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# A CONCEPTUAL FRAMEWORK FOR POSITIONING THE ARCHITECT WITHIN A CONTINUAL DIGITAL APPROACH TO DESIGNING ARCHITECTURE: THE "DIGITAL CHAIN" CASE

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**Sladjana Markovic[1], Irina Miodragovic Vella[2], Ludger Hovestadt[3]**

[1]SaRa Lab (Sustainable and Resilient Architecture),
Faculty of Architecture, University of Belgrade, Serbia
[2]Department of Architecture and Urban Design,
Faculty for the Built Environment, University of Malta, Malta
[3]Department of Architecture, ITA, ETH Zuerich, Switzerland

ORCID iDs: Sladjana Markovic https://orcid.org/0000-0001-6882-360X
Irina Miodragovic Vella https://orcid.org/0000-0003-3022-0592
Ludger Hovestadt N/A

**Abstract**. *Studying the development of digital technology in architecture during the last thirty years highlights the opportunity for exploring the process of positioning the architect within an architectural approach based on the continual digital data-driven design and realization, using the example of the "digital chain" principle. Digital tools and processes have evolved driven by technological advancements and supporting the architectural design, but also challenging the influence and role of the architect as designer.*
*Accordingly, the positioning of the architect within the design and realization of architecture is a process that constantly is developing, evolving, progressing and changing, but not simultaneously with the development of technology. The paper investigates this with the focus on the "digital chain", which is the continual approach that links architectural design and realization by coding the process and involving digital fabrication (machine and material) and the architect in each step of architectural accomplishments.*
*Methodologically, this research is based on overlapping the information of a (rapid) review of the continual digital data-driven design principle (example of "digital chain") over time and the conventional (analog) design focused both on architect's discourse, role and influence in the current and future design and implementation of works of architecture. The paper does not define the exact position of the architect in the "digital chain" because the process is further evolving and also depends on the type of fabrication, taking into account the freedom of choice of the architect. It does, however,*

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**Corresponding author**: Sladjana Markovic, SaRa Lab (Sustainable and Resilient Architecture),
Faculty of Architecture, University of Belgrade, Bulevar Kralja Aleksandra 73/II, 11120 Serbia
e-mail: marsladjana@gmail.com

*identify the zone and type of influence of the process effects on the architect, and determines the necessity and role of the architect as a designer in the process.*
*The work aims to define and outline the currently developing conceptual framework of the positioning of architects, while a precise definition of the position would hinder the architect from expressing creativity. However, new research directions open a scientific field of constant redefinition of the design process with architectural influence in terms of activities and characteristics of the role of the architect within continual digital approaches to designing architecture.*

**Key words**: *emerging architecture, positioning of the architect as designer, redefinition of the design process, continual data-driven design*

## 1. INTRODUCTION

Today, architectural design and realization cannot be considered separately from the emerging architecture based on digital technology. Digital technology is a tool that enables the translation of ideas into reality by incorporating approaches such as the introduction of manufacturing into the conceptual development of the architectural process (Markovic, 2016). Due to the increasingly high technical complexity of buildings and the urgent need to reduce the environmental impact of the built environment, digital tools and processes are now inevitable in the design and realization of contemporary architecture

Regarding the overall understanding of digital culture, it is necessary to examine the changes and the formation of transformations and cultural forms of different processes – phenomena (Miller, 2011). Technology is already moving on from a data-driven design to artificial intelligence (AI) with a swiftly increasing number of digital design and decision-making tools, especially for implementation, such as BIM. Most architects are still adapting to digital design environments and consequently the new ways of thinking and designing that come with them. Acceptance of technology, digital tools and the knowledge that they encapsulate enables or disables the architect in the design process (Witt, 2010). In this context, it is crucial to reflect on the possible future role of the architect as designer, human agent, with specific personal skills and abilities based on natural intelligence (Cross, 2011).

From the perspective of the digital theory, the term *context* takes on a new meaning. It is created for the code of an artificial environment, where the selected parameters influence and define the digital design (Markovic, 2020). In short, coding is now the context and a fundamental means of producing digital design. This new context, as a setting for the (dis)positioning of architects, filters and demystifies the intersection of the dual approach processes (digital and conventional) based primarily on the explanations by Bryan Lawson and the special treatment of material and machines through the architect's discourse.

