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Intricacy of Architectural Design Process as a Heterogeneous Network

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ABSTRACT: Architectural design has grown alongside the expansion of digitalism's aspects, and design initiatives are the product of several collaborations, interactions, and nodes. Focusing on an architectural competition as a case study, this article demonstrates how the architectural design process works by highlighting the characteristics of a network produced by the assemblage between heterogeneous nodes. These assemblages could modify every design phase and outcome according to their strengths and weaknesses. Therefore, the socio-technical aspect of the design process is used to demonstrate the reciprocal relationship between nodes as humans and nonhumans. This paper uses a qualitative approach by using the methodological aspect of actor-network theory to map the intricacies of the design process from three independent narrations to give complementary components to form the design process's multiplex network. Thus, the study proposes a paradigm for exhibiting and grasping the complex data network in architectural design and boosting the value of unseen data that may significantly impact outcomes.

Keywords: *Actor-network Theory, Co-design, Architectural Design Process, Designers' Network.*

INTRODUCTION

The architectural design process is a complex process with many intertwined levels. This could be the consequence of acknowledging the significance of many actors in the design process. Latour describes these actors in the concept of actor-network theory, their networks, and interactions with other actors by questioning modernity's dual connection between subject and object. Each network is a collection of indefinite interconnections between actors (Erlhoff & Marshall, 2007). By introducing this ontology, he tries to describe everything in a network through the connections. In this view, any active actor in a network could be a network for other actors. The rapid growth of digitalism and the IT revolution have changed the morphology of society and design. This new morphology is information-based, i.e., the value of information is hidden in data, and “meaning” is produced due to sharing data.

Furthermore, by incorporating intelligent technologies into the design process, designing is no longer the only outcome of individual activity. That is why we should be more concerned about the role of nonhumans. Latour has reframed the relationship between science, technology, and society. He offers a new synthesis between technology and society by changing the perspective of such societies and recognizing the activism of nonhumans alongside humans (Latour, 1987). Indeed, Latour’s ontology has linked practice and study by considering design inquiry as akin to research inquiry by drawing the "sociogram" and "technogram" for both of them (Bradbury, 2014).

Today, the design process is becoming a networked course, and by clarifying the involved nodes, a complete picture of the design process can be provided. This could be similar to several images stacked together to produce a larger image, comparable to a panorama (Ekomadyo & Riyadi, 2020). This network is multidimensional and intertwined. In network designing, the individualistic approach is replaced by collective intentionality, collective intelligence, and pluralism, and the output is produced by a bottom-up structure based on a sudden event. At this point, “The Other” discourse arises, and accepting The Other becomes crucial. Most recent papers on the use of information technology in the architectural design process concentrate on technical and formal structures; however, the

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present paper attempts to uncover the social and philosophical components of acceptability in the design process. Acceptance of the role of The Other results in the design process becoming more negotiation-oriented, and its quality becomes vital for assembling the connections.

Taking such a divergent approach leads us to the following questions: What characteristics of the architectural design process does the network narrate for designers and design output? How would actor-network theory reveal the assemblage of divergent data with actors' acts and the design process's outcome? In this research, we used Latour's actor-network theory to narrate "design in the making" (Yaneva, 2009) at an architectural competition by mapping a heterogeneous network of the design process.

Many articles have focused on the interaction between Science and Technology Studies (StS) and design in the last ten years. Several studies have attempted to investigate methods for studying architecture through practice-led analysis (Fraser, 2013, 23). Bradbury (2014) examines Latour's works to propose a new paradigm for connecting academic and functional dimensions of architecture. He indicates when and how the design process could be considered as a research paradigm, where he believes "if we can start to reveal how the process of design works, we may, at least in part, be seen not in opposition to the process of research, but as part of the same system of progress." Concerning the relationship between design and ANT, Storni et al. (2015) conducted a survey that argued a new way to look at designers and their intervention in the design process.

Moreover, Binder et al. (2015) negotiated the democratic potential of co-design. They proposed that designing things should be "viewed as socio-material assemblies of public interests and issues that change over time." Palmas and von Busch (2015) discussed strategies to democratize urban planning and design using co-design. They believed, "Actor-network theory might be used as a powerful tool to make explicit the democratic deficiencies of co-design practices." Schoffelen et al. (2015) also showed the value of visualization in integrating diverse individuals in co-design by making the process more transparent and readable. Andersen et al. (2015) employed ANT to deconstruct actors as a "network of heterogeneous material" by pointing out that (1) the actors are the main configuration of the network; (2) every step of a project depends on participation, and (3) there are no predetermined rules. DiSalvo et al. (2011) discussed collaborative dialogue of concerns as a tool for creating a new framework for interventions in a design process. Telier et al. (2011) addressed the shift from designing objects to designing a collection of heterogeneous entities drawn together by divisive issues of concern. Furthermore, Ecomania and Riyadi (2020) used ANT to show the socio-technical behavior of the collective design process by encoding its actors and implementing it in a project design process in Indonesia. Dinser (2020) investigated the mutual relationship between humans and nonhumans in the construction process with the benefit of ANT and believes that the actor-network theory has a place as a research method in addition to its analytical value, and Knox (2021) methodologically applied ANT to outline interactive space in social relationships.

