and what is in 'not knowing' that is not in 'knowing'? Referencing to a labeled knowledge confines us within the boundaries of that specific knowledge. This knowledge possesses its own specific name and geography. However, abstaining from labeled knowledge does not place us under any specific name and does not define us within any particular geography. In this way, we find ourselves within a broader horizon. The possibilities that using not knowing provides differ from what we gain through interdisciplinary and participatory design. In those systems, each participant usually considers themselves loyal to a specific geographical area of knowledge. Participatory design is an attempt to broaden the horizons of ideas while each participant remains individually constrained to a specific area. While it is better for designers to have a beginner's mind, especially in the early stages of design, they should be able to doubt all of the knowledge and information that illustrate a specific way. Untrusting what has been done so far is an important step. Just

68 Philipp Oswalt, Wissen - Nichtwissen - Entwerfen, 2015. http://books.google.ie/books?id=BueRzgEACAAJ&dq=Philipp+Oswalt+Wissen+%E2%80%93+Nichtwisen+%E2%80%93+Entwerfen&hl=&cd=1&source=gbs_api

like a kid's mind, which is unaware of the existence of structures, frameworks, and labeled knowledge, or even accepted rules and norms. Children can continue playing without organizing the playroom. They can build and destroy in chaos for a long time. They are not interested in using manuals or rules of the games. At the same time, they can have significant ideas. Peter Skillman did the marshmallow challenge[69] with 500 business, engineering, and design students in different universities around the world, including in the US, Japan, and Taiwan. He says: "The engineers in Taiwan were solid. They did not game the rules. They were efficient and methodical but did not get the highest scoring."[70] The result was exciting when he did the same challenge with children. "On every objective measure, Kindergartners had the highest average score of any group that I have ever tested … the thing I love about children is they will teach you and remind you what you forgot… Children jump in and do it."[71] Untrusting or disregarding known ways and labeled knowledge can also be compared to the mind of a life-sentenced prisoner trying to find an unpredictable way out of prison or to the mind of someone looking for tax loopholes. Designers need to doubt the information that shows them the way. Untrusting what has been done so far is an important step.

Cautious and suspicious, the designer moves forward in the forest's darkness until the path becomes clearer. Intuition in complex situations is not a sudden glint but a process of slowly lightening the path, which continues from the beginning to the end. Observing the behavior of two design teams in two different projects, Di Russo says: "Emerging from complex uncertainty was an increase in intuition. Both design teams 'felt' their way through unknown and conflicting terrain. Knowledge gaps and unknown future states proved to increase the level of intuitive language in both design teams, influencing the designers to abductively "guesstimate" future scenarios and ideal user outcomes."[72] The point is that this path, at the same time as it is found by the passerby, disappears behind, and no trace of it

69 A team-building activity where teams compete to construct the tallest free-standing structure using 20 sticks of spaghetti, one meter of tape, one meter of string, and one marshmallow. This activity highlights the importance of collaboration, innovation, and problem-solving strategies.

70 Original Design Challenge. "Peter Skillman Marshmallow Design Challenge." YouTube, January 27, 2014. https://www.youtube.com/watch?v=1p5sBzMtB3Q.

71 Ibid.

72 Di Russo, *Understanding the Behaviour of Design,* 113.

remains in the forest. A wanderer usually is unable to remember the entire path unless it has been marked. If the traveled route has been recorded, it will probably look like a tangled web, and this is due to the complexity and not knowing of the situation. Consequently, every design solution is unique.

In the analogy of a forest, using not knowing is equal to increasing the sensitivity of our sensors to find the path. Just like when the eye becomes used to the dim light, as the pupil dilates, it gains the ability to see things in darkness. The use of not knowing in design is akin to the insights shared by Jad Abumrad, the creator of the radio program Radiolab, who has been praised for his innovations. In describing his creative approach, Abumrad insists that a journalist must not know. In fact, Jad engages his audience in the exploration and revelation, or, in other words, the process of seeing, moving, seeing, which will be explained later. Through this reflective conversation, audiences find more accurate sensors to perceive complexities and potential paths are gradually seen by them. These paths are the very references that guide us towards the forest's other side. Abumrad states:

> *There's a real correlation between time spent in the German forest and these moments of emergence. And to be clear, the German forest changes. That sense of, the work is just too big to put my head around this, how am I gonna do this, that never changes. But what does change is that the terror gets reframed for you, because now, you've made it out a few times. You can see over the treetops, and into the future, to where, there you are, you're still there, you're still alive.*[73]

The freedom that the use of references gives to the designer can be explained by lateral transformations, while the use of precedents can be compared to the vertical transformations in Vinod Goel's experiment. In 1995, he conducted a practical experiment comparing the use of paper, pen, and hand-drawn sketches in design to a very basic computer-based vector drawing program. For that, he identifies two types of movement or transformations in the design process: lateral transformations and vertical transformations. In a lateral transformation, movement is from one idea to a slightly different idea. In a vertical transformation, movement is from one idea to a more detailed version of the same idea.[74] He

73 Nevala-Lee, "Surviving the German Forest."
74 Vinod Goel, *Sketches of Thought*. (MIT Press, 1995), 119.

demonstrated that hand-drawn sketches, due to the freedom they provide to designers, also offer greater potential for meditative thinking. In his experiment, designers who used computers generated far fewer lateral transformations compared to those who used hand-drawn sketches. In other words, working with software and less ambiguity had caused designers to emphasize vertically transforming their ideas and offered less opportunity to 'see' different interpretations of their drawings. In sketching (both on paper and on the monitor), each line can serve as a reminder of a memory, a form, a meaning, or a concept. A more freely flowing pen, unrestricted by any rules, can glide across the paper and give birth to form and ideas from the void of a blank page. This could be a way of starting from a point of not knowing and a practical approach to exercising it. By contrast, computer drawings (mostly in old-generation design software), usually built upon rules and calculative thinking, have been less dense and less ambiguous, offering limited possibilities for meditative thinking and imagination. Goldschmidt states: "among the unique advantages of sketches as displays that feed directly into the design process are their vagueness, their lack of commitment to scale or level of articulation, their partiality and the ease with which they can be transformed. One can sketch whatever comes to mind, whether or not it is deemed relevant to the task at hand." Both theoretical and empirical research have shown that the design process finds a solution to the problem through unpredictable references. In essence, a degree of unpredictability is almost essential during creative exploration.[75]

Three methods to facilitate complexity in design

To solve complex problems, transformation design uses interdisciplinary collaboration and participatory design to look outside the normal solution space and create fundamental change. Designers in this system proceed with a dynamic co-evolutionary process that can be modified repeatedly according to the conditions. They "identify and maintain operational gaps in order to be able to repeat itself in response to unforeseen problems. The blank spaces remain empty so that they can be filled

75 Philip Nicholas Johnson-Laird, *The Computer and the Mind.* (Harvard University Press, 1988), 258.

differently in the reproduction of the system, depending on how this progresses".[76]

In participatory design, "citizen participation in decision making ought to include "participation at the moment of idea generation."[77] As the graph in the first part of this article shows, with transformation design, we witness a key shift from the design of tangibles to the 'design' of intangibles,[78] and the complex projects that transformation design often deals with are usually related to social, cultural, political, urban, and environmental, mainly macro-projects and services. However, the results of Di Russo's study show that designers ultimately prioritize their intuition over the participants' ideas. In this type of macro complex situation, the citizens themselves are generally one of the variables that may even cause more ambiguity in the project. In addition, due to lack of clarity, uncertainty, and unknown aspects in a complex problem, the kinds of knowledge that may enter into a design solution are practically limitless. However, in practice, only a limited number of the scientific fields will be involved in the project. Civil engineers, structural engineers, geotechnical engineers, water and sewage engineers, architects, project managers, specialists in environmental laws and regulations have participated in the Lake Urmia project. While many other specialists, such as geologists, hydraulic engineers, traffic and transportation specialists, IT specialists, tourism specialist, economists, ornithologists, robotics engineers, cultural affairs specialists, sociologists, psychologists, agricultural engineers, mathematicians, physicists, botanists, zoologist, and perhaps dozens of others that are not even defined in the modern academic system, could be included in the design team as those who have the potential to come up with ideas for the project or play an essential role in the design of a way to connect two sides of the lake. In addition, although the uncertainty in the proposed solution and dynamic co-evolutionary process is the strength of this approach, the successful realization of transformation initiatives is a significant challenge, and transformation design may not adequately