The connection between architecture and digital technology exists, but today's technology inappropriately assumes, in certain segments, the primary role of guiding the architectural idea. In this way, it seems that the context – digital environment, human – "architect, user, and artifact – of both the design and the house should be questioned in both position and scope" (Markovic, Nikezic, 2023). The paper approaches the subject of the position of the architect in architectural design and realization processes using the "digital chain" as an example of a continual digital approach. The "digital chain" refers to a digital design process in architecture supported at every step by a computer that comprises the design assignment, the approach to the design assignment, and the design-to-production. The concept is explained and researched by Prof. Dr. Ludger Hovestadt,

CAAD Chair[1] at the ETH Zurich. Today, "digital chain" expands to include digital architectonics with topics like encoding, coding and decoding overlapping with social realms – sacred, public and private (Hovestadt, 2023).

The development of the "digital chain" from the design to production by architectural discourse could be followed with a rapid review over time – from the example of the Monte Rosa mountain shelter (Dohmen and Rüdenauer, 2007); through the testing of the "digital chain" considered as paradigm (Loveridge, 2012), the redefinition (Markovic, Svetel, Lazovic, 2017) and experience (Cvetic and Markovic, 2017) of architectural design based on it. The topic has been further extended to include the creation of a knowledge base in monitoring as part of Industry 4.0 (Meski at al,2019), the virtual reality of hand gestures (Numfu at al, 2020), the internet-of-things (Sakshi and Sharma, 2023) and kinematically redundant robotic system (Subrin at al, 2019).

Similarly, the issues of structural integrity and life span is placed in the context of today's circular construction method. Considering the complexity of architectural requirements and general issues of design and realization, sustainability, maintenance, durability and recycling in emerging architecture, the topic of the integrity and life of architectural structures is highly topical. Architectural spaciousness, as a creative activity and durability of construction in terms of careful and complex design of the structure, has a multi-layered networked - common effect (Markovic, 2020). The circular construction could be explored and expanded from the basic principles of the "digital chain" and extended in its scope.

With the development of digital fabrication, the next step in circularity could also be robotically assembled structures based on a material processing technology (Mangliar and Hudert, 2022).

Digital design thinking, as "the core creative process for any designer" (Cross, 2023) is still an evolving process in the emerging architectural design and practice. As an emerging essence, the competence of design thinking has become critical in the inclusion to the discourse, which includes computer science as a necessary component of the building process and clearly demonstrates the continued value and emphasis on the participation and collaboration of all interested parties. It opens an opportunity for a diverse group of individuals from many aspects of architecture and engineering community, the opportunity to investigate and innovate through collaboration on potential design projects with a focus that ranges from a more inclusive, industry-focused approach to identifying the challenges of the event (Peters and Peters, 2013). The increasing involvement of the user and other stakeholders in participatory or co-design reduces the creative influence of the architect (Markovic and Nikezic, 2023) and makes the process less continual.

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[1] http://www.caad.arch.ethz.ch/blog

*"The CAAD Chair (Computer aided architectural Design) under the leading rule of Prof. Hovestadt at the ETHZ developed prototypes of "Digital Chain of Production". The aim of this work is to show the process of design and building, which is in every step supported by computers and whose interfaces are digital. A "Digital Chain" is an uninterruptible digital process from the design (structure and form finding), over the construction (detail) to production (CNC- fabrication (manufacture)). Every step is a programmed entity, which are connected by universal interfaces. The computer does not appear like a passive digital drawing board, but like an active design controlled work tool. Rules, connections and aims are verbalized by architects, who can make optimizations of a number of different variants as a result of the computing power of* a computer. *The role of architects moves from a designer of form to a designer of process. The Aesthetic of results is sometimes exciting and exceptional, sometimes organic and self-evident… it is always the result of specified parameters.*
*There are three crystallized topics, which could have influence on the contemporary architecture: efficiency, complexity and refinement."*

The theoretical stance of this paper approaches the concept of human drivers (Colomina and Wigley 2016/2022) as uncontrolled, fluid parameters in the algorithm of future relationships in data-driven, continual architectural design and realization processes. They are process connectors, as "man and machine are components of the communicational model" (Vrachliotis, 2022). The continuity is lost without "natural intelligence" (Cross, 2001) and the process result of human activity towards "architectural materiality" (Picon, 2020). Furthermore, the paper approaches digitally or computationally enhanced design thinking as an extension of Nigel Cross's understanding and exploration of natural intelligence as part of AI. Cross uses the latter as a testing ground for better understanding its natural counterpart.

The research aims to propose the "digital chain" as an efficient, complex, specific and defined design process based on the characteristics of different materials, which continually leads to the limited series of automated architectural realization. According to Fleischmann and Menges the form, material and structure have been analyzed and generated together as part of design in order to create complex relationships and achieve a common result with the requirements of fabrication. The process is controlled by the creative contribution of the architectural profession in every part of the architectural chain. The standardization of architectural education takes place through the adoption of digital design approaches (Chiu, 2006). Future architects can improve the connection between design and realization based on the technological discourse in architecture and lead to computational/informational changes in society (Miller, 2011).