The present article attempts to offer a narrative about the influential divergent data of the collaborative design process, which is akin to actors in a heterogeneous network and can affect the quality of the design process. Consequently, we first argue co-design as a heterogeneous network, then demonstrate how ANT would provide us with an analytical foundation for valuing concealed data. Therefore, this research aims to use ANT to analyze the network nature of the co-design process and value the impact of reading the architectural process

Table 1: Literature Review

Authors	Year	Main Idea
DiSalvo et al	2011	Collaborative dialogue for democratic and innovative process
Telier et al.	2011	A shift from designing an object to designing hybrid
Bradbury	2014	Proposing a new paradigm in architectural design review
Storni et al.	2015	Suggesting a new way to survey the designer's interaction
.Binder et al	2015	The democratic potential of co-designing
Palmas & Von Busch	2015	The democratic potential of co-designing
Schoffelen et al.	2015	The visualization value in co-designing
Andersen et al.	2015	The use of ANT in designers' network
Ekomadyo & Riyadi	2020	Socio-technical behavior of actors
Dincer	2020	The hybrid relationship between humans and nonhumans in the process
Knox	2021	Studying the performance of interactive space in social relations using ANT

as a heterogeneous network. Reflecting on this, ANT is a way to rethink co-design activities in the direction of design democracy (Storni et al., 2015). Table 1 presents the research literature.

Co-designing as a Heterogeneous Network

In science and technology studies, design has social and political aspects which play crucial roles in forming societies. Today, design is no longer a solo activity; in fact, the collective nature of design generates a network of events that drive the design process. Meanwhile, the development of technology and computational design has built new phases in architectural design and has empowered the role of design, where it is the result of complex components that are linked together (Erlhoff & Marshall, 2007). That is why design is less limited to design studios with fixed actors. In fact, with the intervention of so many actors in the design process, this process is becoming more complex and inclusive. The scope and limits of this intervention are said to be difficult to comprehend (Storni et al., 2015).

Although co-design has a fruitful background, it is not a rigid closed discussion; thus, its domain changes in every project. The co-design procedure is complex, and many studies seek to explore the relationship between designers and design issues and how they respond. As Akama (2015) defines, co-designing is an emergence-based action in which elements change one another to achieve a collective goal. It is a way to integrate “The Others” into the creation process. This could be linked to the concept of "between-ness" in collective actions. The design process tries chiefly to validate tangible and apprehensible activities, though the term “co-” could be related to imperceptible and intellectual actions. Akama claims that “co-designing among the plurality of between-ness means that we are all implicated, embedded, and changing as part of a whole of ever-changing moments.” This means that things could seldom be defined solitarily. To emphasize, it is crucial to define “co-” in co-design, as it affects every aspect of the design process. In this paper, the prefix “co-” may refer to the action of The Others - humans or nonhumans - who intervene in the design process. As Latour (2005) states, the “co-design” approach is more than the sum of designers' or users' participation in the design process.

Different and diverse components compose the design process, which may be derived from co-designers thoughts to some objective ones. Such components in the collective nature of design activate heterogeneous networks linking human and nonhuman (H-NH) actors in the design process. These activated networks can be assessed based on the quality of in-network negotiations between actors (H and NH), the networks’ strength, and the learning cycle between actors. When new actors emerge, they can connect to an established network, causing its expansion. Networks can inspire actors to create and collaborate in production, representing a major shift from Fordist production to networked innovation (Erlhoff & Marshall, 2007). When viewing situations through the lens of networked thinking, it is vital to comprehend the significance of each node in the network and how it interacts with other nodes (Kozikglu & Dursun, 2015). It is worth mentioning that the network structure is a highly dynamic, multidimensional, and flexible system capable of incorporating additional nodes. Additionally, tiny variations in a node lead to all sorts of changes in the whole network, and each network, depending on the number of nodes and their interactions, either stays strong or is destroyed. Some networks have complex structures due to the vast number of nodes and connections (Hu & Liu, 2013).

Scrutinizing the co-design process through a network-oriented approach requires a new tool for self-representation (Storni et al., 2015). In this regard, the actor-network theory would help unveil the assemblage between humans and nonhumans and reflect the quality of interactions. Early discussions on ANT attempted to demonstrate the network connection between each scientific fact (Callon, 1986; Latour, 1987). As Latour mentioned, it is more than a framework or theory; it suggests a comprehensive and holistic approach with basic principles for describing each node involved in forming a black box. He explained that ANT is about the connection of descriptions (Latour, 2020) and has developed a way to research the relationship between science and technology in science and technology studies (Latour, 1999, 304). This theory also gives helpful tools for design research (Yaneva, 2009) and the development process, where buildings are seen as socio-technical objects (Latour & Yaneva, 2008). In Latour’s theory, a network -- as a concept -- is formed within the process (Latour, 2005, 132) and plays a noteworthy role in facing heterogeneity and plurality in the design discourse (Akama, 2015). Accordingly, the function of ANT for designers is either an analytical description of what they are doing or for intervening after the end of the process. In contrast to modern designers, the spirits of ANT are “no creativity without collaboration” and the way it values design as a strong tool for making changes; however, Storni suggests that further research into the efficacy of their joint efforts is needed (Storni, 2015).