76 Dirk Baecker, "Wie Steht Es Mit Dem Willen Allahs?" Zeitschrift Für Rechtssoziologie 21, no. 1 (May 1, 2000): 145–76, accessed April 15, 2024, https://doi.org/10.1515/zfrs-2000-0106.
„ein System operative Leerstellen ausweisen und bereithalten muß, um sich selbst in der Antwort auf unvorhergesehene Probleme wiederholen zu können. Die Leerstellen bleiben leer, damit sie in der Reproduktion des Systems, je nachdem wie diese verläuft, unterschiedlich besetzt werden können." (translation by author)

77 Elizabeth B.-N. Sanders, and Pieter Jan Stappers. "Co-Creation and the New Landscapes of Design." CoDesign 4, no. 1 (March 2008): 5–18. https://doi.org/10.1080/15710880701875068.

78 D. Jones, "What kind of thinking is design thinking?" Proceedings of the 8th Design Thinking Research Symposium, Sydney University of Technology, (Sydney, New South Wales, 2010), 219–28.

address the challenges in practice. The gap between design concepts and solutions on the paper and real-world implementation can be considerable.

Instead, Andrew Pickering's approach is defined entirely in action. In similar circumstances, he suggests doing without science. In this way, he reminds us of a model of dealing with the world that is not dependent on science and Apollonian powers. Pickering highlights that complex problems cannot be solved by framing. His approach is a kind of acting with the world that does not hinge on science but is currently overshadowed by it. He talks about a partnership and dialogue that do not need to dominate and control the conditions but move in harmony with them. It means acting with the world rather than acting on it. The most significant difference in his approach to problem-solving is that the process of addressing complex issues is accompanied by engaging with influential elements or agencies. In Pickering's method, which he calls dances of agencies, none of the known and unknown influential factors has superiority and control over the other. In this sense, the design process differs from what is usually done in scientific laboratories or by design teams in the office. Sometimes, the designer must surrender and start with pure observation. Pickering suggests abandoning standard methods and instead using 'not-doing.' We need to put aside the illusion of control and what we have known so far due to its one-dimensionality, incompleteness, and definiteness. In a complex situation, more than we know, we indeed do not know. Therefore, it is better not to treat our not knowing as knowing. Not only will it not help solve the problem, but it will make it more complicated. Sometimes, the side effects of a wrong solution could be more harmful than we can imagine, just like the consequences of the bridge's construction on Lake Urmia's life. However, the problem is that the Pickering method does not seem to be applicable to all kinds of problems and his examples are often limited to agriculture and similar cases.

Donald Schön's method – which offers a way to simplify complexities in design process – is labeled as the sequential, conversational structure of seeing-moving-seeing. This approach assists the designer in managing complexities, progressing step by step, and "harnessing the remarkable human ability to recognize more in the consequences of our moves than we have anticipated or described ahead of

time."[79] In his method, Schön suggests the process of reframing the problem. Since designers do not have sufficient information even about the problem itself due to ambiguity and complexity, reframing the problem, reviewing its structure and even questioning the problem will be obvious. Therefore, "design can be considered to be a process to manage the co-evolution between problem formulation and solution generation."[80] In design, just as the solution is not limited to one option, the dimensions of the problem cannot be limited to its initial boundaries. With a conversational approach, they can also change.

Designers should deal with the problem in such a way that it is not seen as concrete and untouchable. In his book How Designers Think, Lawson explains that designers often develop initial ideas about solutions long before they truly understand the problem. That is, in the first step, the problem loses its credibility and rulership. This becomes even more important when dealing with complexity. Jeffrey H Johnson, in his paper, Embracing Design in Complexity, where he talks about the necessity of the design process for progress in the science of complex systems, emphasizes that complex systems inescapably involve changing the problem, and this process contrasts with problem-solving in the conventional sciences where the rules are that the problem cannot be changed.[81] Reformulating the problem, especially in complex projects, allows the designer to consider different possibilities. A wicked problem has no definitive resolution formula but can only be satisfied under current conditions because "there are no ends to the causal chains that link interacting open systems".[82]