## 2. Context for the Modified Role of the Architect as an Overlap between Conventional and Digital Approaches to Architectural Design – the "Digital Chain" Principle

Emerging architecture, a contemporary architectural reality, is represented by various architectural products created in simultaneously running design and realization processes using conventional, digital or combined tools. In response to a complex context and the requirements of emerging architecture itself, an experimental mode based on the digital approach is required. It involves experimentation and change beyond the prototype phase to test the whole process, from design to fabrication, including production, materials, and the machine. These constant changes in the process trigger the change in the positioning of the architect (Markovic, 2016).

The impact of digital technology on the development and behavior of the architectural process, and the theoretical and practical research of computer numerical controlled (CNC) technology in the architectural realm, is most apparent in the overlap with conventional design and realization experience (based on "demystification of architectural process" by Lawson, 2004, 2005, 2009). The conventional architectural design and realization process is driven by the preliminary design of the design task, the personal vision of the architect. The process is linear and consists of design parts and manufacturing architecture based on the architect's methodology, trust, knowledge and experience. The architectural chain, thus, comprises ideas, projects, models, development and realization in single collaborative circles and a common line (see Fig. 1,1a).

Each project deeply embeds components of design thinking through long-term mental processes based on controlled conditions, team conversation and work media. The role of the conversation is essential as a verbal idea description as the design thinking begins

with the discussion. “True creativity begins where language ends” (Lawson, 2004), while the integrity of the architect's knowledge, the designer's expertise, is its inevitability and a complex collection of skills (Lawson, Doorst, 2009). In conclusion, the architect possesses expert knowledge of interdisciplinary teamwork that offers collaborative values to all participants in the mutual process.

The digital process is an upgraded version of the conventional chain in architecture. It engages computational tools developed for design solutions to meet complex requirements while imposing certain architectural constraints. (see Fig. 1,1b). The digital process is commonly used in architecture to handle multiple, variable architectural and contextual parameters. The resultant complexity is not always related to pursuing geometrically complex forms. Instead, it emerges from the complexity of the building’s concept, appearance, and construction and the complexity of the relationships that are fundamental to the digital architectural process (Markovic, 2013). In short, the complexity of its emergent forms is not necessarily a pursued design intent but an intrinsic by-product of the digital process’s contextual engagements (Miodragovic, 2019).

The design assignment is the beginning of the “digital chain” that provides input to the entire digital design process. The demystification of the “digital chain” is done by explaining the components of the process as *links and connectors* (Markovic, 2013), their overlap or divergence from the conventional architectural design and realization, and their manifestation through the practical use in architecture. *Links* refer to differently organized and represented sub-processes in the “digital chain” (see Fig. 1). They include the approach to design assignment, digital design (coding), Realization 1 (production of prototypes) and Realization 2 (production of structure). They occur individually, as a part of the chain, and are influenced by several *connectors*. *Connectors* are derived from the interactivity of complex architectural design and realization processes. They represent disruptions of the chain's linearity instigated by internal and external influences to achieve design assignment and digital design (coding). They include influences from machines, material properties, and fabrication, such as transport tools and assembly requirements. The end of the chain refers to the post-production phase linked to the presentation and confirmation of structures. The “digital chain” in architecture is set as a principle of connected design and realization through coding in terms of the complexity of parallel codes in the completed product.

Furthermore, the more recent context is the communication of the programming parameters through coding. Emerging architecture is also a product of the overlap between technological tools and their context, the connection between multiple complex requirements, and the architect’s approaches and actions with a meaningful connection to the product, i.e. space. The architect is, thus, a code creator for product creation, and the design process is a harmonization of the context and functions as spatial results, forms that fulfil the architect’s aesthetic criteria (see Fig. 2).

At the heart of conventional architectural approaches lies the drawing that predicates the notational sameness between the architect’s intention and the realization of this intention into a spatial object (Carpo, 2011). Here, the architect codified the form. In the new context, the architect encodes the formation of the form, a set of architectural processes from the design intent until realization (Miodragovic, 2019). More recent approaches driven by the technological significance of interactive architectural design and realization require, from a sociological perspective, interactivity between subjects. These include participants in the architectural process, who carry the idea, external and internal influences, and the modelling and implementation of prototypes into the final product, the

architecture. The core purpose of architecture remains unchanged, but its process and the roles of participants change significantly (Markovic, Svetel, Lazovic, 2017).