Recently, ANT changed its focus from StS, which is “critical of modernist separation,” to a concern “with reassembling the social and building a common world, where democratic, ecological, and political issues permeate everyday life, and design and technology are an integral part of it” (Storni et al., 2015). This theory somehow assists in bridging the gap between information created by practice-based research and traditional research outputs. Bradbury (2014) mentioned that Latour’s discussion on science and technology could be linked to architecture. Because every detail in the design process can shape and modify the character of the design research, a study of the design process as socio-technical networks is required to determine their contribution to closing the research-practice gap. A key point here is the intervention of actors in the design

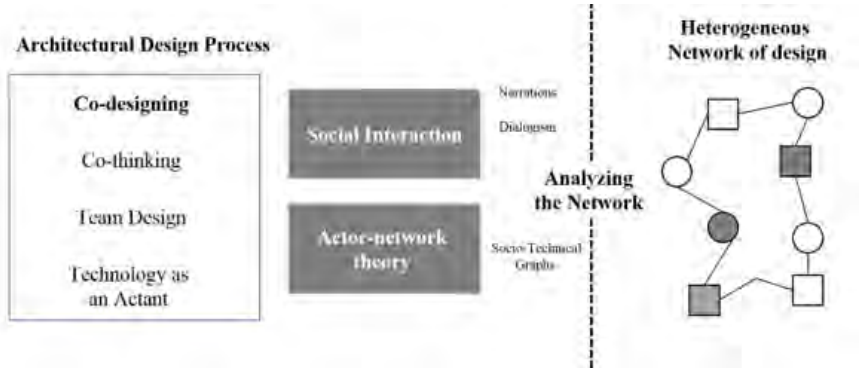


Fig. 1: Process of conducting the research

process, which is often ignored by others (Andersen et al., 2015). As a result, it appears that network orientation to the co-design approach is an intelligent entity that can learn, react, respond, rearrange information, and make decisions through convoluted processes. Because of these changes, we must know how to think in a collaborative process, knowing who the actors and actants in each step of the design process are and what entity could participate in this network. Figure 1 displays the process of conducting the research.

Tracing Co-designers: Negotiability in Network

The widespread usability of digital information has reformed the architectural design process. Thus, each design process seems like an interconnected network based on data exchange, intelligent technology, freedom of thought, and actions. As a result, the definition of designer and their functions in this world has shifted, and designers play different roles in the design process. Here, design is built on interaction with and the significant impact of The Other to promote design as a co-design network. By accepting the decisive role of The Other and the interactions among the actors, the community begins. According to Bakhtin, the existence of The Other and their interactions is the beginning of a community. In communication analysis, Bakhtinian notions of dialogue, polyphony, and carnival are useful (Vaagan, 2007). As he mentions, every human being makes personal meaning from social encounters. He believes that the world is evolving through dialogue, which is why, in his dialogism, the meaning would grow in the interaction process (Bakhtin, 1973,18). According to his text, polyphony is a notion similar to "dialogue," but it is greater, involving at least three or more people or voices. Bakhtin always intended to fight against formalistic forms in art, science, and politics.

Latour, on the other hand, attributes The Other's nature to humans and nonhuman beings. He describes network assemblage between humans and nonhumans through negotiation and translation procedures (Hassard et al., 1999). The quality of dialogue and negotiations that emerge in the co-designers network directly impacts the design process and its outcomes by influencing thinking, idea quality, and data organization (Horelli, 2002, 633). Here, translation is a key term that connects actors (Latour, 1987, 117). "Translation is a complex process that consists of several different communicative acts, all of which are destined to construct a network" (Belliger & Krieger, 2006). As Bradbury mentioned, the network of human and nonhuman actors becomes stable after negotiating specific conflicts (Bradbury, 2014). Subsequently, negotiation in the co-design approach affects the design process among network actors, where the interaction of nodes is defined based on the quality of negotiations. The generated connection and a new node might grow the whole network at each design phase, which could change the outcomes.

In the architectural design process, many active actors must be examined in a complex heterogeneous network of humans and nonhumans. Each network, based on its underlying properties, may have varying capacities. The ability of networks to empower actors implies a fundamental shift away from centralized, linear, and serial production toward network and creative production (Erlhoff & Marshall, 2007). Every design process develops through a dialogical approach; however, the role of each actor may not have an equal capacity with others (Lindstrom & Stahl, 2015), and the quality of the dialogue will vary, either obligatorily/hierarchically or by negotiating through equivalent interactions of actors. Quality of negotiation is extremely important because, during the negotiation cycle, the objects may change, new ideas may be created, and critical thinking may be highlighted. Reflecting this, we have used the actor-network theory to classify qualitative dialogism in co-designer networks in four levels (Figure 2) and mapped their progression from monologue to chorus (where each entity has the same value in a network) (Zare et al., 2021).