Dealing with complexities and solving problems is a step-by-step, interactive dialogue influenced by the designer's initial judgment and their active sensory appreciation of actual or virtual worlds. Designers can easily describe and appreciate the current conditions based on their sensory experiences using words like small, big, narrow, wide, unpleasant, bright, weak, strong, rough, gentle, similar to something (a specific scene, memory, image, phenomena, etc.) and hundreds of such words and sentences. Intuition usually occurs at

79 Schön, "Designing as Reflective Conversation with the Materials of a Design Situation." 3–14.
80 Simon, *The Sciences of the Artificial.* 194.
81 Alexiou, Johnson, and Zamenopoulos. Embracing Complexity in Design, 195.
82 Rittel, "Dilemmas in a General Theory of Planning." 155–169.

the judgment phase and helps in identifying patterns and meanings. "Appreciations are expressed in acts of judgment that we are able to make tacitly, without necessarily being able to state the criteria on the basis of which we make them."[83] For instance, if the initial judgment and appreciation indicate that something is too small or short, the designer will likely seek ways to enlarge it. Afterward, it becomes necessary to contemplate the consequences of this new change and the emerging patterns that have taken shape. In the judgments of the designer, unlike what is expected in the legal system, there is no absolute right or wrong, no definitive conclusion. Each designer may perceive a pattern or a clue to find the way in the forest's darkness from their perspective. We must note that "clues, in the sense we employ the term here, are never universal, and they mean something specific to a particular person under certain circumstances while they may signify something totally different or nothing at all to another person, even under similar circumstances."[84] This means that two different designers may arrive at completely contradictory solutions, yet both solutions effectively solve the problem and lead to a satisfactory outcome. Essentially, as Donald Schön puts it, each designer constructs a unique design world. To judge, a designer is not even obliged to rely solely on the available evidence around the problem. Instead, valuation and judgment can be based on an apparently unrelated idea from outside the problem's context.

In transformation design, it can be imagined that due to interdisciplinary collaboration, ideas from different fields enter the design process. These ideas can be unrelated to the precedents or related to them. Of course, it should be remembered that since transformation design often attempts to improve an existing situation, the starting point is usually a product, system, or service under operation that needs to be transformed. Therefore, in such cases, the designer can not formulate the problem without at least a vague idea of the past solutions. Accordingly, the primary generator in transformation design often has a trace of precedents in it.

In the Pickering method, precedents along with the designer's knowledge, which is considered limited and incomplete, are put aside, and the designer uses intuition extensively.

83 Schön, "Designing as Reflective Conversation with the Materials of a Design Situation." 3–14.
84 Goldschmidt, "CREATIVE ARCHITECTURAL DESIGN," 258–270.

In Donald Schön's method, the primary generator comes out of the designer's judgments in the very first steps. These judgments are often intuitive. In contrast to a judge in a legal system, when judging as a designer, it is better to see the problem without focusing on existing solutions and precedents. For instance, in the context of the project concerning the connection between the two sides of Lake Urmia, if the design team, by redefining the problem, considered enhancing the connection not as reducing the distance but as enriching it, we would be faced with a completely different solution based on the quality of the connection rather than simply minimizing the time quantity. In this project, the design team based their approach on changing the traditional method of transporting cars and passengers by a ship that had been operating on the lake for years. Therefore, the primary goal was to upgrade this old system. Consequently, the designers were caught in the trap of shortening the connection and bridging the two sides of the lake. However, if the design team had placed previous solutions in parentheses, judgment about the word 'connection' could have involved concepts with different meanings. For example, 'the best route is not always the shortest one.' With this judgmental sentence, the project could potentially have shifted towards a different direction, one that did not necessarily involve building a bridge over the lake. The outcome could have been a longer but enjoyable journey along the lake shore instead of a short trip on the dried-up lake bed. This would mean improving the quality of the connection between the two sides of the lake by constructing a lakeside road and utilizing the lake shore as a tourist attraction and an environmental asset. A solution that, given the cultural and geographical conditions, could have had a significantly positive impact on both the lives of the local residents and the migratory birds.

Every design project is a free and open dialogue. To participate in this dialogue, although both precedent and reference are helpful, precedents, compared to reference, shorten the conversation and support reaching the outcome faster and with more confidence, but references provide pleasant and stimulating dialogue that opens the eye to new horizons.