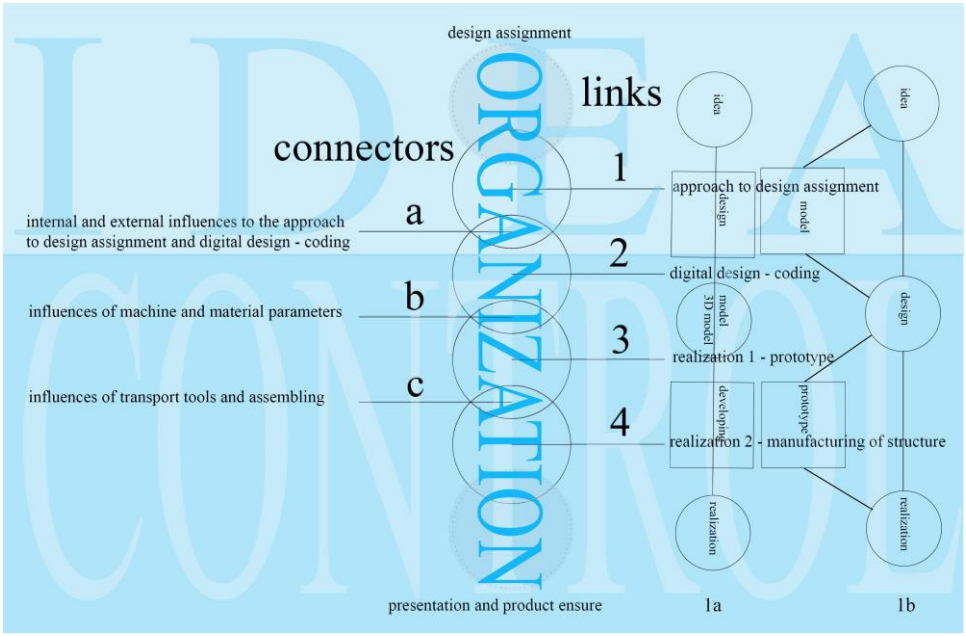


**Fig. 1** Positioning of three dominant characteristics of the architect in the "digital chain" Scheme with elements of the "digital chain" *links* and *connectors* overlapping with 1a Conventional procedural model in design and realization in emerging architecture and 1b Digital procedural model in design and realization in emerging architecture

When discussing network intelligence, the reintegration of the architect into production, and how to approach the principle of "digital chain", "we might begin by noting that design is both a noun and a verb and can refer to either the end product or the process" (Lawson, 2004). Also, "design has been described as making inspired decisions with incomplete information" (Aish, 2005). The digital process provides an ideal balance to a continual architectural process. It embraces coding from idea through prototype to realization as a procedure that simultaneously enables creativity and control. Code allows for different levels of communication in the design process. It concurrently exists as the line, model, and the prototype, as well as concept, detailed design and architecture.

The design and realization parts within a "digital chain" are not separated, but overlap substantially as the fabrication inputs are included in the idea, both at the beginning of the chain and *link* 3 (realization 1 - prototype). In this way, the limitation of the architect's control over production is reduced. Parts of the conventional design are present throughout the chain, indicating that the machine influence is obtained directly at the idea stage. As a result, the idea and realization parts are much closer throughout the design process. The architect designs the process and returns to the realization in two ways. Indirectly, the architect knows the machine and material parameters needed to encode the idea. Directly, in terms

of the architect's control over the products. "The focus is on the idea that the designer introduces to the program and on the possibility of expressing those ideas by using the idea of the program development" (Peters, 2013).