This map demonstrates the progress of dialogue through the co-designers design process. In many design projects, designers do not have enough opportunities to intervene equally in the design process, even when working collaboratively. Thus, we

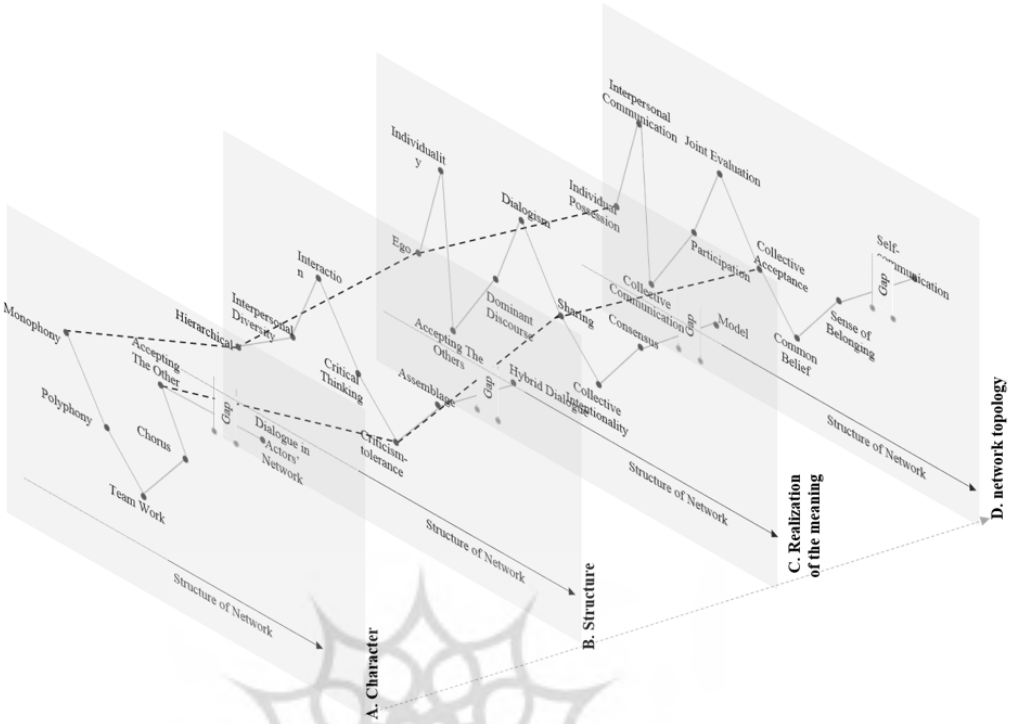


Fig. 2: Dialogism in the co-designers network (Zare et al., 2021)

tried to scrutinize an architectural design competition using ANT tools to show where we could admit that the design process and interactions are negotiated through the network.

MATERIALS AND METHODS

Architectural design projects gather different actors with diverse backgrounds. Consequently, they represent controversial aspects of design. Using analytical data and analyzable graphs in the design process, the actor-network theory provides a new design-based form for exploring and forming its object of inquiry. Notably, the use of these diagrammatic and graphical maps helps our understanding of the interrelation of each node as a researchable box. Thus, it is important to (1) identify the actors as either human or nonhuman and the way they link to each other; (2) recognize every active network which is influencing the co-design process, and (3) outline the impact of this relational process on each design step and outcome. As novel insights are formed through the practical design process, this research is categorized as practice-led research (Bradbury, 2014). Thus, the term “co-designer” in this research refers to (1) the interaction of designers as a team, (2) the collaboration of designers and users, and (3) the activation of nonhuman actors that play the role of “designers” in the design process.

Considering this, we scrutinized the design process in the Iranian Architecture Centre's architectural competition, which took place in the autumn of 2019. During the "social responsibility of an architect” competition, 7 out of 44 teams were mentored by the author. The whole competition was completed in one day. During the design process, all teams (primarily bachelor/master students and junior architects) collaborated from 8 a.m. to 5 p.m. and presented their work to judges from 5:30 p.m. to 11 p.m.

As the co-design process is anecdotal, each moment in the process is referred to as a fragment. Therefore, we utilized the four steps to clarify the design process networks based on inner events. We (1) interviewed and gathered design process narratives from three different perspectives: a) designing teams; b) mentors; c) judges; (2) collected diagrams of each design step as reported by actors; (3) mapped all the intertwined layers; and (4) analyzed any assemblage that led us to a network. As three of our seven teams were nominated in the top ten (among 44 teams), we have mapped their design processes in the following sections from three perspectives, co-designers (team members), mentors, and judges. The narration data is described in Table 2.

Table 2: Actors' narration from three perspectives

First Narration	Co-designers' Perspective	"For team members, participation in the competition provided a chance to be seen and confronted simultaneously by six mentors and six expert judges. Another advantage of this contest over the previous one was observing the design process in a single day in front of each team's mentor. The competition's atmosphere was special; there were no limits for its participants, and we competed directly against people of different scientific levels. The subject, "Designing a project that demonstrates an architect's social responsibility, " was revealed a week earlier. Architecturally, the number of aspects into which we might delve was limitless, 'so we started inquiring and surveying users and expert designers to determine what they expect. We were looking for a not-too-complicated design opportunity and issues we confront daily. Thus, we headed to the city's alleys to observe, interview people, take photographs, and gather data. This competition strengthened our collective power. Moreover, observing other teams' processes allowed us to learn various elements of co-designing."
Second Narration	**Mentors' perspective**	"The competition addressed a social issue and attempted to answer the question, "What roles do architects play in dealing with social issues? Certainly, architectural problems could involve many different issues. This competition attempted to demonstrate the range of thoughts on many issues while measuring the creation of solutions for various topics. In this competition, the design was a way to foster dialogue and conversation. This competition provided a chance for small-scale interventions in the city. The noteworthy aspect of this event was that the participants had to find the "question" alongside the "answer" only by "consideration." The groups began working from the earliest hours on competition day. Along with them, we. As a result, each time a group heard criticism from others, they approached their challenges from a fresh perspective."
Third Narration	**Judges' perspective**	The competition was centered on how designers might observe societal problems from various perspectives. The key objective was to become more concerned about the city and the life under its layers. It sought to demonstrate some tiny influences on other events by intervening. Because there were no limits on the participants, diverse aspects of each issue were expected to be presented, which practically occurred. The problems expressed in the competition ranged from the alley of the competition location to the famous main square in Tehran and beyond. The objective was to show how they represent and convey these sites by identifying a problem and its solution and providing an effective presentation. Participants presented their approaches in the form of models, sheets, collages, movies, and different forms of performance art on the event day. Finally, the outputs could be divided into several categories: - Solutions to societal issues that occur at the competition venue; -Presenting an architectural space with new functions to solve problems in a city or country; - Presenting social performance with innovative and non-architectural concepts but with an architectural basis to demonstrate citizenship culture and not be apathetic to social, cultural, and political concerns and challenges.

Dialogism Aspects in Socio-technical Diagrams

During the architectural design process, many events have the potential to be considered as an actor, which ANT can reveal. Furthermore, because an entity that could influence the network's actors is an actor inside that network (Latour, 2005, 150), many distinct actors develop new networks. In these networks, the design issue would be questioned from design to production. It is emphasized that nothing is discovered (reconstructed) in the study of network actors. Rather each entity defines itself by defining its links and creating a network in the network. As mentioned, actors in networks transform and connect as they come into contact with one another. Latour stresses the action paths' eventualities. According to him, every event has unforeseen happenings that cannot be predicted (Latour, 1996, 82).

To clarify the heterogeneous network in the competition's co-design process, the analysis of the narration leads us to the following map (Figure 3) to study the entangled and interconnected nodes of the co-design process by encoding the acquired data.

How Co-designers Deal with a Heterogeneous Network: A Comparison of Two Teams

As we monitored the co-designing process, the quality of the negotiations varied among various teams. Despite the multiplicity of team members, some led their teams unanimously, while others agreed to accept another role. Many ideas were put forward among the teams and rotated with the