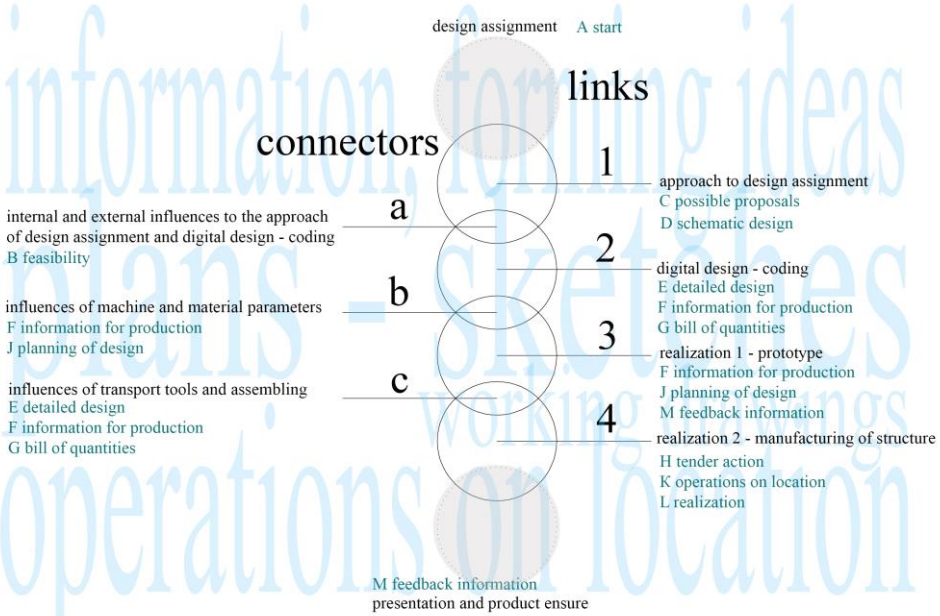


**Fig. 2** Overlap of "digital chain" and Lawson's parts of the design

## 3. Architect in Digital Approach to the Process of Design and Realization in Architecture

Recent research, some of which is mentioned below, opens a scientific field that studies the influence of the digital approach on architecture. It pursues the positioning of the architect's activities and the characteristics of the architect's role in the architectural design and realization guided by digital principles. Today and in the future, the position of the architect in the design process based on the digital approach is to develop innovative, demanding, and thoughtful spatial solutions, regardless of the degree of overlap with conventional principles and activities.

Substantial changes have been observed as a result of the consideration of the "digital chain" principle in the architectural design and realization. Changes are also reflected in the design thinking among architects who have gone through an experimental process and who have pointed out to the overlap with the conventional chain as a necessary characteristic of the processes. Observing the overlap of key point positions and the relationship between the architect, machines and materials with parts of a "digital chain" sets up the current positioning of the architect options in the new approach. It is established as the architect's characteristics

and activities and as a condition for continuity of principle. In conclusion, the dual nature of the architect's necessity is represented in the "digital chain" principle as the functionality of the process and the singularity of the architect's personality. The "digital chain" becomes the conductor of the architect's cognitive activity. Although with a proven linearity, implementing a complex idea requires the architect to connect several process chains. In short, it is fabrication through prototype analysis.

The pivotal responsibility, thus, lies with the architect to engage with digital design thinking and expand the instrumental knowledge of the machine to become an "expert amateur" (Paulos, 2013) who tinkers and hacks both conventional and new architectural design and realization processes. In this way, the architect explores, exposes, encapsulates, and engages context in these processes to derive spatial responses with an effect, a pre-personal, unmediated intensity that generates multiple meanings, thoughts, and emotions (Moussavi, López, 2009) yet expresses relatedness (Miodragovic, 2019).

Architects establishing the characteristics of architectural activities and the regulated positions of a "digital chain" will accelerate the meaningful application of technology in architecture. It will, thus, improve the design and production methodology as it is based on trust and architects' confidence in technological innovation.

### 3.1. Continuity of the process and constant change

Herbert Simon explains the essential characteristics of the designer personification: "Anyone, who invents the courses for acting of action to change the existing situations into desirable, is designing" (Simon, 1996). Simon's statement opposes the prevailing understanding of design as an answer to the question. Instead, it shifts the focus to the person who determines courses of action and whose desirable situation is designed. It, thus, resonates with the question of the architect's decisions in contemporary architecture and what knowledge, besides broad and multidisciplinary, is required.

Necessary effective solutions to the complex context, issue and architectural nature coded through developed technological tools can only be achieved by one medium - the architect. The architect's idea and digital skills fill the discontinuity of the process where product development is not digitally equivalent.

The position of the architect is the main parameter of continuity in the chain that ensures a coherent system. The architect's capabilities are necessary for the creative parts to survive as the vital link in the system.

The architect holds three parts of the control throughout the chain:

1. the verification of solutions between the rational and emotional conditions,
2. the certainty of the process's continuity,
3. the verification of the architect's necessity in the process.

The architect's connection, role and intention in the architectural design and realization are inseparable. The relationship is timeless and mutually dependent.

### 3.2. Machine in the architect's approach

Details are rarely present at the beginning of a conventional design process, partly due to the introduction of machinery. The role of the machine in creative professions is primarily automation. Although automation reduces and expedites activity, especially labour, it also reduces creativity. This is alarming for an architect unfamiliar with the digital process. The "digital chain" addresses the architect's activities with a machine in a changed position

beyond sole automation to include the scope and meaning of the technological development. The strategic position of the architect requires interdisciplinarity, interactivity, and creativity to ensure the interplay between existing elements and programs and to establish flexibility in the controlled system. It also varies depending on the development of tools, design, and implementation. The architect, thus, becomes the designer of a machine tool "specific to every needed process" (Schodek, 2005).