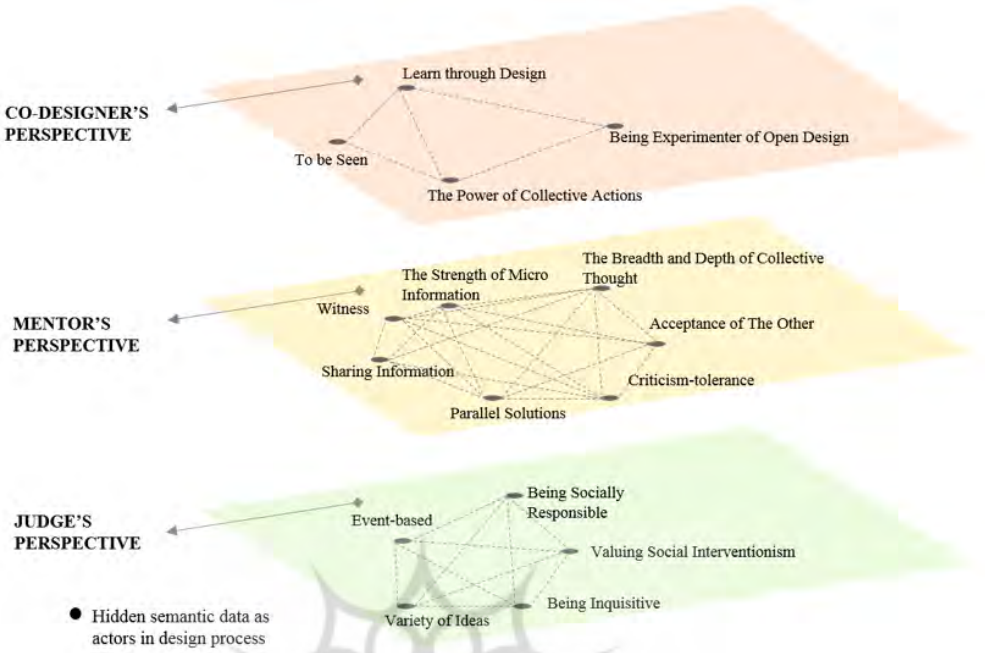


Fig. 3: Different viewpoints on the co-designing process

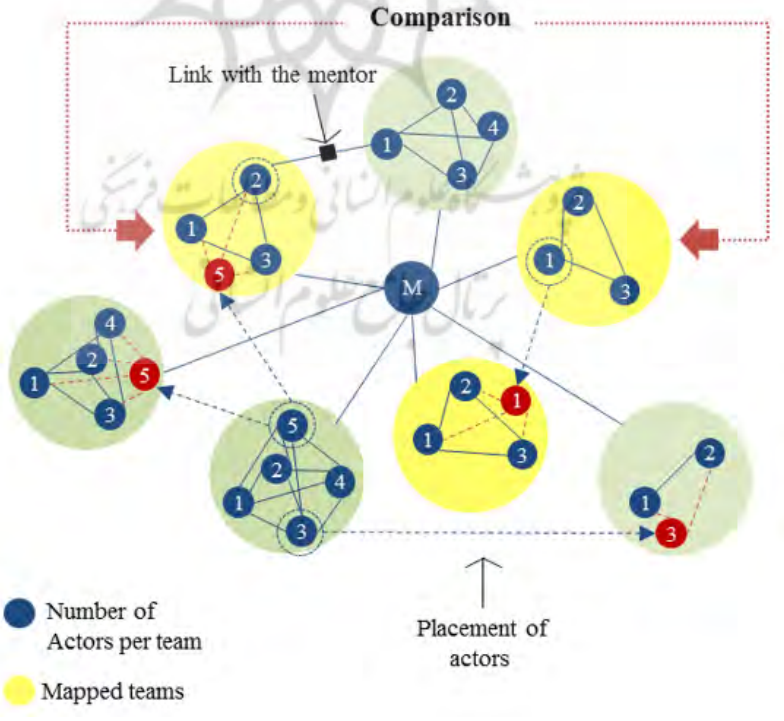


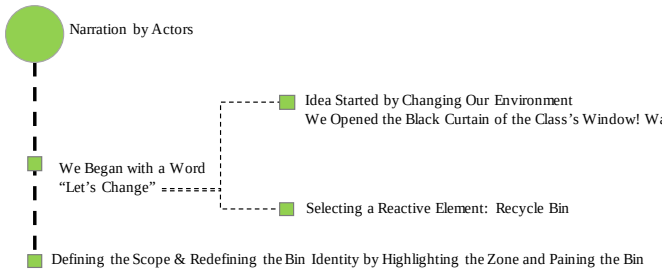
Fig. 4: Map of the macro perspective

mentors' guidance (Figure 4).

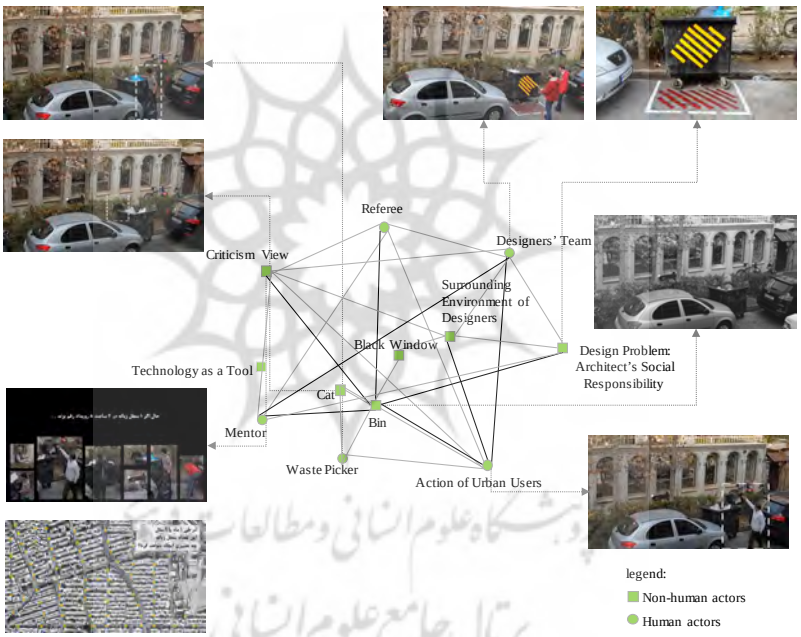
Given that the competition was at the team level between 44 teams and among six mentors, this placement of actors between small networks caused ideas to change until the last moment of the presentation, and a critical dialogue took place between micro and large networks. Table 3 displays the actors' narratives' storylines and the design process of network mapping.

Table 3: Actors' storylines of two teams and how they developed their design

Narration of actors runner up team

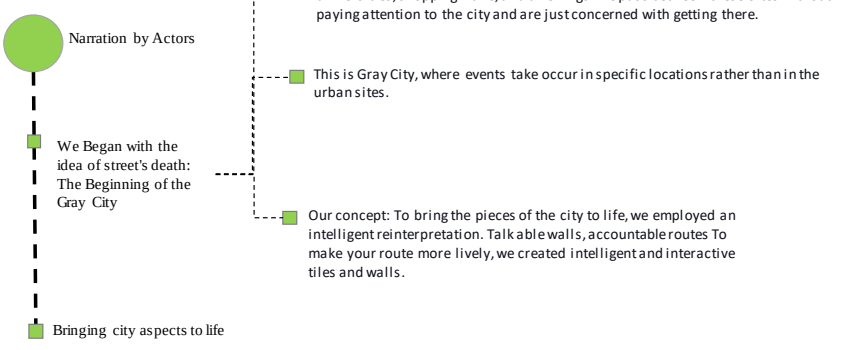


Co-designer networks mapping (Zare et al., 2021)