### 3.3. Cooperative expertise and education

Technological change, as the trope of the contemporary context, requires a continuous expansion of expertise, learning, and knowledge exchange within architectural design and realization processes. Another significant factor is the power of influence grounded in the cooperation between stakeholders, conversations between colleagues, clients, customers, public administration, and others with vested interests in the architectural project. The unifying factor among them is the drawing, the main agency of codifying and communicating the architect's idea. Therefore, the architect's connection with the computer in every aspect is the improvement of both factors. As a result, the computer dictates the architect's and architecture's emerging position in business and in the design and realization process. In the future, an architect who does not engage with digital tools will be in the same position as an architect of the past who did not draw.

Lawson states that in architecture dealing with the "digital chain", the problem and the solution are bound together, and the design process depends on the architect's extension of knowledge implemented in the project. The concept formulation, the initial step of the design process, is derived from information gathered from briefing, analysis, synthesis, and evaluation. The subsequent design process steps are based on problem structuring, solutions, preliminary design, realization and details (Lawson, 2004).

Architectural activities are grounded in education, practice, and the link between theory and practice, and vice versa. The architect maintains the continuity of the digital approach as a fluid human-machine-material relationship. The creation and development of design expertise is the quality of each designer and the core thread of each architectural process (Markovic, Svetel, Lazovic, 2017).

This expertise is summarized in a seemingly small but essential part of the project - in the idea. The idea refers to the architect's intuition and senses that bridge problems and solutions. For the architect, it is a tangible concept that visualizes the initial to the final moment of the process. It binds architectural thinking to drawings, which, as Denise Scott Brown says, "are never done as a piece of art, they are done as communication with self and with people around the table" (Lawson, Doorst, 2009). Ideas for architects always need further improvement, review and reinterpretation.

The first step in this process is related to the education of architects in terms of cognitive understanding of the technological part of the process - from the initial idea through digital design to the prototype realization and the finished product. It also extends to the process's organization and control which contributes to the evaluation of the requirements of architecture as a discipline.

The overall consideration of architects' involvement in architectural design and realization of the "digital chain" principle unveils several cognitive and perceptual aspects. They can be defined as art/emotion, logic/organization and prediction/continuity. These aspects accompany the architect's abstract activities, such as vision, cooperation, talent, learning, and listening.

## 4. TRENDING POSITIONING OF THE ARCHITECT

The discussions in the previous sections present the positioning of an architect in architectural design and realization processes based on the "digital chain" principle. The experimental methodological framework, implemented through the subject impact testing, establishes the architect in relation to the key process points as criteria parameters: architecture, materials, and machines. Architect-machine, architect-material and architect-architecture relationships are allied, non-restrictive, and position the subject's tasks within the digital approach. The requirements of the architect's qualities and activities in the "digital chain" are observed based on digital techniques and the contemporary context. They require the recognition and necessary engagement of the digital architectural product, the duality (digital and conventional) of education and the design process, and the architect's experience of the contemporary digital architectural realm.

The paper recognizes the architectural influence in the digital approach to the architectural design and realization processes. Although the digital and conventional approaches to architecture are different and separate, they lack a clear boundary. The continuous approach in the architectural design and realization of the "digital chain" principle is both a challenge and a solution to the complexity of the contemporary context. The architect ensures this continuity as a conductive connecting fluid energy of all parts, links and connectors (Markovic, 2013).

The design and instrumental knowledge of digital technology are steadily spreading among architects. Its impact is felt mainly in large-scale architecture and material innovation and research. On the other hand, due to architecture's unwavering focus on the finished product, its design and realization do not use digital technology as a driving force for further development. Among other things, the *Fabricate 2014* conference laid the foundations for further digital architectural process development. After testing a large number of digital technologies in terms of the use of various constructive techniques, such as robotic fabrication and 3D printing in the service of architectural traditions through prototyping, pavilions and small buildings, the main topic is spreading to real architecture and complex processes and relationships of design and realization. As technological tools cause a change of sensibility and methods to influence the culture of design and construction, architects have to become experts in these areas, as they are needed to solve the problems of transforming a complex digital design model into a built reality (Gramazio, Kohler, Langeberg, 2014). During the closing session of *Fabricate 2024*, arguments were made for using digital technology for humane purposes, placing the architect at the forefront to pursue solutions to environmental problems and natural balance through digitally aligned, empathically guided processes.