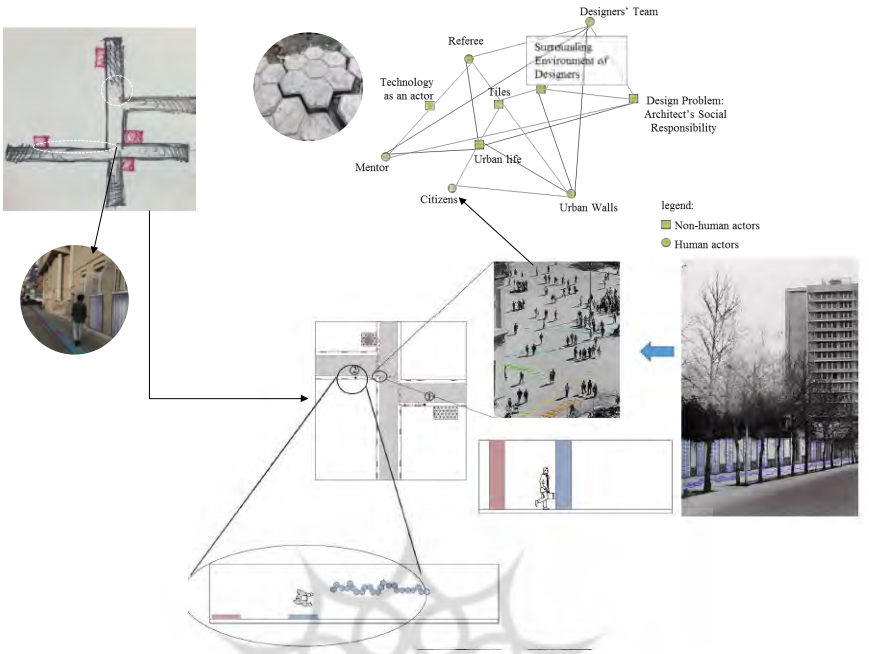
Team Members: A. Pezeshki, D. Ghelichpour, and S. Kalhori

Narration of actors 4th team



Continiue of Table 3: Actors' storylines of two teams and how they developed their design

Co-designers' networks mapping
4th team



.Team Members: M. Parpanchi, S.M. Jafari & A.H Azizi

RESULTS AND DISCUSSION

Examining the architectural design process through a network-oriented approach reveals an image of the design process in which every aspect may be narrated as an actor impacting the network's lifetime. This narrative comprises interconnected sequences in which the network's power is determined by how nodes act. This result follows Akama's (2015) value of connections notion. A dominating notion is no longer forced on the design process in this context; design becomes event-based by separating itself from prescriptive instruction, and all of its steps are shaped by occurrences. The network structure of team interaction leads us from monophony to polyphony and even chorus (Figure 5).

Furthermore, by acknowledging the involvement of nonhumans, design becomes a collective experience that does not belong just to a brilliant designer. Similarly, Ekomadyo & Riyadi (2020) state that nonhumans would play a constructive role in reaching the desired outcome. In such a setting, ideas emerge from the center of events and evolve through the dialogue cycle between performers.

The actor-network theory in this cycle analysis highlights unnoticed details and builds an interaction map between actors, which aids in understanding the actors' narration. Akama (2015) stated, "Connections are as valuable as the gaps in between." This between-ness resembles empty holes in a net that seek to eliminate boundaries and disconnected entities while still providing meaning to intangible entities. Latour (2005) explains this concept as "plasma" - all unconnected entities - which are every "thing" that is "not yet" engaged. Therefore, ANT mainly guides the study of the interactions of behaviors between beings and non-beings and would enable recognition of the effects of each action on them. An interpretive use of ANT tries to make everything visible to everyone for negotiation. In Dincer's (2020) opinion, ANT provides an important perspective for investigating architecture. He valued the importance of nonhumans in influencing the design process.

The application of ANT in our project analysis revealed that in teams where dialogue (uniform interaction of actors) was observed, performers had greater liberty to come up with ideas. Dialogues became more critical, and the designers had a more democratic experience. On the other hand, random events in the design process reduced its predictability; therefore, the idea of programming (Duerk, 2007) was transformed into "programmability," and the process was extremely flexible and dynamic. Latour also underlines the action path's eventuality. According to him, there are unexpected happenings in every event that cannot be predicted (Latour, 1996, 82). As mentioned in ANT, each event begins with actors and their connections, progresses through change and transformation, and eventually predates traditional structures and frameworks. ANT studies