The necessary overlap of the digital and conventional approaches is evident in the theoretical discourse and research of the digital approach to architecture. The duality in architectural education and design is present in the thinking of leading theorists, researchers, and practitioners, like Fabio Gramazio & Matthias Kohler (Fabricate, 2014), Mark Burry (Scripting culture, 2011), Mario Carpo (Digital turn in architecture 1992-2012), Robert Aish (Inside smart geometries, Fabricate, 2014) and Anchim Menges (Fabricate, 2014). The overview of their discourse and research can be summarized as a set of guiding principles:

- the digital approach and engagement of the "digital chain" principle overlap with the conventional principle. The differences are in the control of the process and the level of influence of idea realization;
- the architect dictates creativity and process control;

- the architect's participation in the realization process is twofold: firstly, to determine the machine parameters and then to guide the interdisciplinary process as the application creator;
- the digital coding is a set of parameters that defines the new context;
- the architect ensures the digital approach continuity and the "digital chain" principle.

Architectural education demands a dual approach from the very beginning. First, it should demystify both traditional/manual/analog and digital methodologies, bridging the gap between the two. Additionally, it must integrate both theoretical and practice-based design, ensuring that design processes are firmly grounded in hand- and mind-drawing, model-making, and conceptual thinking while remaining open to future technologies, tools, and techniques. Architectural research topics should explore context-specific and personal characteristics through diverse approaches, highlighting the importance of varied outcomes and the development of future architectural profiles. This exploration moderates the establishment of conceptual frameworks, translating these characteristics into visual representations that deepen spatial understanding. In this sense, the contribution of technology is much more about the intention of the project and the process, which is more important than the tools (Burry, 2011).

The aim is to determine the criteria for the complexity of design and realization of emerging architecture as the reason and basis for directing the development, advancement and improvement of the architectural profession and the education of future *digitally born* architects (Palfrey, Gasser, 2008). It also determines the necessary qualities of the architect and tasks within the "digital chain".

As transiency, indeterminacy, and instability become contemporary tropes, the digital approach becomes increasingly relevant for contemporary architecture (Miodragovic 2023). Its experimental approach to architectural thinking and working methods provides a valid methodology that establishes the positioning of the architect. It addresses the architect's behavior in the digital approach regarding innovation, knowledge exchange, experience, and overlays, as well as challenges with the conventional approach (Miodragovic Vella, Markovic, 2024). The experimental approach combines the architect's experience with iterative testing and investigations using prototypes to address problem formulation, provide proof of hypothesis and derive valid conclusions.

The architect's activities are human drivers as 'soft skills' that determine the energy of the architectural design and realization processes of the "digital chain", like intuition, instinct, emotion, intention, choice, decision, control, organization, coordination, creativity, flexibility, communication, expertise and education The activities, and/in relation to digital skills, based on spatial cognition in digital data/code driven processes in architecture also ensure the chain's continuity, efficiency and agency in creating emerging architecture and are the parametric criteria for the possible future algorithmic relationships in the "digital chain".

The accelerated shifts in the contemporary context impinge upon architecture (Cuff, 2012). For the architectural profession to develop and remain relevant, the role of the architect is to ensure things happen and to support others in making things happen. In the digital era, the architect is the project leader of the architectural project (Negroponte, 1995) that addresses and responds to these shifts by embracing new technologies and collaborative work processes (Carpo, 2023).

The emphasis remains on the importance of creativity, depth of personal characteristics, and freedom (Doshi and Hauser, 2024). These soft skills as (and) non-coding elements are

crucial for addressing aspects of design that resist data(fication) within the implementation of the data-driven architecture. Alongside the development of digital fabrication (new machines and materials), these qualities continue to be primary drivers of future research.

## 5. CONCLUSION

Technology is the active agent that moves the culture and society after the causal principle. The relationship between architecture and technology entails the architects' trust and confidence in technological innovation and the acceptance of digital culture as progress, in which the user enables the direct role in designing. The possibility of practical applications of the "digital chain", in architectural design and realization represents, with the architect's influence and control at all steps, the basis for determining the continual digital approaches' qualities. They consist of properly assimilating production parameters within digital design techniques, i.e. the design of the necessary information (Svetel, 2022).

Today, we are faced with the unresolved position of the architect in the contemporary condition of architectural design and realization, instigated by a lack of proficient engagement of technology. The situation expands to include both the future positioning of the architect and the return to the primordial role of the designer who creates and builds. The paper considers the redefinition of architectural processes based on a digital approach of the "digital chain" principle. It does not dismiss the conventional approaches that retain their specific place, albeit with a changed meaning. The paper establishes the discourse of technological process, in which the architect's role is indispensable for the continuity of the process due to its primeval quality of unique observation of the product.

The positioning of the architect in the newer circumstances of the complex relationship of architecture and technology and the practical application of the "digital chain" process approach each new project as an experiment in architecture and construction. The result is unexpected outcomes and incomplete technological explorations.

The open-ended research focuses on the connection between digital design and realization as a translation of code from the design to the machine. It also includes the architect creating new and improving existing applications, as well as producing their digital tools. The network of research results is linked to the network of natural intelligence, as the beginning of the story on the amount of energy in the artificial environment contributes to the contemporary practice to uncritically develop relationships between architecture and technology. It is opening topics, such as:

- the positioning of architect in the digital age,
- the transition of approach to architecture - design and realization,
- design and realization based on data-driven, artificial intelligence and digital literacy,
- sustainability and resilience criteria with the integrity and life of structure - flexibility and emotions of the architectural space.

The paper provides the base for the approach to the problem of non-standard education and training of future architects in the technological realm and in the context of emerging architecture. It argues that introducing new digital tools is inevitable and entirely expected for today's, and especially for tomorrow's generations, born within the digital realm, but with a critical attitude. This generation's acceptance and knowledge of technology will be part of their personality. Architecture is showcase of the society. It moves boundaries by developing and improving architectural approaches, principles and relations, that will

form the future architects. The positioning of the architect in emerging architecture today and in future is showing further impacts of technology on architecture.

The paper emphasizes the specialty and future importance of the personal creative features of the architect and their relation to the spatial atmosphere/ appearance with functional program and material tasks, as well as the freedom in the creation, recognizing it as a non-coding element in the coded (data-driven) digital processes. The study of human drivers is necessary for the future of architecture as a professional/practical and scientific discipline. In particular, it is relevant to the inevitable position of the architect-designer-artist in aesthetic, functional and formal terms in architectural design and realization within the framework of spatial cognition and the digital architectural world.

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# KONCEPT POZICIONIRANJA ARHITEKTE U KONTINUALNOM DIGITALNOM PRISTUPU PROJEKTOVANJU ARHITEKTURE – PRINCIP "DIGITALNOG LANCA"

*Proučavanje razvoja digitalne tehnologije u arhitekturi tokom poslednjih trideset godina daje jasniju sliku mogućnosti istraživanja procesa pozicioniranja arhitekte u arhitektonskom pristupu zasnovanom na kontinualnom projektovanju i realizaciji vođenim digitalnim podacima (engl.*

*digital data driven design) na primeru principa „digitalnog lanca“. Digitalni alati i procesi su se razvijali prateći tehnološki napredak i podržavajući arhitektonsko projektovanje, ali izazivajući uticaj i ulogu arhitekte projektanta.*

*U skladu sa tim, pozicioniranje arhitekte u projektovanju i realizaciji arhitekture je proces koji se neprestano razvija, evoluira, napreduje i menja, ali ne istovremeno sa razvojem tehnologije. Rad ovo istražuje sa fokusom na „digitalnom lancu“, koji je kontinualni pristup koji povezuje arhitektonsko projektovanje i realizaciju kodiranjem procesa i uključuivanjem digitalne fabrikacije (mašine i materijala) i arhitekte u svaki korak stvaranja arhitekture.*

*Metodološki, ovo istraživanje se zasniva na preklapanju informacija (brzog) pregleda principa kontinualnog projektovanja vođenog digitalnim podacima (primer „digitalnog lanca“) tokom vremena i konvencionalnog (analognog) projektovanja usredsređenih na diskurs, ulogu i uticaj arhitekte u sadašnjem i budućem projektovanju i ostvarenju arhitekture. U radu se ne definiše tačna pozicija arhitekte u „digitalnom lancu“ jer se proces i dalje razvija i zavisi i od vrste fabrikacije, uzimajući u obzir i slobodu izbora arhitekte. Međutim, rad identifikuje zone i vrste uticaja ovih procesnih efekata na arhitektu, i određuje neophodnost i ulogu arhitekte kao projektanta u tom procesu.*

*Ovaj rad je usmeren na postavku konceptualnog okvira pozicioniranja arhitekte koji se trenutno razvija, dok bi precizno definisanje pozicije sprečilo arhitektu u sopstvenom izrazu kreativnosti. Međutim, novi istraživački pravci otvaraju naučno polje stalnog redefinisanja procesa projektovanja sa arhitektonskim uticajem u pogledu aktivnosti i karakteristika uloge arhitekte u digitalnim pristupima projektovanju i realizaciji arhitekture.*

Ključne reči: *novonastajuća arhitektura (engl. emerging architecture), pozicioniranje arhitekte kao projektanta, redefinicija procesa projektovanja, kontinualno projektovanje zasnovano na podacima (engl. data driven design)*