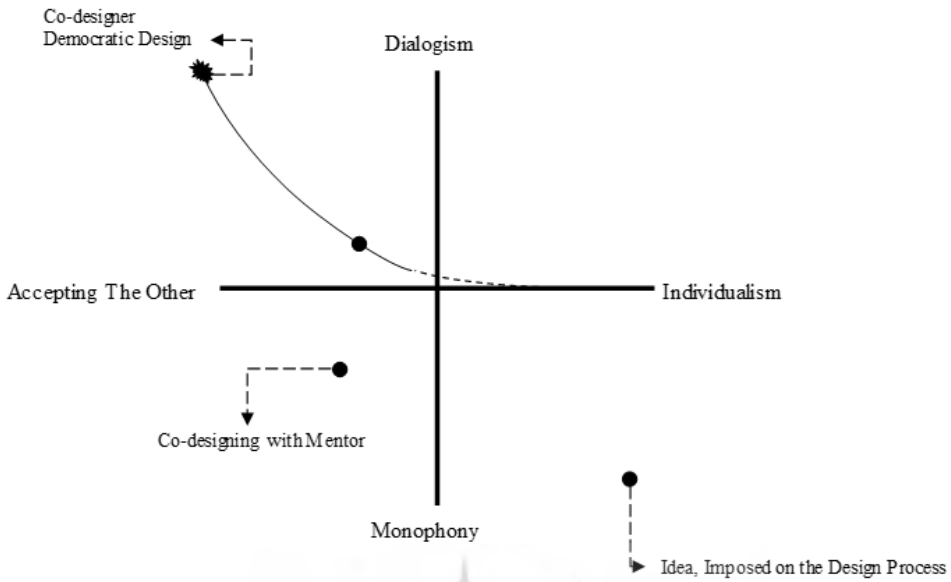


Fig. 5: Democratic Design in the Co-designers' Network

actors using new terminologies and gives a different language (Latour, 2013, 247). Since ANT represents the co-designing process as anecdotal, everything could be linked to "matters of concern" (Latour, 2008) rather than "matters of fact."

A "co-designers network" is the outcome of connecting various nodes during the design process. This network's nature causes the design challenge to become multi-layered, and the design outcome arises from the overlap of many levels. In this approach, a network of designers analyzes the issue from a much broader perspective. Let's consider the problem-oriented approach to be retroactive and the solution-oriented approach to be forward-looking. The operation of such a network is exposure-oriented and occurs in the present, a confrontation in which everything is based on an interactive discussion between design actors. The conclusion of each negotiation is subject to alteration. The function of this network makes "form follows the actants" actions.

As a result, the growth of design from a person-centered and genius-oriented approach to a co-design and networked method leads to the confrontation with architectural issues and the way of encountering the design process from problem/solution-based to happening. This is in alignment with Ekomadyo & Riyadi (2020), who stated that using ANT aids in comprehending the intricacies of the co-design process and gives a coherent understanding of the process. Moreover, as Storni indicates, applying ANT could significantly contribute to a novel ontology of design networks. Additionally, the paper emphasizes that today's technologies should not be regarded as simple design tools, as some literature implies, but as nonhuman actors capable of moderating the co-design process and impacting how it is built and carried out in practice (Chitanana, 2021).

In addition to what was discussed in this paper, the study of architectural co-design from Latour's AIME project (an inquiry into modes of existence) and the notion of shifting from networks to modes of existence (Tummons, 2021) would be an entire research area.

CONCLUSION

Architectural design is a multi-layered and interconnected process. Actors revolutionized the co-design process in the previous decade, allowing nonhumans such as technology to become influential and perform a role. As technology progresses, new challenges emerge in architectural design, such as the vast amount of data. There are no linear or sequential structures for the design process in this situation. Examining such a process necessitates using a context to reflect its changes. To do this, we used actor-network theory as an analytical framework to describe various interactions and map the actors in an architectural competition as a case study. As mentioned before, there is a decisive role for actors. They can interact freely in the network, and their potential lies in their interactions and impacts on each other. Today, because of the decisive effect of generative technology, we can admit that co-design is becoming more heterogeneous than before. Indeed, as a network becomes more sophisticated, its behavioral range

becomes wider, and its response to change becomes more inventive and variable. As Latour mentioned, the nature of the group in the design process constantly changes. That's why co-designing is such an open and unlimited process that actors can join at any design step and change the outcomes. Events through the design process would become more effective, and because such a network is open, coordination based on the quality of negotiations in the design process is vital.

Scrutinizing the competition's co-design within the framework of the actor-network theory made the process more readable and revealed hidden assemblage. Indeed, we obtained interesting results by recording the narration of actors (H-NH) involved in the competition design's network and mapping the design process in two different groups. Initially, based on collective wisdom, engaging in a conversation with others led to the identification of additional components surrounding complex data. This altered how the co-designers approached the design process and the equilibrium point of the design network. By broadening the scope of data, the co-designers network can present ideas in parallel solutions with broader ideas. The co-design approach generates more ideas than the person-centered approach. In dealing with varied arrangements of collective design models, by validating all entities in equal positions, the network model modifies the executive procedures and makes the design process more democratic. Moreover, given that the democratic design process supports functional values, this contrasts with intuitive and avant-garde designs in that it is more reasonable.

AUTHOR CONTRIBUTIONS

F. Zare performed the literature review, and the action research process mentored teams in the competition, and mapped and analyzed data through the ANT framework. K. Bazrafkan helped in the literature review, results analysis, and manuscript preparation. H. Behbahani and B. Mansouri helped with idea generation and manuscript preparation.

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CONFLICT OF INTERESt

The authors declare that they have no potential conflict of interest regarding the publication of this work. In addition, ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, have been completely complied with by the authors

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